

HIF1A Selection and Endurance in Acrobatic Displays

BACKGROUND

In birds that perform acrobatic courtship displays, extended and precise movement and aerial flight is standard (fig. 2).

Hypoxia-inducible factor 1-alpha (HIF1A) is a gene that assists with the regulation of red blood cell production, the formation of new blood vessels, and metabolism.

By investigating variation in this gene among an array of lekking species I can draw correlation between HIF1A gene expression and enhanced endurance ability.

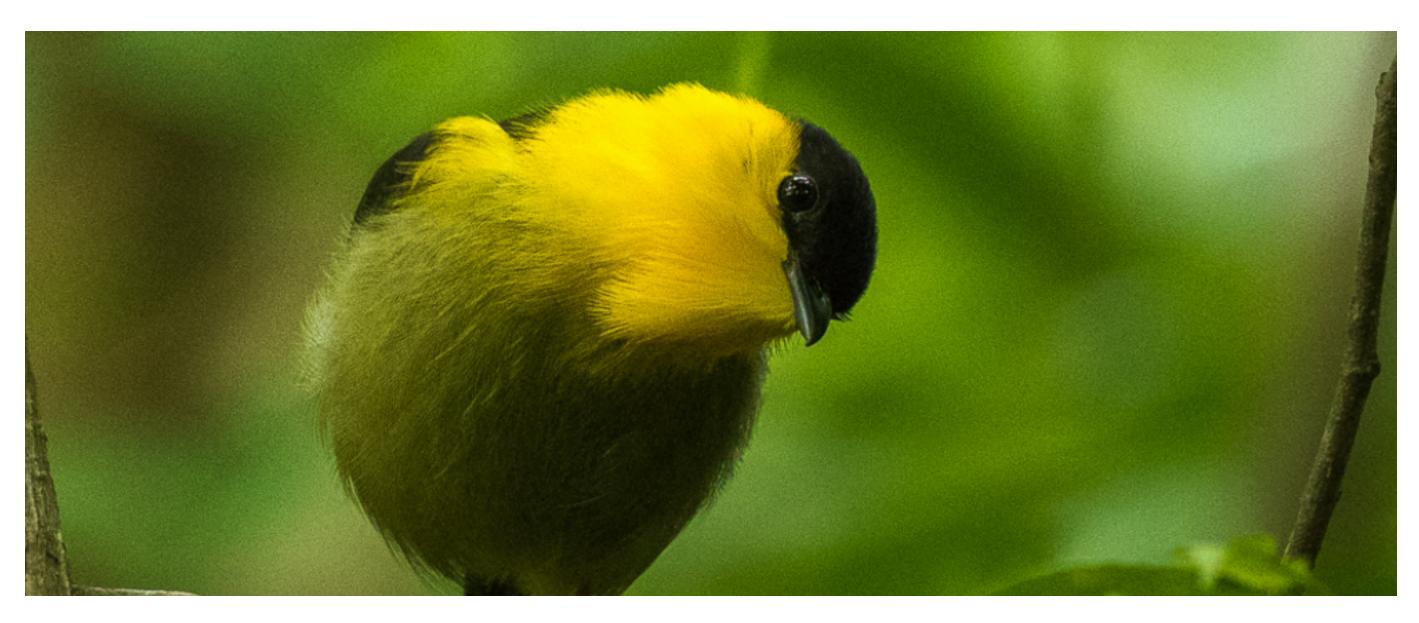


Figure 1: Photo of golden-collared manakin. [Photo by Francesco Veronesi]

Research Question: How does variation in the Hypoxiainducible factor 1-alpha gene contribute to endurance in acrobatic displays?

Hypothesis: The aBSREL test will find evidence of episodic diversifying selection in the phylogeny on the HIF1A gene.

METHODS

- 1. Selected a group of related, courting bird species to create a cross-species analysis.
- 2. Accessed the GenBank record to collect the exon coding sequences of the species.
- 3. Used MEGAX sequence alignment to align the genes using the codon aware MUSCLE algorithm and edited to prepare for testing.
- 4. Ran the aBSREL model, phylogeny (fig. 3), and sequenced gene to test if positive selection has occurred on selected branches.

