The effect of sexual selection on genetic rescue and adaptation rates of small and declining populations

It is clear that our world is changing rapidly due to human activity, for example, climate change, pollution and habitat fragmentation. However, how populations adapt, which populations are most vulnerable and will conservation efforts be effective are considerably less clear. I plan to investigate the evolutionary and ecological effects that sexual selection may have on such factors, with specific focus on populations of conservation concern. Using a well established model organism, the bulb mite (*Rhizoglyphus robini*), and performing experimental evolution in the laboratory I plan to investigate the consequences of sexual selection on population fitness addressing the specific questions:

Q1. What are the effects of sexual selection on the genetic rescue of small inbred populations?

Q2. Are the effects of sexual selection on adaptation rates altered when populations decline in size?

In the first question I will enforce inbreeding to establish small inbred populations with low fitness and low genetic diversity. I will introduce new males to these inbred populations which differ in their degree of sexual fitness, and test whether sexual selection has any effect on the success or failure of genetic rescue. I will estimate introgression rates by performing whole genome sequencing pre and post rescue events and measuring changes in allele frequency which are unique to introduced males. Furthermore, I will periodically perform fitness assays to quantify the effects of genetic rescue on population fitness. This experiment will allow me to assess whether differences in sexual selection influence introgression rates and the genetic rescue of populations over many generations.

In the second question I will use large populations (1000 individuals) which have been artificially selected for or against the expression of a sexually selected trait for multiple generations. By bottlenecking these populations to both 500 and 50 individuals, while simultaneously exposing them to an increased temperature, I will test whether the expression of sexually selected traits influences adaptation rates and whether these relationships are altered when population size declines.

Sexual selection is a fundamental theory of evolution and explains the existence of many elaborate traits we observe in nature, such as peacock tails and deer antlers. Such traits increase the reproductive success of the bearer, but often at the expense of survival. The consequences of sexual selection to population fitness are complex. On one hand sexual selection may increase population fitness because only the fittest individuals with highest quality genes win in the competition for mates. But on the other hand, sexual selection can increase extinction risk because sexually selected traits are costly to produce and conflict between the sexes exists. Understanding these effects under situations which may be relevant to species of conservation concern has however largely been overlooked to date.

The approaches to address both questions are novel and may have important implications to our understanding of crucial evolutionary and ecological processes. Furthermore, these new insights may be important in conservation programmes. For example, helping to identify which individuals will most likely have long lasting positive effects on the genetic rescue of inbred populations is clearly important as habitats become more fragmented and increased human intervention is required for conservation. Genetic rescue has the potential to be a powerful tool; however, it should also be viewed as a last resort. Therefore, if conservation is to be successful, a long term view is required and understanding how adaptation rates may be influenced by ecological and demographic processes is of clear importance.