Maternal effects in the large milkweed bug

Oncopeltus fasciatus

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

Maternal effects are the non-genetic contributions of mothers (or fathers) towards the phenotype of their offspring. Maternal effects are now well recognised as a facilitator for evolutionary change in offspring phenotypes and life history strategies which can have effects on population dynamics, population divergence and even speciation. Furthermore, maternal effects have been shown to have a heritable genetic basis and that they are genetically variable, which suggests that they contribute to maintaining phenotypic variation. Maternal effects may impede or accelerate responses to selection which has implications for adaptive evolution and making predictions about their evolutionary potential. The importance of their contribution to phenotypic variation and life history evolution has made maternal effects an important consideration in fields such as conservation and population biology, evolutionary ecology and evolutionary genetics.

The aim of this thesis is to investigate if maternal effects can influence offspring life history traits and fitness parameters through maternal resources via the egg. Main questions that are asked include: can maternal effects help facilitate transition to a novel host-diet (Chapter 2); does maternal diet influence egg composition and, if so, does this have an effect on offspring life-history parameters (Chapter 3); is there a genetic basis to egg composition and is there potential for egg composition to evolve (Chapter 4); and are defensive compounds from the diet transferred into the eggs, if so, are these uni- or biparentally transferred and does this offer protection against predation (Chapter 5)? To address these questions we used a specialist insect herbivore, the large milkweed bug *Oncopeltus fasciatus* (Hemiptera: Lygaeidae). In the wild, *O. fasciatus* feed on plants from the genus *Asclepias* (Apocynacea). However, *O. fasciatus* can be reared successfully in laboratories on sunflower seeds *Helianthus annus*. For our experiments we used two populations of *O. fasciatus*, one population has been maintained on dry seeds of *A. syriaca* while the other population has been reared and maintained on sunflower seeds.

The results of Chapter 2 were suggestive of a maternal host-diet effect on egg mass and hatching success, but we did not find evidence that maternal host-diet was significant in influencing a transition to a novel host. In Chapter 3 we found that there was variation in the free amino acid profiles of the eggs between our treatments suggesting that amino acid profiles may be influenced by maternal diet. The results of our multivariate selection analysis to examine linear and nonlinear

(quadratic) relationships between maternal diet and the free amino acid profiles of the eggs suggest that there may be population-specific responses which can influence specific amino acid profiles in relation to hatchling mass. In Chapter 4 we used only the milkweed-adapted population to determine if there was a genetic basis to amino acid profiles in the eggs. We constructed a genetic variance-covariance (**G**) matrix to determine the strength and direction of the relationships between amino acids and to assess the potential for amino acid profiles to evolve. While we found genetic variation for amino acids, and that there was evidence for positive moderate to strong genetic correlations between many of them, we also found evidence for constraints for the potential for amino acid profiles to evolve as evidenced by the calculation of g_{max} (which represents the linear combination of components that has the highest genetic variance and which is the most accessible to evolution). In Chapter 5 we found maternal, but not paternal, transmission of cardenolides into the eggs. However, this did not confer protection of all eggs against predation from larvae of the green lacewing *Chrysoperla carnea*.

Overall, results suggest that for our populations of *O. fasciatus*, maternal effects are significant in influencing early life history traits such as egg mass and hatchling mass. However, we did not find any significant effects on other offspring life history or fitness parameters that we measured. This may be surprising as positive, and negative, effects of non-genetic contributions of females (and males) to their offspring has been widely reported in many taxa. The patterns and implications of maternal resource allocation and their effects on offspring life history evolution are explored and discussed, as are the limitations of our experimental designs. I hope that this research can be used to stimulate further investigations into maternal effects and the relationships between host-plant, maternal allocation strategies and life history evolution.

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