

Sexual selection in *Drosophila simulans*

Submitted by Manmohan Dev Sharma to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Biological Sciences in October 2010

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Signed: Manmohan Dev Sharma

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Abstract

Over the last 100 years sexual selection has advanced into a vast field of theoretical and empirical research. While Darwin's idea of female preference being an integral mechanism of sexual selection is no longer debated, our understanding of female preference is still very limited. For example, we know little about the genetic variation in female preference, and the costs of preference over and above the costs of mating with particular male phenotypes. Additionally, while costs of mate choice are well documented, the benefits of mate choice and their implications are still debated. For example, controversy exists over the inevitability of good gene benefits and their capability to promote adaptive sexual selection. Furthermore, the adaptiveness of sexual selection itself is debated. Our understanding of the traits involved in mate choice is also far from complete. Here I investigated aspects of sexual selection in *Drosophila simulans*, employing a range of behavioural approaches along with artificial selection and environmental manipulations. The findings presented here indicate that female preference can evolve when directly selected on, and that preference itself is not particularly costly. There was also no conclusive evidence for the good genes benefits of mate choice in *D. simulans*. These benefits are considered crucial in promoting the adaptiveness of sexual selection, and although we found sexual selection to be adaptive under some test conditions it was not adaptive in other conditions. Our investigations into traits involved in mate choice established sex-specific genetic variation in cuticular hydrocarbons and the genetic architecture of this trait was found to sex-specific evolution of cuticular hydrocarbons under natural and sexual selection. Additionally, we found that a secondary sexual character, the sex combs was positively allometric – just like most signalling and weapon traits, and there was no association between trait fluctuating asymmetry and trait size. These findings collectively indicate that sexual selection in *D. simulans* is consistent with classical models of this process.

Acknowledgements

I was once told that the road of knowledge is infinitely long, and it is impossible to traverse it without appropriate guidance. Thus first and foremost I offer my sincere gratitude to Professor David Hosken, who has guided me for the past three years, and showed me how to be a scientist. I am indebted to him for nurturing the unrelenting inquisitiveness within me, and for sharing his wealth of knowledge with me. Those of his students who came before me, have often referred to him as the (tor)mentor with benefits (and we are not talking about mate choice benefits) and the evidence collected by me seems to support this view. Equally, my sincere thanks to Professor Tom Tregenza, for providing much needed guidance and support throughout my research. I have no doubt that I have benefited hugely from the knowledge and experience of both of my supervisors and the limitless insightful support they provided.

Thanks also to Dr. John Hunt who not only guided me in the quest for quantitative genetics, but also allowed me to use his most expensive toy – the gas chromatograph and mass spectrometer! My sincere thanks to Professor Nina Wedell, who has not only provided feedback on quite a few problems I encountered in the “fly world”, but has also kindly accepted to be the internal examiner of this thesis.

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I did embark on another long journey as well; this one was away from all my family and friends. The scientific part of this journey was made easier with some help from the “good genes” (and no Dave, I don’t mean it in the classical sense) passed on to me from my grandparents and parents! Thanks are due to my dearest elder brother Sanjive Shukla, to my dear Amrita and my sister Anuradha. All of you should know that thesis is dedicated to you - my family.

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Contents

Title Page: Sexual selection in <i>Drosophila simulans</i>	1
Abstract	2
Acknowledgements	3
Contents	5
Tables and Figures	6
Author's Declarations	10
Chapter One: Introduction	12
Chapter Two: Female mate preferences in <i>Drosophila simulans</i> : evolution and costs	35
Chapter Three: No good genes in <i>Drosophila simulans</i> ?	44
Chapter Four: The genetics of cuticular hydrocarbon profiles in <i>Drosophila simulans</i> . 74	
Chapter Five: Antagonistic responses to sexual and natural selection, and sex- specific evolution of <i>Drosophila simulans</i> cuticular hydrocarbons.....	111
Chapter Six: Role of sexual selection in adaptation to a novel environment: A study with <i>Drosophila simulans</i>	140
Chapter Seven: Sex combs, allometry and asymmetry in <i>Drosophila</i>	179
Chapter Eight: General discussion: Sexual selection in <i>Drosophila simulans</i>	210
Appendix A: Additional information for Chapter Seven	245
Appendix B: Male attractiveness, fertility and susceptibility to oxidative stress are influenced by inbreeding in <i>Drosophila simulans</i>	259
Appendix C: Sexual selection in flies: A comparison of <i>Drosophila simulans</i> and <i>D.</i> <i>melanogaster</i>	288

