Polyandry promotes successful colonisation in novel thermal environments

Rebecca Lewis*, Michael Pointer*, Lucy Friend, Ramakrishnan Vasudeva, James Bemrose, Mathew J.G. Gage and Lewis G. Spurgin**

School of Biological Sciences, University of East Anglia, Norwich Research Park, United Kingdom

* These authors contributed equally to this work

** **Correspondence**: L.Spurgin@uea.ac.uk

Abstract

Global climates are getting warmer, with dramatic consequences for population dynamics and species distributions. We have limited understanding of the colonisaton dynamics when species shift to novel thermal environments, and of the evolutionary processes that promote colonisation and extinction. Previous theory and experimental research has showed that polyandry can promote successful colonisation through reducing levels of inbreeding in newly colonised populations. Here we show that polyandry provides substantial benefits in the colonisation of novel, and harsh, thermal environments. Using colonisation experiments with the model beele *Tribolium castaneum*, we founded populations at increased temperature using either singly or doubly mated females, and followed population dynamics for ten generations. We found that extinction rates were XX in polyandrous compared to XX in monandrous-founded populations.

Key words: colonisation, extinction, population dynamics, sexual selection, Tribolium

Introduction

The aim of this study is to test how polyandry affects colonisation dynamics in a novel thermal environment. We placed singly and doubly mated *T. castaneum* females into an empty habitat at high temperature, and allowed populations to grow for 10 generations. We first tested the hypothesis that populations founded from polyandrous females were less likely to go extinct. We then tested the hypothesis that, in extant populations, polyandrous populations exhibited higher population growth rates and levels of fitness. We use these findings to determine how mating strategy and inbreeding interact to affect colonisation dynamics in novel thermal environments.

Materials and Methods

Experimental protocols

All beetles were of our Karakow Superstrain (KSS) [1] and were maintained both before and throughout the experiment on a fodder medium consisting of 90% organic white flour, 10% brewer's yeast topped with a thin layer of oats for traction.

Founding females and their mates were reared and mated under standard conditions of 30°C and 60% humidity. Matings were carried out in 5 cm Petri dishes containing ~20 ml fodder. All females received two matings lasting 24 hours each. In the first round of matings, random pairs of virgin females and virgin males (aged ~7 days post-eclosion) were combined. In the second round of matings, females from the monogamous treatment were re-mated to the same male, who was removed from the dish before being replaced. Females from the polyandrous treatment were mated to a second male, with males being cycled within groups of five females.

After the second mating round, females were transfered to a population container (100 ml PVC screw-cap containers, with the caps pierced for ventilation, and containing 70 ml fodder) and left to oviposit for 7 days at 38°C, after which she was removed and the offspring left to develop. All containers post-mating were marked only with a randomised ID number so that experimental treatment was unknown by researchers during subsequent handling.

After 35 days, the first generation of offpsring were separated from the fodder by sieving, the fodder was discarded and the container and sieve cleaned with ethanol. The number of live adults was counted and placed into fresh fodder to seed the next generation. If >100 individuals were present, 100 were retained and the remainder discarded after counting. Another 7 days later, adults were removed by sieving and the offspring again left to develop. This process was repeated for 10 generations.

Statistical analyses

Results

We tracked a total of 114 *T. castaneum* populations in a novel thermal environmental until extinction, or for up to 10 generations. In the first generation, six populations founded by singly-mated females went extinct (11%), while no populations founded by doubly-mated females went extinct. By generation 10, 18 monogamous populations (33%) and five polyandrous populations (8%) were extinct (Fig. 1A). The effect of treatment on time to extinction was significant (Cox proportional hazards; hazard ratio = 0.250; 95% CIs = 0.100, 0.625; P = 0.003). This effect remained significant after removal of populations that went extinct in the first generation (hazard ratio = 0.352; 95% CIs = 0.134, 0.926; P = 0.034).

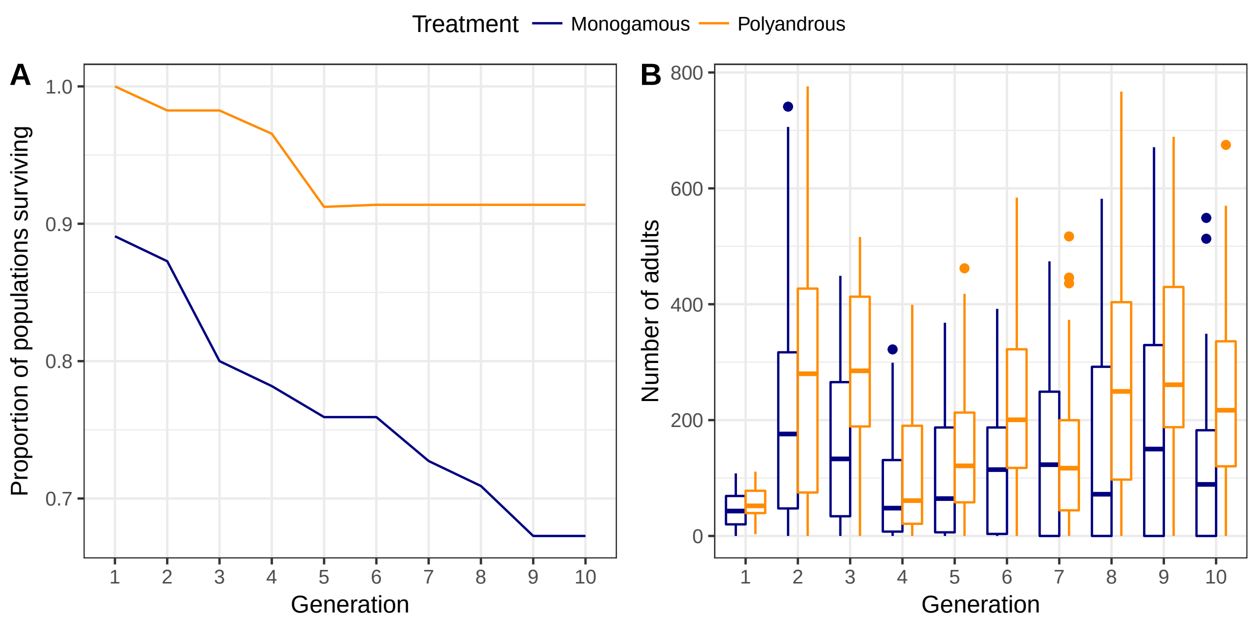

Figure 1 Colonisation dynamics of experimental *T. castaneum* populations founded from singly-mated (monogamous) or doubly-mated (polyandrous) females. **A** Proportion of populations survivng over time; **B** number of adults in experimental populations that survived through ten generations.

Discussion

References

1. Dickinson M. The impacts of heat-wave conditions on reproduction in a model insect, tribolium castaneum. PhD thesis, University of East Anglia; ueaeprints.uea.ac.uk. 2018.