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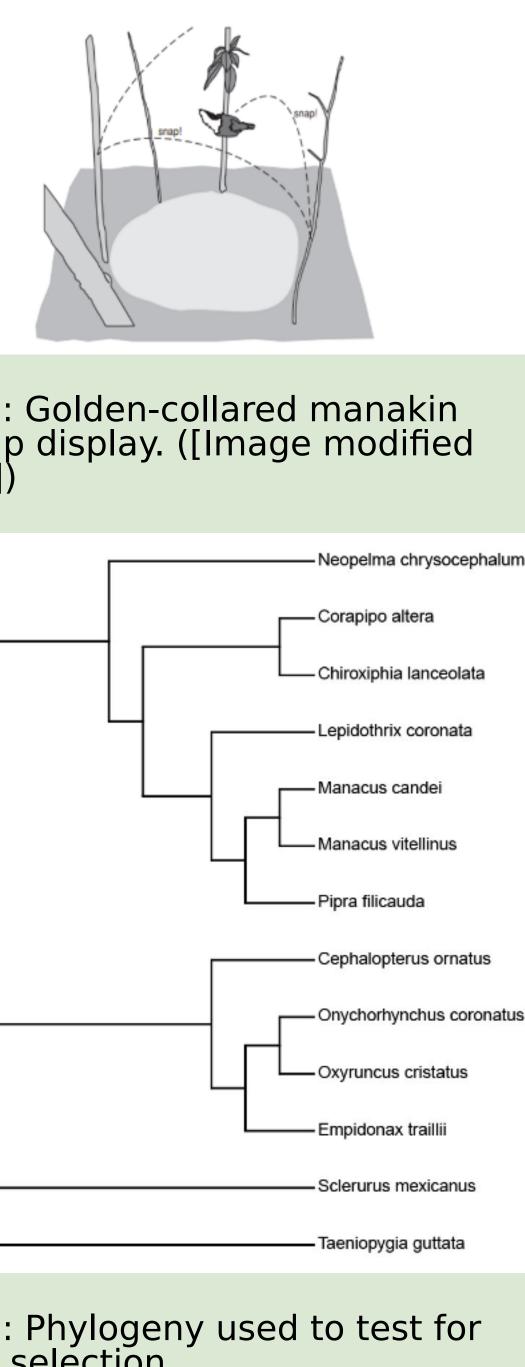
Florida State University, Department of Biological Sciences

