GENOTYPE-BY-ENVIRONMENT INTERACTIONS AND SEXUAL SELECTION

Submitted by:

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I certify that all materials in this thesis that are not my own work have been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

ABSTRACT

Genotype-by-environment interactions (G x Es) describe genetic variation for phenotypic plasticity, such that the relative performance of genotypes varies across environments. These interactions have been studied in the context of natural selection for decades, but research interest in the evolutionary consequences of G x Es in sexual traits is more recent. Theory suggests that G x Es in sexual traits could be of fundamental importance to the operation of sexual selection across heterogeneous environments, but empirical research lags behind the theory. In this thesis, I review the current literature on the role of G x Es in sexual selection and identify areas for further research. Using cuticular hydrocarbons (CHCs) in the fruit fly *Drosophila simulans* as a model system for sexual selection, I examine G x Es in trait expression and quantify the effect of these G x Es in terms of sexual signal reliability and the coevolution of male and female sexual traits.

To do so, I use a combination of quantitative genetics and laboratory environmental manipulations. First, I demonstrate that male CHC profile is subject to sexual selection through female mate choice and find some variation in patterns of mate choice across diets and temperatures (Chapter 3). Next, I identify G x Es in male and female CHC expression across diets and temperatures, although G x Es in male CHC profile across temperatures are weak (Chapter 4). I find that G x Es in male CHC expression can cause sexual signal unreliability, as predicted by theory, since male CHCs do not reliably signal heritable aspects of male attractiveness across diets and temperatures (Chapter 5). I also find G x Es in some aspects of female mate choice across temperatures (Chapter 6). In spite of the evidence for signal unreliability and variation in female mate choice across environments, I show that the overall outcome of mate choice is unaffected by G x Es, such that the same male genotypes are attractive across diets and temperatures (Chapters 5 and 6). From my results, it seems likely that females assess male attractiveness based on multiple male sexual signals, so that whilst male CHCs influence mate choice, CHC profile does not necessarily correlate well with overall male attractiveness. I discuss the implications of these results for the evolution of sexual traits and the genetic covariance between male and female sexual traits across environments. The research in this thesis highlights the importance of multivariate studies of sexual selection across environments for a more complete understanding of the evolution of sexual traits.

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AUTHOR'S DECLARATIONS

During the research contributing to this thesis Fiona Caroline Ingleby (FCI) was supported by a studentship from the ESF. All of the chapters presented in this thesis were written by FCI with comments and editing from David J. Hosken (DJH) and John Hunt (JH). The laboratory populations and inbred lines used in Chapters 3-6 were set up by FCI using animals collected by Natasa Fytrou in Greece in April 2010. Further contributors for each chapter are detailed below.

Chapter 2

A version of this chapter was published as a review article in the *Journal of Evolutionary Biology* 23: 2031-2045. FCI, DJH and JH are grateful for the comments of two anonymous reviewers.

Chapter 3

The data in this chapter was collected by FCI, Kristy Flowers (KF), Michael F. Hawkes (MFH), Sarah M. Lane (SML) and James Rapkin (JR). Chris Mitchell provided training for gas chromatography techniques. FCI and JH conducted the statistical analyses.

Chapter 4

The data in this chapter was collected by FCI, KF, MFH, SML and JR. Ian Dworkin (ID), FCI and JH conducted the statistical analyses. FCI wrote the manuscript with comments and editing from DJH, JH and ID. A version of this chapter has been accepted for publication in the *Journal of Evolutionary Biology*.

Chapter 5

The data in this chapter was collected by FCI with assistance from Eoín Duffy and Richa Joag during mating assays. FCI and JH conducted the statistical analyses. A version of this chapter has been accepted for publication in the *Journal of Evolutionary Biology*.

Chapter 6

The data in this chapter was collected by FCI with assistance from Jack Boyle, Nicole Goodey and Claire Young during mating assays. Statistical analyses were carried out by FCI. A version of this chapter is currently in review with *Heredity*.

Appendix 3

This chapter was co-authored by FCI, DJH and JH. A version of this chapter appears in: *The role of genotype-by-environment interactions in sexual selection* (Ed: DJ Hosken and J Hunt). In press with Wiley-Blackwell.