

Co-option of pre-existing traits as a critical model for the evolution of elaborate male sexual display

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Introduction

How extravagant male displays evolve remains one of the most controversial issues in evolutionary biology.

Currently popular co-evolutionary models (e.g. runaway and some versions of good genes) have weaknesses that have been largely ignored, such as how required genetic correlations are maintained.

Preexisting preferences that typically have not been shaped by selection cannot explain the high level of functional adaptation and complexity commonly seen in male display traits.

Co-option of preexisting male traits has been largely ignored in discussions of the evolution of elaborated sexual displays¹, but is very attractive because of 1) its simplicity, 2) abundant supporting evidence and 3) it provides a plausible explanation for how good genes indicators evolve².

The model

Preexisting male traits may indicate male quality such as heritable good genes. Female preferences for males with high quality variants of these traits increase in frequency due to good genes or possibly good parent benefits for choosing females.

Some types of co-option for sexual display:

1. Traits co-opted from a nonsexual context (e.g. aggressive display, traits that show FA).
2. Courtship traits co-opted for a new function in mate choice (e.g. bowerbird bower).
3. Display elements mimicked from other species (e.g. bird song).

History

A few authors have discussed the co-option of aggressive displays³⁻⁵. There has been sporadic suggestion of the co-option of other traits⁶⁻¹² and of co-option generally⁵.

It is common for traits evolved in another context to be co-opted for use as indicators of male quality

- Fly eye stalks**
Panhuis and Wilkinson 1999, Sivinski 1997
- Barn swallow tail streamers**
Norberg 1994, Møller 1987
- Cichlid nest/bower**
McKaye et al. 2001
- Stickleback nest**
Barber et al. 2001
- Bowerbird bower**
Borgia 1995
- Firefly flash**
Lewis 1999 (see Borgia 2006, *Advances in the Study of Behavior* 36: 249-302)

Arguments supporting the co-option model:

1. Iconic sexual display traits across many taxa are the result of the co-option of traits initially evolved for other functions (see Fig. above).
2. This simple co-option model does not require the difficult co-evolution of traits and preferences due to genetic correlations yet can allow for mate selection based on good genes. Females need only evolve a preference for males with high quality expression of the preexisting trait.
3. Co-option is a common theme in evolution and explains many complex non-behavioral traits e.g. inclusion of endosymbionts as organelles, diversification of gene families, etc.
4. Costly traits already expressed by a male that are co-opted as indicators of male quality can be honest indicators without great added cost. Novel traits that evolve costliness to provide honesty must have these costs subtracted from the benefits they provide and this may limit their evolution.
5. With the gradual evolution of male traits, it is unclear how cost-dependent honesty is achieved when incipient display traits are small and not costly. Co-option of developed and already expensive traits solves this problem.

For further discussion of these issues please see reference 2 available at: <http://www.life.umd.edu/biology/borgialab/> or search Google: Borgia bowerbird

Preexisting traits that may be co-opted

Fluctuating asymmetry (FA) - females use preexisting differences in male traits to choose males with more developmental stability⁸.

Bright male (Hamilton and Zuk) - females use preexisting male differences in plumage brightness to identify disease resistant males².

Male aggression - females use differences in male aggressive displays, e.g. bird song, to identify physically superior males with good genes²⁻⁶.

Chemical cues - females use differences in odor/taste of urine, feces, diffusible molecules to identify healthy or genetically compatible males.

Male constructions - females use differences in nests⁹, bowers^{10,11} etc. to identify more healthy and/or neurologically better males.

Conclusions

The importance of co-option in the evolution of sexual display has been vastly underestimated in the literature.

The preexisting traits model suggests that natural and sexual selection both commonly contribute to the evolution of male sexual display.

The co-option model is attractive because of its simplicity, abundant supporting evidence, and its ability to resolve difficult issues in the evolution of male display traits.

A summary of models:

Requires Genetic Correlation	Produces Good Genes Effect	
	Yes	No
Yes	Good genes	Runaway
No	Pre-existing trait	Pre-existing preference

References

1. Mead, L.S. and Arnold, S.J. 2004. *Trends Ecol. Evol.* 19, 264-271.
2. Borgia, G. 2006. *Advances Study of Behaviour* 36: 249-302.
3. Borgia, G. (1979). In "Sexual Selection and Reproductive Competition" (M. S. Blum and N. A. Blum, Eds.), pp. 19-80. Academic Press, New York.
4. Berglund, A., Bisazza, A., and Pilastro, A. (1996). *Biol. J. Linn. Soc. Lond.* 58, 385-399.
5. Borgia, G. and Coleman, S.W. 2000. *Proc. R. Soc. Lond. B.* 267: 869-874.
6. Panhuis, T. M., Wilkinson, G. S. (1999). *Behav. Ecol. Sociobiol.* 46, 221-227
7. Sivinski, J. (1997). *Florida Entomol.* 80, 142-162
8. Møller, A. P. (1994). "Sexual Selection and the Barn Swallow." Oxford University Press, Oxford.
9. Barber, I., Narin, D., and Hungerford, F. (2001). *Behav. Ecol.* 12, 390-396.
10. McKaye, K. R., Stauffer, J. R., Turner, G. F., Konings, A., and Sato, T. (2001). *Aquariol Aquar Sci* 9, 121-133
11. Borgia, G. (1995). *Ann. Scientist* 83, 542-547.
12. Lewis, S. M., Cratsley, C. K., and Demary, K. (2004). *Ann. Zool. Fennici* 41, 809-921.