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Project 1. Can plasticity increase male fertility thermal limits?

Tropical species are predicted to be most at risk as they live close to their current upper thermal limits. However, assessments have predominately focused on upper critical thermal limits, the temperature at which adults stop moving or die. I have recently shown that male upper fertility thermal limits – which are much lower than critical thermal limits – are better at predicting species' extinction temperatures and current distributions. This suggests that species may be more vulnerable to climate change than currently projected. Nonetheless, these projections ignore the potential for phenotypic plasticity –the ability for organisms to change their phenotypes under different environmental conditions – to increase male fertility limits. This project will explore whether plasticity can increase male upper fertility limits and whether responses differ across tropical and widespread species of Drosophila.

Project 2. Exploring the potential for endosymbionts to impact vulnerability to climate change

Heritable intracellular bacterial endosymbionts infect many species of arthropods. They have been shown to alter the reproductive biology of their insect hosts (e.g. cytoplastic incompatibility) and some have recently been transferred to mosquitos as a biological control agent to try to control Dengue Fever and other mosquito borne diseases. A handful of empirical studies suggest that some endosymbionts may influence the thermal tolerance of their hosts, but the extent to which their presence may alter the climate change vulnerability of their host is unknown. This project will examine whether bacterial endosymbionts influence thermal tolerance in Drosophila to explore the potential for them to be used as a tool to increase thermal tolerance in other species.

Charles Robin

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Project 1: Gene Drives for Insect Control

Gene drives are being actively studied as a means to control pest insect populations. However there is much to learn about their effectiveness and hazards. This project will investigate some design features of gene drives, mechanisms by which resistance could arise, in experimental populations of Drosophila melanogaster. A potential target for gene drives is Drosophila suzukii a major pest to horticulture that has not arrived in Australia yet. The foundations of a couple of projects are set and we are looking for students to experimentally examine inheritance bias and gene drive potential of several gene drive strategies.

Project 2: Do Ecdysone-kinase like enzymes help white flies prevent the activation of cyanogenic glucosides?

Many plants produce cyanogenic glucosides to prevent insects feeding upon them. These can be considered pro-toxins that are activated when insects feed upon them. Cassava, a major crop of Africa, produces a cyanogenic glucoside called linamarin. However, some white flies (Bemisia tabaci) are major pests of cassava partly because they vector plant viruses. Recently it has been reported that these white flies produce linamarin-derivatives that are phosphorylated. It is speculated that the phosphorylation prevents the degradation of the protoxin and thereby allow the whiteflies to avoid the plant defence. We think we know which gene family encodes the enzymes that phosphorylate linamarin and want to test this hypothesis.

Project 3: Can we revert phosphine resistant beetles to their ancestral susceptible state?

Australian grain growers have excellent access to markets around the world because they have a zero beetle tolerance policy in their exports. Yet there are many species of beetles that thrive in stored grain. For decades the application of phosphine gas to silos and other grain storage chambers have kept the stored grain free of beetle infestations. However, phosphine resistance has arisen, repeatedly, in different beetle species, at the same two loci. The Specifly lab, is embarking on a program to develop transgenic tools for the red flour beetle Tribolium castaneum. We are seeking masters students interested in advancing this program.

Joshua Thia

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Project 1: Population genomics and demography of an invasive pest, the redlegged earth mite

- Redlegged earth mites are major pests of grain and pasture crops in Australia.
- Possible projects would involve the use of genomic data to: (1) Characterise the genetic basis of pesticide resistance, (2) Test for signatures of environmental adaptation, and (3) Model demographic parameters of the Australian metapopulation.
- Background in computer programming is essential, e.g., R and/or Unix, or a keen interest to develop these skills.

Project 2: Co-evolution of insects and their endosymbionts in response to pesticide selection

- The endosymbiotic bacteria living inside insects provide an important source of heritable variation in functional traits.
- Possible projects would focus on aphids and involve a combination of molecular and experimental techniques to study how: (1) Pesticides affect their endosymbionts, and (2) The role endosymbionts might play in adaptive responses to pesticide.
- Bioinformatics component could be added for students with an interest in developing such skills.

Project 3: The role of climate change on the evolution of pesticide resistance

- Increasingly warming climates might affect the evolution and spread of pesticide resistance by enforcing costs on resistance or reshaping the genetic variation underpinning resistance.
- Various project options available depending on personal interests, ranging from predominantly experimental to predominantly analytical (e.g., simulations). Flexible study system (aphids, flies, lepidopterans, computers).