Figures and Tables

Chapter One	12
Chapter Two	35
Chapter Three	44
Figure 1. Mean (\pm SE) male attractiveness for 6 <i>Drosophila simulans</i> isofemale lines..	51
Figure 2. Interaction plot showing a significant isoline effect on daughters' longevity.....	56
Table 1. Descriptive statistics of offspring longevity and dams' LRS data for attractive (lines 1 and 2) and unattractive lines (lines 5 and 6).....	57
Figure 3. Regression of female and male offspring longevity from attractive and unattractive sires..	59
Figure 4. Interaction plot showing a significant isoline effect on dams' lifetime reproductive success.	60
Chapter Four	74
Figure 1 Typical GC profile for male (a) and female (b) <i>Drosophila simulans</i> . The x-axis shows the retention time and the y-axis the response from the ionisation detector. Peak numbers are indicated (2-19; see Table 1 for details).	80
Table 1 Mean relative contribution of the 18 cuticular hydrocarbon compounds identified on <i>Drosophila simulans</i> , and their retention times, names, formulae and molecular weights.....	81
Table 2 Overall principal component analysis for CHCs. Principal components with an eigenvalue greater than 1 are retained for further analysis. Correlation between CHC	

peak (\log_{10} concentrations) and the three components extracted from the overall principal component analysis are presented as factor loadings.	87
Figure 2 (a) Graph representing the isoline*sex interaction showing how PC1 varies between isolines and sexes. (b) Isoline*sex interaction for PC3. Mean PC1 or PC3 scores for each isoline and each sex are plotted on the respective Y axis.....	89
Table 3 Intraclass correlation coefficient (t) \pm SE for male and female cuticular hydrocarbons in <i>Drosophila simulans</i> . These values have been calculated based on the extracted principal components, and are indicative of the “CHC bouquet” heritability.....	90
Table 4 Intraclass correlation coefficient (t) for male and female cuticular hydrocarbons in <i>Drosophila simulans</i>	90
Table 5 Jackknifed intrasexual genetic correlation (r_G) matrix (male and female CHCs). Male genetic correlations are above the diagonal and females’ below the diagonal.	91
Table 6 Jackknifed intersexual genetic correlation (r_G) matrix (i.e. male vs. female) of CHC principal components (\pm SE).....	93
Table 7 Jackknifed intersexual genetic correlation (r_G) matrix (i.e. male vs. female) of individual CHCs. Heritability (t) estimates form the first column (female) and row (male).	94
Chapter Five	111
Figure 1. The selection protocol employed.	118
Figure 2. A typical GC profile of a male <i>Drosophila simulans</i>	121
Figure 3 The evolutionary response of male CHCs to natural and sexual selection	122
Table 1. The identification of the 24 cuticular hydrocarbon compounds in male and female <i>D. simulans</i> and their relative contribution.....	123

Table 2. Principal Component analysis for female and male CHCs, respectively.....	124
Table 3. Multivariate Analysis of Variance (MANOVA) examining the effect of sexual selection, natural selection and their interaction on the CHC profile of male and female <i>D. simulans</i>	125
Figure 4. The evolutionary response of female CHCs to natural and sexual selection.	127
Chapter Six	140
Figure 1. Outline of the basic experimental evolution procedure (see text for details).	150
Figure 2. An overview of the mating design used while testing for inbreeding depression after > 30 generations of experimental evolution under elevated natural selection.....	155
Table 1: Results of the univariate analysis testing the effect of natural selection, sexual selection and their interaction on the fitness	158
Figure 3: This plot shows the interaction between sexual and natural selection for lifetime reproductive success..	159
Figure 4: Interaction plots showing the trajectory of our elevated natural selection populations under relaxed or elevated sexual selection.....	161
Figure 5: Plot showing the results from the paired <i>t</i> test..	163
Chapter Seven	179
Figure 1: The sex combs of (A) <i>D. simulans</i> , (B) <i>D. melanogaster</i> and (C) <i>D. pseudoobscura</i>	184
Table 1: Details of sex comb tooth number in different populations of three species of <i>Drosophila</i>	186
Table 2: Details of allometry of (log) comb length (regressed against (log) wing length) as calculated by various methods.	188

