**REPROEVOL: The evolution of Reproductive systems in insects**

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Our project addressed the causes and consequences of variation in the rate at which females remate in insects, and the impact this has on the evolution of male behaviour. We utilized flies of the genus Drosophila as these:

a) Are easy to rear in the laboratory and perform realistic behavioural experiments on.

b) Have a variety of mating systems, including species where females mate once in their life, and species where females mate daily

c) Have excellent knowledge of their genomic constitution from genome sequencing studies.

We made five principle findings:

i) Plasticity in male mating behaviour is not confined to species where females mate multiply.

Previous work by another group had demonstrated that male D. melanogaster would mate for longer with a female when they were maintained with a competitor prior to mating. Extended mating gave males the opportunity to increase their success in competition with later males that mated with the same female. This creates the prediction that mating plasticity should be found in species where females mate multiply, but not where they mate singly. We demonstrated that mating plasticity was not confined to species where females mate multiply, but was also observed (and observed more strongly) in species where females mated just once. This indicates that our initial understanding of male behaviour was either wrong or partial.

ii) Plasticity in male mating behaviour is an evolvable trait.

The study above suggested that plasticity in male mating behaviour might be a ‘universal’ in Drosophila, and not an evolved trait. We tested this in the sap feeding fruit fly *Drosophila bifasciata*, which has a very different ecology from species previously tested. We revealed this species did not show any plasticity in male mating behaviour – males kept confined with females had the same characteristics during mating as males kept separately. We observed that this species is one where there is a physical mating plug that prevents females from remating, and hypothesize this adaptation alleviates the need for plasticity in mating behaviour.

iii) Plasticity in male mating behaviour in species where females mate once is associated with male-male competition

This study was a ‘follow up’ to finding one. Why did males in species where female mate singly mate for longer when maintained with a competitor? We hypothesized that this may be driven by raised intensity of male-male competition in species where females mate just once, which renders them ‘tired’. We tested this by examining whether males in these species showed reduced success at obtaining a mate, either alone or in competition, than males in species where females mate multiply (and thus the intensity of male-male competition is lower). This hypothesis was verified. In species where males mated just once, males that had been in competition with other males obtained a mate less commonly both when given free access, and when in competition with a male that had not been exposed to competition before mating. Thus, we can conclude that male mating behaviour is influence by both pre- and post-copulatory sexual selection.

iv) Thermal environment is a key determinant of female remating rate.

What determines the rate at which females remate and their lifetime number of mating partners? Past work had examined this issue in terms of sexual conflict – manipulation of female behaviour by males – and the benefits of multiply mating to females. In insects, thermal environment is commonly variable – both seasonally and spatially – and likely to change with global climate shifts. We reasoned that, as insects are cold blooded, and activity varies with temperature, different thermal environments would alter female remating rates. We tested the degree to which this was true, examining the effect of temperature during courtship on remating propensity, and the effect of temperature outside of courtship. Both factors were found to influence remating rate, with temperature at the point of courtship being the most important. Overall, a 10 degree rise in temperature was associated with a 3 fold increase in mating rate by females. Thus, thermal environment is a key determinant of mating biology in insects.

v) Male reproductive transcriptome varies between monandrous and polyandrous species.

Where females mate multiply, males experience sperm competition, where their sperm is alongside the sperm of other males in the reproductive tract competing for fertilization. As a result, males have evolved to place a number of small protein chemicals in the accessory fluid alongside sperm that improve their ability in sperm competition. We reasoned that if this logic were correct, the accessory fluid of males in species where females did not mate multiply would be more simple than in species where they did. We examined this through developing genomic methods to profile the genes expressed in accessory glands, where these proteins are produced, and applied these to males from species with different mating systems. We have successfully developed these methods (and have validated them on a species with a polyandrous mating system), and are currently awaiting the profile from males from species where females mate just once.

Project deliverables:

We have to date published three papers on our work, with a further three in preparation. The work has been widely profiled in the press. <http://io9.com/5828809/on-the-paranoid-mating-of-fruit-flies>

<http://www.sciencedaily.com/releases/2011/08/110808104524.htm>

The work informs us about a very basic aspect of insect ecology – mating rate. Mating rate is a very important parameter in insect control using sterile male release, and this project will inform strategies for control in the field.

Details of Dr Lize’s work can be found at: **http://tinyurl.com/6o8lhv7**