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Carry-Over Effects of Climate on Prothonotary Warbler (Protonotaria citrea) Feather Quality

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Introduction

Ornamentation in animals, namely birds, has intrigued scientists for centuries, prompting a multitude of studies on its evolutionary purpose and relationship with environmental factors.[1]

Coloration achieved through molt, particularly carotenoid-based pigments, requires energy derived from food sources. As such, it can be considered an honest signal of individual condition.[2]

Since climate affects insect abundance, there may be a link between climate conditions during molt and feather quality the following season.

We assessed the relationship between temperature and precipitation during molt and female Prothonotary Warbler (Protonotaria citrea) breast and crown feather reflectance metrics the following year.

Photo: Owen Deutsch

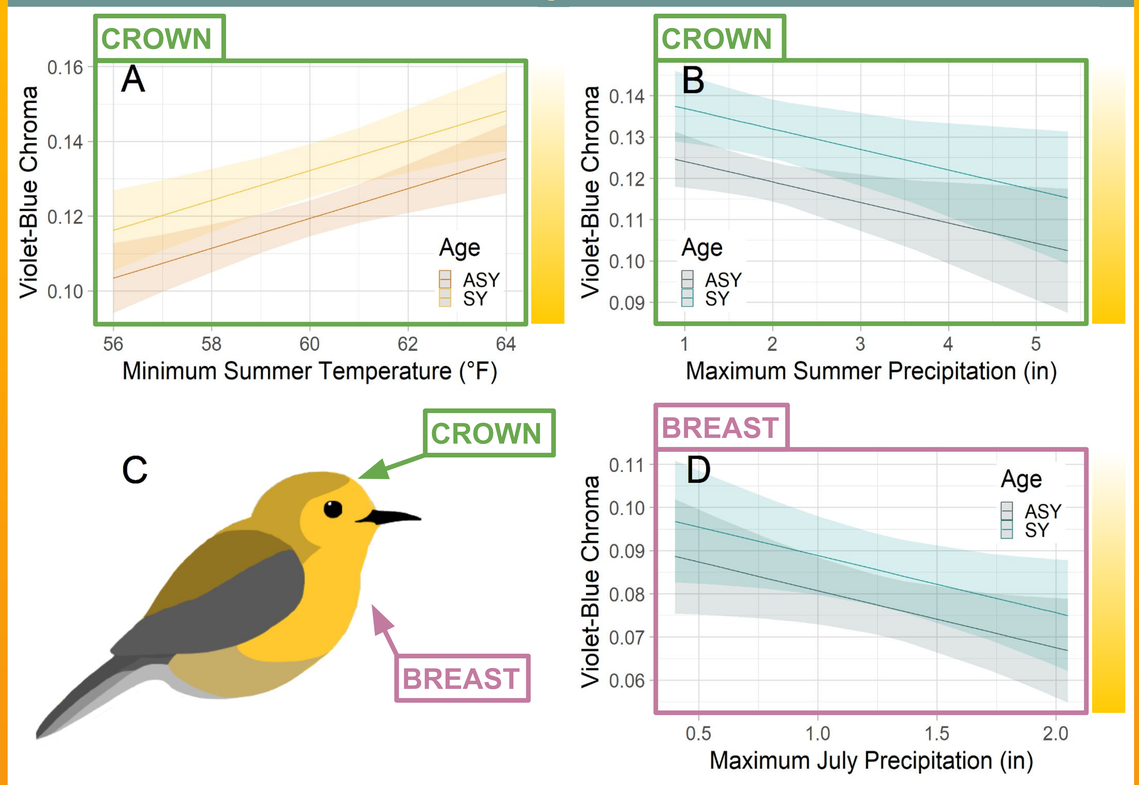
Methods

Field Methods
We collected breast feathers from 474 females and crown feathers from 436 females across 13 years (2010-2023) in a tidal freshwater system in eastern Virginia, USA. Nine breast and six crown feathers were taken from three locations in their respective feather tract.

Feather Measurements
Five crown feathers and five breast feathers were stacked then measured with a spectrometer. Reflectance was averaged from five readings on the breast feathers and three from smaller crown feathers.

Statistical Analysis
We used temperature and precipitation from the previous year during the months when feathers are grown (July/August) as predictors of violet-blue (VB) chroma, ultraviolet (UV) chroma, and yellow intensity in linear mixed effects models with year as a random effect. The top model was determined by Akaike's Information Criterion adjusted for small sample size (AICc).

Figures



Results

The best-supported model for crown VB chroma included summer (July and August) temperature, summer precipitation, and age (SY and ASY) and had an AICc model weight of 0.65 (R^2 = 0.115). Higher minimum temperatures (95% CI = 0.0018, 0.0061) and lower maximum precipitation (95% CI = -0.0095, -0.0004) during July and August the previous year led to lower carotenoid content (Figures A & B). Younger birds exhibited lower carotenoid content than older birds (95% CI = 0.0054, 0.0202).

The best-supported model for breast VB chroma included July precipitation and age and had an AICc model weight of 0.31 (R^2 = 0.060). Higher maximum precipitation in July the previous year (95% CI = -0.0270, 0.0005) led to higher carotenoid content (lower VB chroma values) (Figure D). Younger birds exhibited lower carotenoid content than older birds (95% CI = 0.0021, 0.0141).

Conclusion

Feather quality is positively associated with cooler and wetter conditions during molt.

Specifically, lower temperatures were associated with higher carotenoid content, UV chroma, and yellow intensity. More rainfall was associated with higher carotenoid content but lower values of yellow intensity and UV chroma.

Younger birds were generally less ornamented than older birds.

References

1. Hill, G.E. and McGraw, K.J. (2006). Bird coloration. Function and evolution, vol 2. Harvard University Press, Cambridge
2. Tibbetts. (2014). The Evolution of Honest Communication: Integrating Social and Physiological Costs of Ornamentation. Integrative and Comparative Biology, 54(4), 578–590. https://doi.org/10.1093/icb/icu083

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