Information content of multiple plumage ornaments and habitat contingency in the Cerulean Warbler

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26 October 2011
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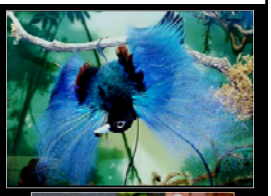
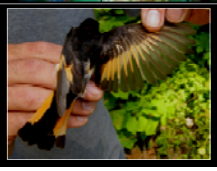
Why do birds display colorful plumage?

- **Theory of honest signals** – to provide reliable information about the **quality** of an individual (Darwin 1871, Andersson 1994)
- Typically males display and compete; females choose
- Males of many species display multiple plumage ornaments (Møller and Pomianski 1993)





Why possess multiple ornaments?

1) Send multiple messages (about different qualities),
2) Send redundant messages (about overall quality), or
3) Because females simply prefer some plumage traits (via runaway selection)

Several mechanisms may allow for multiple messages:

a) Plumage ornaments of different metabolic origin may reflect different intrinsic (production) or extrinsic (social) costs to the individual (Searcy and Nowicki 2005)

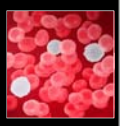
b) Environmental/habitat contingency; environmental conditions may render some signals more effective (Roulin et al. 2008)

What is individual "quality"?

- Any phenotypic or genotypic trait directly related to individual fitness (i.e., survival or reproduction) (Wilson and Nussey 2010)

Measures of individual quality could include:

- Body condition
- Foraging ability
- # of fledglings produced
- Immunocompetance
- Age/survival



Mechanisms of avian coloration

- Can be created by pigments, physical structure, or a combination (Hill and McGraw 2006)
- **Carotenoids** – produce reds, yellows, and greens
- **Melanins –** produce black, gray, brown, buff, and some yellows
- **Structural** – produce blues, some greens, iridescence and glossiness (and whites)

Plumage ornaments

May signal quality in relation to:

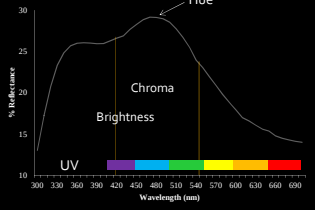
1) Size of feather patch (Senar 2006)

2) Color variables of feather patch (Montgomerie 2006)

a) Brightness – Total reflectance

b) Hue – Wavelength of peak reflectance

c) Chroma – Proportion of reflectance located in a specific region (e.g., Blue-Green) of the color spectrum



Cerulean Warbler blue – Structural

Breast band – Eumelanin

White tail spots – Achromatic

Three research questions

1) Do Cerulean Warbler plumage ornaments act as honest indicators of quality? If so, do they send multiple messages or redundant messages?

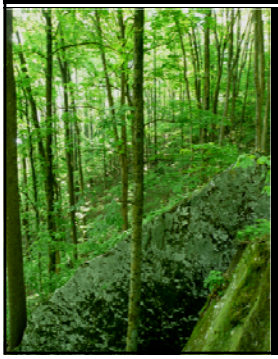
2) Does habitat heterogeneity impact information content of ornaments (and if so, how)?

3) Do birds that display differential elaboration of plumage ornaments inhabit different habitats?

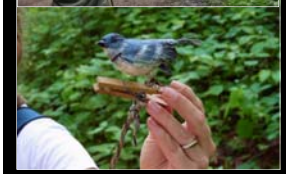
Importance and novelty

- Canopy-dwelling species with unique plumage which occupies unique light environment (Théry 2006)
- Assessed three potential plumage ornaments of different metabolic origin
- Evaluated relationship between habitat conditions and signaling system

