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Investigating The Potential For Inter-Generational Effects Of Temperature Stress On Blow Flies

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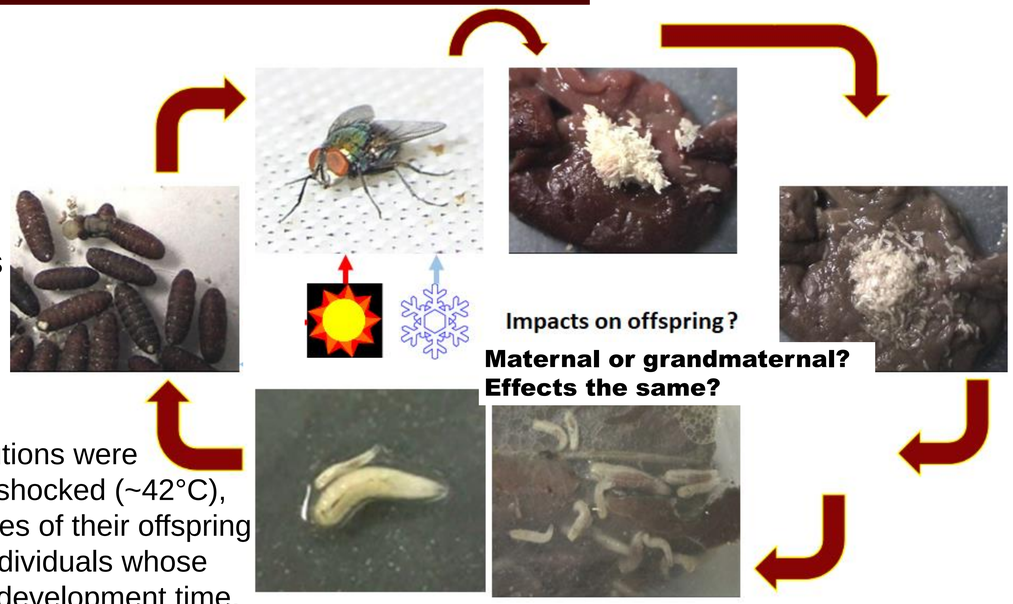
Abstract

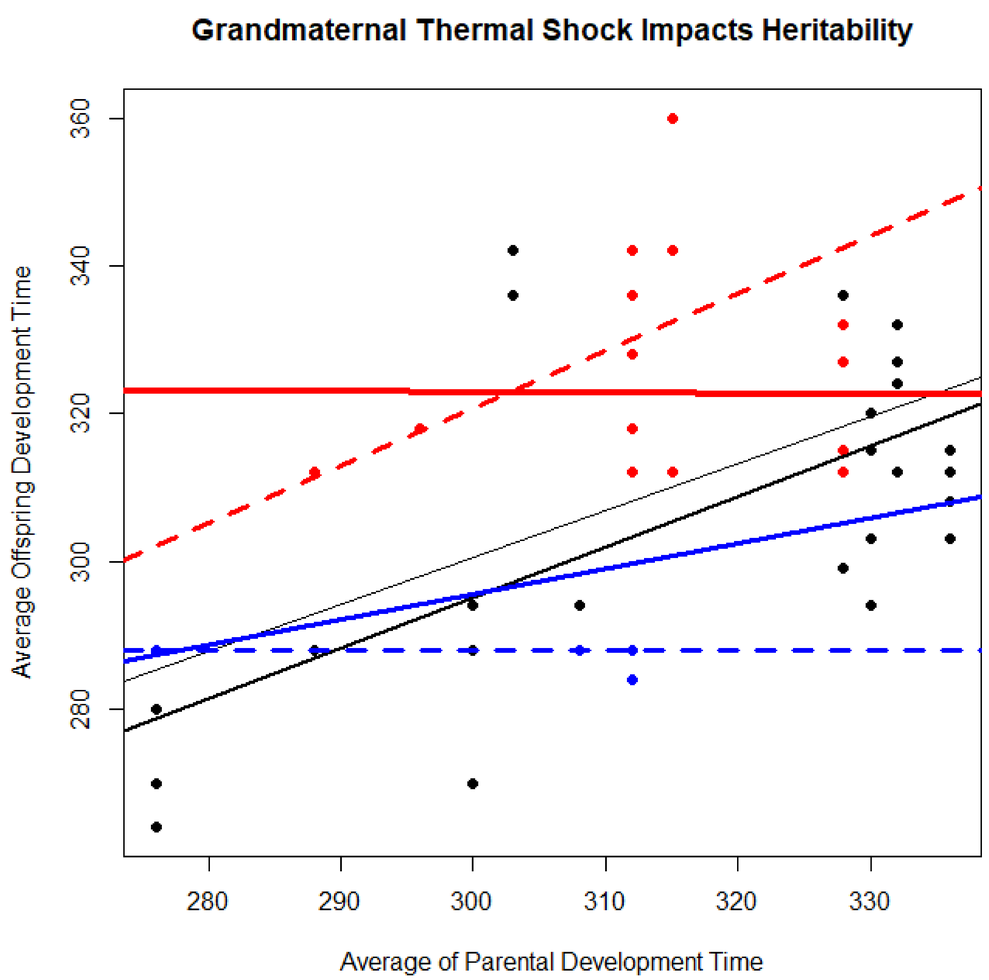
Blow flies (Diptera: Calliphoridae) are important species that help recycle nutrients into the ecosystem by consuming animal remains. The rate at which they develop and their size can impact the rate at which this process occurs. This lifestyle also has important consequences for disease transmission and forensic science. Currently, little is known about inter-generational impacts of blow fly responses to temperature. For instance, if a female blow fly experiences cold stress, does she provision her eggs with different products to enhance their chance of survival? Does the regulation of her offspring's genes change epigenetically? These experiments will test if this happens, which could impact our understanding of seasonality in blow fly biology and associated impacts on nutrient recycling, pathogen movement, and forensic science.

