Abstract

Classical evolutionary theory indicates that rates of adaptive evolution are limited by effective population size (N_e). For pairs of species that are locked in co-evolutionary arms races, these effects of N_e become even more extreme on species with the smaller N_e. Yet, there are species that have persisted over extensive evolutionary time, despite their very low effective population sizes, raising question how these species have been able to survive for a long-term despite their very low adaptability? In this thesis, I use Australian allodapine social host and parasite bees which have substantial disparity in their effective population sizes to address this question. Earlier phylogenetic studies of Australian allodapine host and parasite bees revealed that parasites species have managed to persist over long evolutionary time (since 15 million years ago), and also have tracked their hosts through multiple speciation episodes regardless of their much lower effective population sizes. Allodapine parasite species are locked in tight arms races with their hosts, and are closely related to their hosts. I organize this study into four research data chapters, focusing on host bee *Exoneura,* which is the most speciose genus of the tribe allodapini, and its obligate social parasite *Inquilina,* which displays the highest species richness.

In the first data chapter, I estimate the relative effective population sizes of *E. robusta* and its social parasite *I. schwarzi* through population demographic data collected over several years. My analyses show that the inquiline species have effective population sizes that are about an order of magnitude lower than their hosts.

In the second data chapter, I show that the population-wide sex ratio of *I. schwarzi* is close to parity. I then argue that this pattern of bias is consistent with local resource competition, where inquiline females compete to inherit their natal colony. I also discuss how extremely female-biased sex ratios of *E. robusta* species, combined with overall sex ratio parity in inquilines, may decrease the disparity in effective population sizes between these two species which are locked in an evolutionary arms race.

In the third data chapter, I examine the hypothesis suggesting that parasite lineages with much smaller N_e have been survived for a long evolutionary time because they might have been able to accelerate their rates of molecular evolution. To do so, I compare the rate of

mitochondrial molecular evolution between *E. robusta* and its parasite *I. schwarzi;* and *E. angophorae* and its parasite *I. excavate*. Our finding doesn't support the prediction that rates of molecular evolution in mitochondrial genes are higher in parasite species than their hosts.

In the fourth chapter, I assess how effective population size of *Exoneura* species have changed since late Pleistocene, particularly the last glacial maximum (LGM), using *COI* sequence data and the Bayesian Skyline analyses. Contrasting the timeline of inferred Bayesian Skyline Plots with the glacial history of Australia, suggests that populations of *Exoneura* species are surprisingly unaffected during the LGM and begin to expand with the post-LGM warming period.