Table 3: Descriptors of fluctuating asymmetry and measurement error derived from the results of a mixed model ANOVA of sex-comb length, sex-comb tooth number and wing length, for different populations.	190
Figure 2: Major axis regression plots showing scaling association between comb length and body size (wing length) for six <i>Drosophila</i> populations	193
Chapter Eight	210
Appendix A	245
Table 1. Static allometry in various taxa: Primary intent of this appendix is to suggest that the allometry of non-genital secondary sexual characters has not been given much attention, especially within model species such as <i>Drosophila</i>	246
Appendix B	259
Figure 1. The crossing design used to generate inbred and outbred progeny for a single group.....	266
Table 1. Inbreeding depression estimates calculated using family and group data (see text for details).....	273
Figure 2. The fertility of inbred and outbred males (as assessed by counting the offspring from single matings to outbred females) over time..	274
Appendix C	288

Author's Declarations

Chapter One: Introduction

The views presented in this chapter are my own and were developed under the guidance of Prof. David Hosken and Prof. Tom Tregenza.

Chapter Two: Female mate preferences in *Drosophila simulans*: evolution and costs

Prof. David Hosken and Prof. Tom Tregenza provided guidance for planning and structure of all experimental procedures and in preparation of the manuscript. I collected the data, conducted the analysis and am first author on the manuscript. Laboratory assistance was provided by Jack Hollis, Rob Griffin, Connor-Benjamin Parker and Martin Yeo.

Chapter Three: No good genes in *Drosophila simulans*?

Prof. David Hosken and Prof. Tom Tregenza provided guidance for planning and carrying out experimental procedures and in preparation of the manuscript. I collaborated with Jack Hollis and Rob Griffin to collect the data. I conducted the analysis and am first author on the manuscript.

Chapter Four: The genetics of cuticular hydrocarbon profiles in *Drosophila simulans*

Prof. David Hosken, Prof. Tom Tregenza and Dr. John Hunt provided guidance for planning and structure of all experimental procedures and in preparation of the manuscript. Chris Mitchell provided technical support with gas chromatography and mass spectrometry. I collected and analysed the data, and am first author on the manuscript.

Chapter Five: Antagonistic responses to sexual and natural selection, and sex-specific evolution of *Drosophila simulans* cuticular hydrocarbons

Prof. David Hosken Dr. John Hunt provided guidance for the design and structure of all experimental procedures and in preparation of the manuscript. I collected the data, did the analysis and am first author on the manuscript.

Chapter Six: Role of sexual selection in adaptation to a novel environment: A study with *Drosophila simulans*

Prof. David Hosken and Prof. Tom Tregenza provided guidance for planning and execution of all experimental procedures and in preparation of the manuscript. I collected the data, conducted the analysis and am first author on the manuscript. Laboratory assistance was provided by Jack Hollis, Rob Griffin, Nicole A. Goodey, Michael Hawkes, Martin Yeo, Kensuke Okada, Mikael Mökkönen, Sarah Lane, Connor-Benjamin Parker and Leonora Harbord.

Chapter Seven: Sex combs, allometry and asymmetry in *Drosophila*

Prof. David Hosken and Prof. Tom Tregenza provided guidance for development and execution of all experimental procedures and in preparation of the manuscript. I did the data collection and analysis and am the first author on the manuscript.

Chapter Eight: General discussion: Sexual selection in *Drosophila simulans*

The general discussion, conclusions and future prospects presented in this chapter represent my own interpretation of the data presented in the previous chapters, under the guidance of Prof. David Hosken and Prof. Tom Tregenza.