Methods

The blow fly *Cochliomyia macellaria* was raised at 25°C, 70% humidity, 14:10 L:D and development time distributions were observed. Then, females with observed development times were either cold shocked (~2°C) for one hour, heat shocked (~42°C), or remained unshocked. They were then mated to males of known development times and the development times of their offspring were recorded. Offspring from these matings were also bred to one another to observe development times of individuals whose grandmothers were exposed to thermal shock and to determine if the exposure altered the genetic influence on development time.



Results



Trait regressions in the experiment are on the left. If the slope of parent – offspring regressions is 1, heritability (h^2) is 1 and additive genetic variation (important in evolution of traits) is the main driver of trait expression. If the slope and h^2 are 0, then additive genetic variation (thus the environment and non-additive genetic contributions) are the primary drivers of trait expression (Conner and Hartl 2004). These are parent – offspring regressions for the first two trials of the experiments. The thin dark line is the slope for all experimental data regardless of thermal shock. The thick dark line is for control crosses. Red represents heat shock. Blue represents cold shock. Solid red / blue lines represent effects of maternal thermal shock. Dashed lines represent grandmaternal effects on h^2. Overall and with controls, h^2 is between 0.6 and 0.7 (a moderate contribution of genetics). Maternal heat shock and grandmaternal cold shock are associated with h^2 of ~0. Grandmaternal heat shock appears to deepen the genetic contribution to trait expression (h^2 >0.7), while maternal cold shock lessens it (h^2 <0.4).

Discussion

While more trials are ongoing, it appears as if there are maternal and grandmaternal effects on development time in *C. macellaria*. These effects appear to differ in their impact depending on whether heat or cold is the source of thermal stress.

Maternal effects in flies are expected (Jenkins and Hoffmann 1994, Jann and Ward 1999), including for heat shock protein contributions to the egg in *Drosophila* (Lockwood et al. 2017).

Intergenerational epigenetic effects are unexpected in flies as they lack enzymes that play a role in common forms of epigenetic inheritance (Marhold et al. 2004); though there are some recent examples (i.e. Kuranakar et al. 2019).

These observations imply seasonality in blow fly development times, with some seasons yielding fly development rates that are more due to genetics than other seasons.

Citations

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* Our valued colleague Cliff Spiegelman unexpectedly passed away this summer. His contribution to our prior collaborations will always be valued and he will be missed. This T3 grant was precipitated in part by his interests in epigenetics in our system.