Methods - Habitat manipulations
Basal area: 28.4 – 6.5 m²/ha



Capturing CERW

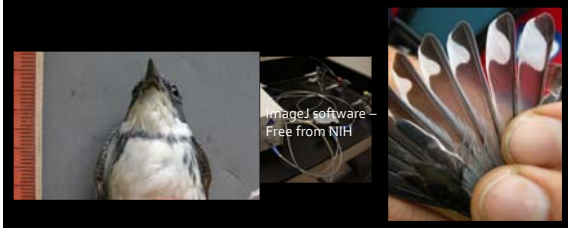







Nest searching and videography


Lab - Plumage measurements



Lab - Quality measurements

Measured

Plumage (Response variables):

- Crown and rump blue-green (435 – 534 nm) hue and chroma
- Breast band width
- Tail white

vs. Quality measures (Predictors):

- Age (SY vs. ASY) - ANOVA
- Current body condition (body mass)
- Condition at molt (via ptilochronology)
- Parental ability (feeding rate/hr/nestling)

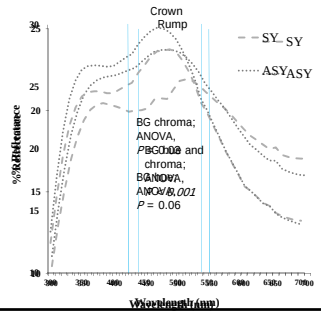
and

- Habitat characteristics (basal area)

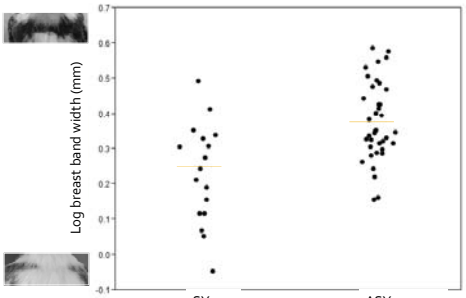
Multiple regression

Results – Redundant messages

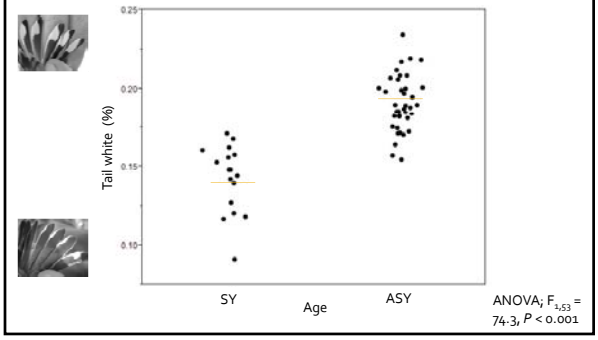
- All plumage ornaments signaled age (SY vs. ASY)



