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COLOR BANDS DO NOT AFFECT DOMINANCE STATUS IN CAPTIVE FLOCKS OF WINTERING DARK-EYED JUNCOS[1]

DANIEL A. CRISTOL, CATHERINE S. CHIU, SUSAN M. PECKHAM AND JAMES F. STOLL
Department of Biology, Indiana University, Bloomington, IN 47405

Key words: Dark-eyed Junco; Junco hyemalis; *color bands; dominance status.*

Researchers frequently use color bands to identify individual birds in field and aviary studies. However, several studies suggest that band color may influence such variables as territory defense (Metz and Weatherhead 1991), mating success (Burley et al. 1982, Brodsky 1988), sex ratio of offspring (Burley 1986, Hagan and Reed 1988), and mortality (Burley 1985). Band colors implicated have usually been similar to those naturally appearing in the species' plumage, such as red on male Red-cockaded Woodpeckers (*Picoides borealis*). Several authors have argued that certain colors of bands may enhance naturally occurring plumage signals, such as status "badges" or species-recognition cues (e.g., Hagan and Reed 1988, Metz and Weatherhead 1991). Enhancing natural plumage signals with color bands might either increase a bird's fitness (e.g., by elevating social status), or decrease fitness (e.g., by providing inaccurate information about social status or behavioral intent).

Much of the information on the effects of color bands arises from *post hoc* analyses of studies designed for other purposes (e.g., Hagan and Reed 1988, Beletsky and Orians 1989). This has complicated the interpretation of some results because colors were not assigned in a truly random manner, and multiple colors were worn simultaneously. Nearly all published work on band color effects deals with reproductive success or social behavior during the breeding season. Here we present the results of a study designed to test the effects of several band colors on social status of Dark-eyed Juncos (*Junco hyemalis*) during the non-breeding season.

METHODS

We tested four band colors; orange, red-green (bicolored—top half red, bottom half dark green), black, and white. An earlier analysis of dominance interactions among 86 captive, color-banded juncos used for another study suggested that birds wearing only orange had unusually low social status (among eight colors of bands), and birds wearing only red-green bands had unusually high dominance ranks. The mean dominance scores of these band colors did not quite differ statistically, so little could be concluded from the initial study. Birds wearing black bands and white bands in the original study had the second-highest and second-lowest mean dominance scores, respectively. Black and white were also included in the present study because these colors most closely approximate the junco's natural plumage.

All birds wore a single aluminum U.S. Fish and Wildlife Service band on their right tarsus. In addition they wore two color bands on the right and three on the left tarsus. Each test subject wore only a single color. Each test flock contained all band colors. We included a non-color-banded treatment as a basis for comparison in the event that all of the tested colors influenced dominance status. While in captivity and prior to testing birds were outfitted with multiple, randomly chosen colors so that they would become accustomed to wearing five color bands. None of the test colors were assigned during this pre-test period to ensure that no subject had previous experience with them.

We captured juncos with baited mist-nets and Potter traps at six locations around Bloomington, Indiana from early January to late February, 1990. Birds were held in groups of 10–20 in five large outdoor holding cages (measuring 2.5 × 2.5 × 2 m), and provided with mixed grains and water *ad libitum.* The age (first year or adult) and sex of each bird was determined by a combination of eye color, plumage color, wing length, skull ossification, and outer rectrix shape (Ketterson and Nolan 1976, 1982; Yunick 1977; Pyle et al. 1987). Birds were in captivity for two days to several months ($\bar{x}$ = 29 days) before being placed into a test flock.

On the night prior to establishment of a test flock five birds of the same sex and age were removed from the holding cages (one from each cage). Each bird was randomly assigned to one of the five treatments (orange, red-green, white, black, or no color bands), and its color bands were replaced or removed. All five birds were then placed in a cut evergreen roost tree in the darkened test cage (measuring 8 × 2.5 × 2 m), and behavioral observations began the following morning. We established 15 test flocks, each of which was observed for 2–4 hr each morning for 3–6 days. We recorded all dominance interactions around the single food dish from a blind adjacent to the cage. Observations were continued until all pairwise combinations of birds had interacted at least five times ($\bar{x}$ = 15 interactions/pair).

An interaction was recorded as a win for one bird and a loss for the other when one bird successfully displaced another from the food dish. Other types of interactions were rarely observed and were not quantified. We classified one bird as dominant to another using the following arbitrary criterion: a bird was dom-