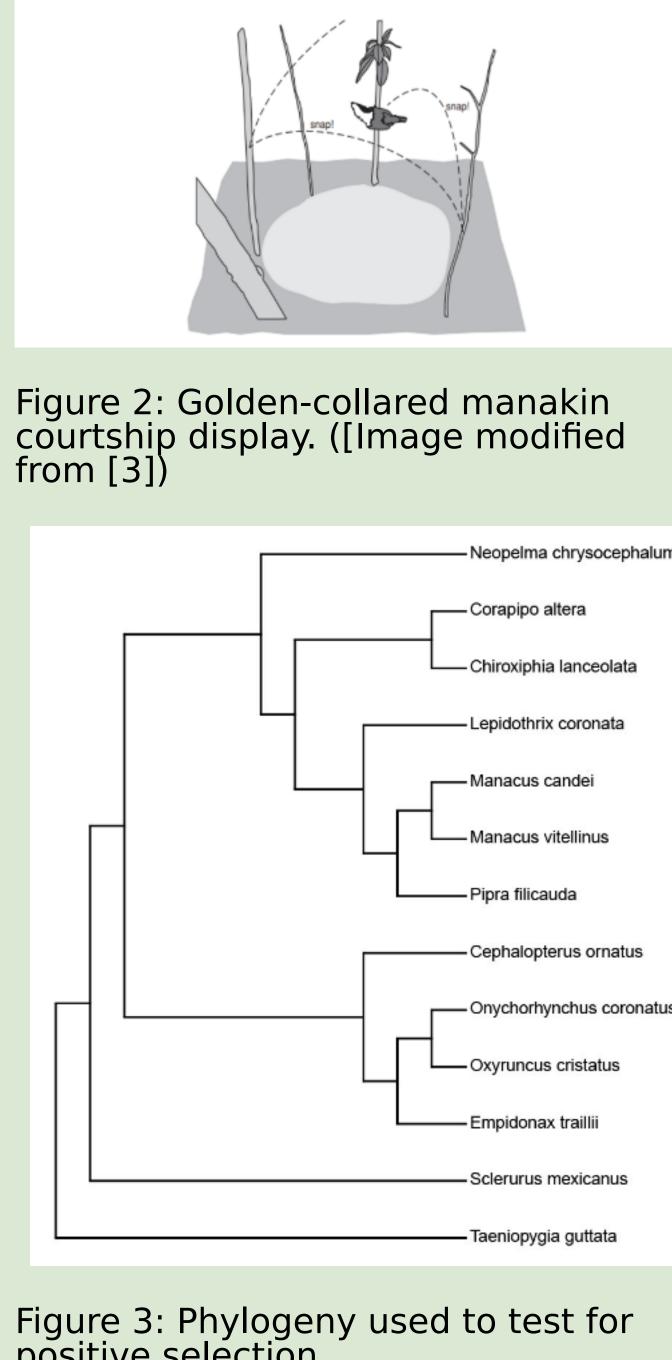
RESULTS

A total of 2 species (*Chiroxiphia lanceolata* and vitellinus) were formally tested Manacus for diversifying selection. Significance was assessed using the Likelihood Ratio Test at a threshold of $p \leq 0.05$, after correcting for multiple testing where the pvalue=1.00.

aBSREL found no evidence of episodic diversifying selection in the phylogeny.

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positive selection.

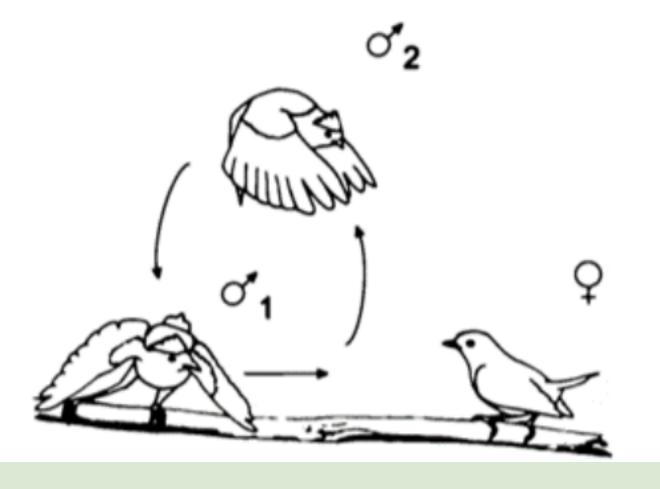


Figure 4: Lance-tailed manakin courtship display. (Image modified from [2])

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Lekking species and all birds likely already require high endurance abilities for flight and would then have little variation on the HIF1A gene.

Managing hypoxic conditions in tissues maintains the life of the tissue; nonsynonymous mutations could otherwise result in death, and not be advantageous.

In future research it could be interesting to observe polymorphisms within a population to gain a better understanding of the advantages of endurance gene polymorphisms.





I would like to thank Connor O'Donnell, Emma Abel, Traysea Malama-Auger, and Kaya Simmons for the weekly discussion meetings and general support.





CONCLUSION

Figure 5 Two lance-tailed manakin males preparing for a courtship display. [Photo by the DuVal Lab at Florida State University]

REFERENCES

1. Döring, F., Onur, S., Fischer, A., Boulay, M. R., Pérusse, L., Rankinen, T., Rauramaa, R., Wolfarth, B., & Bouchard, C. (2010). A common haplotype and the Pro582Ser polymorphism of the hypoxia-inducible factor-1 α (HIF1A) gene in elite endurance athletes. Journal of Applied Physiology, 108(6), 1497–1500.

2. DuVal E.H. (2007) Cooperative display and lekking behavior of the lance-tailed manakin (Chiroxiphia lanceolata). The Auk 124 (4): 1168-1185. 3 Fusani, L., Giordano, M., Day, L. B., & Schlinger, B. A. (2007). High-speed video analysis reveals individual variability in the courtship displays of male golden-collared manakins. Ethology, 113(10), 964-972.

ACKNOWLEDGEMENTS