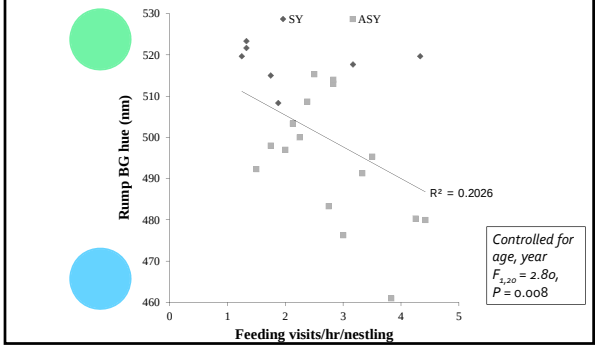
Breast band width



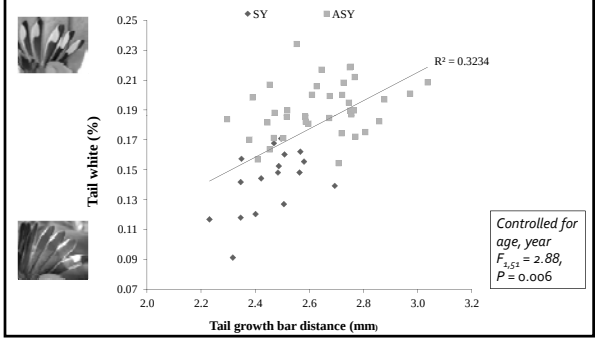
Tail white



Multiple messages – Rump

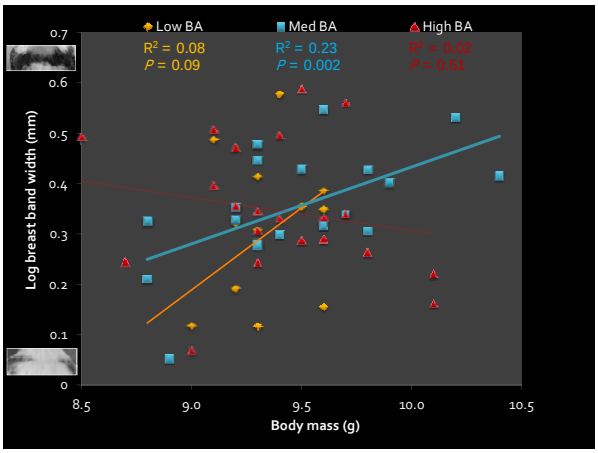


Tail white



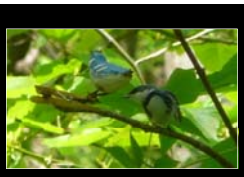
Breast band width

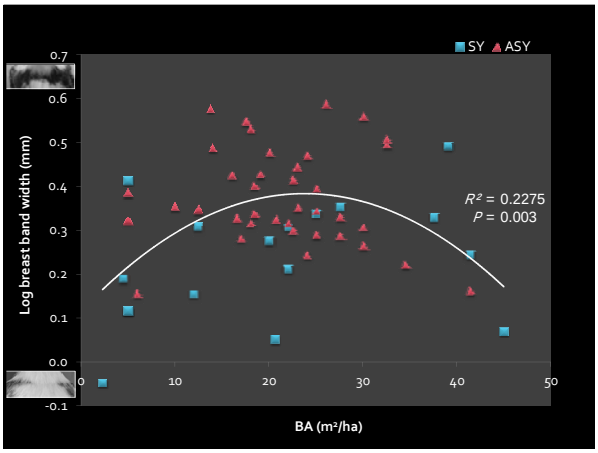
- No initial relationship between breast band and any quality measure, however…
- Habitat contingent relationship between breast band width and body mass (i.e., significant interaction between body mass and basal area)
- Only in **moderately-open** habitats did we observe a significant relationship
- The most densely populated habitat as well



Why might habitat contingency exist?

- Eumelanin production regulated by melanocortin system (Roulin and Ducrest 2011)
- This system of hormones is also responsible for aggressiveness, competitive ability, and stress response
- Melanogenesis is genetically linked to these other traits (pleiotropy)
- Elaboration of melanin plumage signals an ability to compete and respond to stress
- In high-density habitats, individuals with smaller breast bands may be challenged by conspecific males, increasing stress and making it difficult to maintain condition





Summary

- Support for redundant and multiple message hypotheses
- All plumage ornaments signaled age (to differing extents)
- Tail white signaled condition at molt (long-term quality)
- Rump chroma signaled provisioning rate (good parent hypothesis, Møller and Thornhill 1998)
- Breast band width signaled current body condition but ONLY in moderately open habitat, likely related to competitive ability of those birds (related to pleiotropic effects, Roulin and Ducrest 2011)
- Birds with larger breast bands distributed non-randomly; found more often in high-density, moderately open forest

Acknowledgements

- Dr. Lynn Siefferman (ApSU), Michael Butler and labmates (AzSU)
- Committee: Dr. David Buehler (UT), Dr. Pat Keyser (UT), Dr. Todd Freeberg (UT), Dr. David Buckley (UT)
- Funding and support:
- Field assistants: E. Boves, P. Massey, D. Raybuck, J. Piispanen, E. Pankuk, A. Langevin, D. Rankin, R. Gaillard, P. Capobianco

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Questions?