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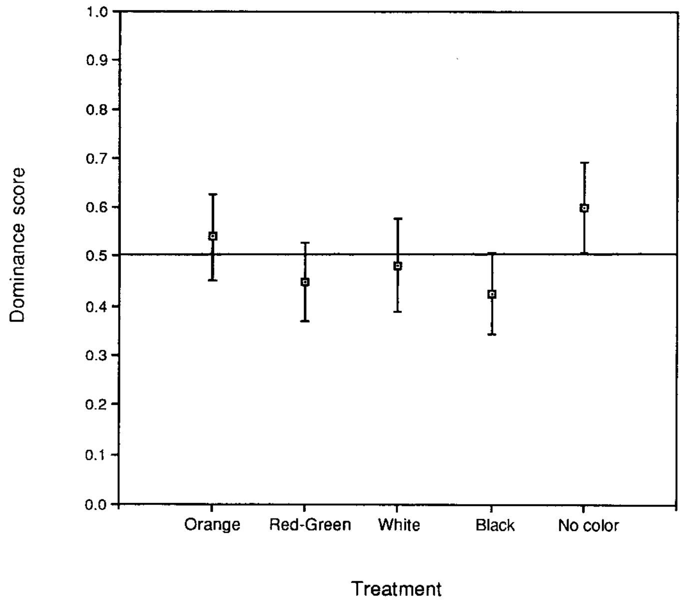

FIGURE 1. Mean (±SE) dominance score for Dark-eyed Juncos wearing orange, red-green, white, black, or no color bands (n = 15 for each treatment).

inant if it won significantly more interactions over an opponent than expected by chance (binomial distribution, $P < 0.05$). Each bird was then given a dominance score, calculated as the number of flockmates dominated divided by the total number of flockmates (always four). In the event that two flockmates were tied in rank (neither had won a significant number of interactions over the other), then 0.5 was added to the numerator of each bird's dominance score. We used an arcsine transformation to reduce the kurtosis of dominance score data before testing with analysis of variance (ANOVA).

RESULTS

In all but one of the 15 test flocks dominance hierarchies were linear, such that bird A was dominant to all flockmates, bird B was dominant to all but bird A, and so on. There were only 12 tied relationships (8%) out of 150 total pairwise combinations of birds. We found no significant effect of treatment on dominance status (one-factor ANOVA df = 4, $P > 0.4$; Fig. 1). The power of the statistical test, or the probability of rejecting the null hypothesis, was 85% for an effect size of 25% (Cohen 1988).

To determine whether other potential determinants of dominance had perhaps overwhelmed the influence of band color (which was unlikely because we assigned colors randomly), we tested for any relationship between treatment and wing length or number of days in captivity. No color was disproportionately assigned with respect to either of these variables (one-factor ANOVA: wing length df = 4, $P > 0.7$; days in captivity df = 4, $P > 0.6$). The effects of age class and sex were not tested because these were matched within each test flock.

DISCUSSION

Juncos lack obvious plumage signals such as red epaulets, so it might seem unlikely from the outset that they would be influenced by band colors. However, blackening the hood and mantle plumage and increasing the amount of white in the tail increases the status of captive juncos, even reversing some previously established relationships (Holberton et al. 1989). Because juncos often expose their white outer rectrices during social interactions, this plumage characteristic could serve as a coverable "badge" similar to the red feathers on a male Red-cockaded Woodpecker.

Although most evidence for band color effects has come from breeding birds the phenomenon should also be considered during the non-breeding season. The mechanism responsible for many of the reported band color effects may be dominance interactions during the breeding season (e.g., Hagan and Reed 1988, Metz and Weatherhead 1991). It is realistic to expect any influence of band colors on dominance status to be apparent at all times of year.

We concluded that none of the tested band colors influenced dominance status. In the future it is still adviseable to perform pilot studies with any band colors that may be biologically relevant to the subjects, such as those appearing as discrete or coverable plumage patches, or to avoid their use altogether. When separate studies are not feasible, assigning bands in a truly random manner will facilitate a *post hoc* analysis of possible band color effects.

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DOMINANCE STATUS AND LATITUDE ARE UNRELATED IN WINTERING DARK-EYED JUNCOS[1]

DANIEL A. CRISTOL
Department of Biology, Indiana University, Bloomington, IN 47405

DAVID C. EVERS[2]
Kalamazoo Nature Center, Kalamazoo, MI 49007

Key words: dominance; Dark-eyed Junco; Junco hyemalis; *differential migration.*

Differential migration by the age and sex classes of a population produces latitudinal segregation during the non-breeding season in many species of birds (references in Ketterson and Nolan 1976). Dark-eyed Juncos (*Junco hyemalis*) wintering in the eastern United States exhibit differential migration, with post-hatching-year birds (hereafter adults) tending to winter south of hatching-year birds (hereafter young), and females south of males (Ketterson and Nolan 1976). Various proximal and evolutionary mechanisms have been proposed as the bases for such differential migrations, most notably: (1) body-size hypothesis—smaller individuals migrate greater distances because of their inability to survive harsh northern winters; (2) arrival-time hypothesis—sexual selection for early arrival at breeding grounds leads to shorter migrations in the territorial sex; and (3) dominance hypothesis—subordinate birds migrate greater distances because of competition with socially dominant birds (for details see Ketterson and Nolan 1976, Gauthreaux 1978, Myers 1981).

The dominance hypothesis predicts that individuals of subordinate age-sex classes should migrate farther from the breeding grounds. This has been substantiated in many differentially migrating species (e.g., juncos, Ketterson and Nolan 1976; waterfowl, Nichols and

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[2] Present address: Whitefish Point Bird Observatory, HC 48 Box 115, Paradise, MI 49768.