Summary

Given that the net effect of sexual selection on non-sexual fitness is still debated and that sexual selection may have multiple positive and negative effects on non-sexual fitness, further studies of its net effect on naturally selected fitness components are warranted. So far, the results from studies asking whether sexual selection increases population fitness by working in concert with natural selection to aid adaption to novel environments have been equivocal. Throughout this thesis I have further addressed these issues using experimental evolution techniques and provide a broad analysis of how different components of fitness respond to variation in the opportunity for sexual and natural selection.

Despite the long established view that natural selection opposes sexual selection, good genes models of sexual selection propose that natural and sexual selection may frequently act in concert. Both evolutionary processes congruently favour individuals of high non-sexual fitness and thus promote adaptation. In **chapter I** I examine if sexual selection overall, increases non-sexual fitness and if sexual selection aids adaptation to a novel temperature environment. Using experimental evolution I established populations of *Drosophila simulans* in their ancestral temperature environment and in a novel temperature environment. Within both environments four replicate populations in which sexual selection was relaxed (by enforcing monogamy) and four replicate populations in which sexual selection was elevated (by housing flies under polyandrous conditions) were reared. A reciprocal transfer design was utilized to assay several components of non-sexual fitness after 48 and 67 generations of experimental evolution. The results presented in this chapter show consistent evidence for a beneficial effect of sexual selection on non-sexual fitness traits. Females which evolved with elevated sexual selection regardless of their evolutionary

environment demonstrated a higher productivity (reproductive output), egg-adult viability, were larger in size and produced larger eggs. This suggests that sexual selection increased population level fitness by likely acting to remove deleterious alleles as described by good genes models. I also present evidence supportive of the adaptive benefit sexual selection has been proposed to confer upon populations evolving in a novel environment. When productivity was assayed in the novel environment, the productivity of females which had evolved in this environment under elevated sexual selection conditions produced more offspring compared to all other populations which were tested here. I suggest that for some non-sexual fitness components at least, sexual selection had aided adaptation to the novel environment by working in the same direction as natural selection.

Whilst ample attention has been given to investigating adaptation to novel environments with respect to non-sexual fitness traits less has been directed at examining the effects on sexual fitness (i.e. male reproductive success). As per the general consensus, if natural selection opposes sexual selection then in a novel environment it can be expected that males will demonstrate a reduction in their sexual fitness. This is a result of natural selection preventing sexually selected traits from reaching their adaptive optima. This scenario is the focus of **chapter II** in which males from the same experimental evolution populations used for chapter I had their competitive mating success assayed after 55 generations of experimental evolution using, again a reciprocal transfer design. In addition, testes size (which can be considered as a proxy for investment in spermatogenesis and hence post-copulatory sexual selection) was also measured using the same reciprocal transfer method. In contrast to expectations, the competitive mating success of males evolving with elevated sexual selection in the novel environment was highest in the novel

test environment relative to all other populations tested here. This outcome is proposed to have been the effect of evolution in a novel temperature environment. Evolution in this environment may have affected the balance between natural and sexual selection by changing the optimum investment level in competitive mating success. Alternatively it may be due to more effective purging of deleterious mutations in a novel environment in accordance with good genes processes. This study also found that the testes size of males from elevated sexual selection demonstrated a response across test environments similar to what is predicted by ecological models of speciation. The testes from these populations were always larger when assayed in their locally adapted environment and significantly reduced in size when tested in the environment to which they were not adapted. The results presented in chapter II highlight how sexual fitness traits can respond in unexpected ways due to changes in the interaction between sexual and natural selection in a new environment. Furthermore they draw attention to how traits associated with sexual competitiveness may evolve in a manner to potentially facilitate reproductive isolation between locally adapted populations.

Intra-locus sexual conflict, defined as a conflict over the sex-specific expression of shared phenotypic traits or fitness has been suggested to play a major role in modulating interactions between natural and sexual selection. In **chapter III** I investigate how the level of intralocus sexual conflict can vary according to the nature of genetic variation for fitness present in populations. During chapter III standing genetic variance is manipulated by enforcing inbreeding in isofemale lines, thus exposing deleterious recessives. Intersexual correlations for fitness (r_{mf}) were examined at three different time points following initial inbreeding and were found to vary in sign. A positive r_{mf} detected after a short period of

inbreeding signified that alleles with deleterious effects on both sexes were still segregating in the inbred lines at this time. At later time points however the r_{mf} changed in sign to negative suggesting that natural and sexual selection acted in concert to purge such alleles. After purging, standing genetic variation for fitness will be dominated by alleles with sexually antagonistic effects with genetic variation being maintained by intralocus sexual conflict, acting as a form of balancing selection. These results suggest that the sign of correlation depends on whether deleterious recessives with sexually concordant effects were purged or not. This study lends support to the outcome of recent studies which suggest that sexually antagonistic fitness variation segregating in populations is dynamic in nature and that changes in the r_{mf} for fitness depend on if populations are at an equilibrium with regard to mutation-selection or mutation-migration balance.