Inconsistent effects of developmental temperature acclimation on low-temperature performance and metabolism in *Drosophila melanogaster*

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ABSTRACT

**Question:** Does acclimation to developmental temperature consistently affect metabolism and low-temperature performance when measured in different laboratory and field assays?

**Hypothesis:** Developmental acclimation reflecting naturally fluctuating thermal conditions consistently increases different components of performance at low temperatures and results in a clearly defined metabolic signature.

**Organism:** The fruit fly *Drosophila melanogaster* acclimated at different temperatures during development under semi-field and laboratory conditions

**Field site:** Mt. Rothwell (37°53’22”S, 144°26’25”E) and laboratory facilities at the University of Melbourne, Victoria, Australia.

**Methods:** Adult females developed under four different constant or fluctuating thermal conditions were tested for their ability to locate food under cool conditions, recovery from a cold shock, or fecundity. Flies from the different acclimation regimes were characterized biochemically using NMR-based metabolomics.

**Conclusions:** Flies reared at constant benign temperatures were more fecund at all acclimation temperatures. In contrast, flies reared under fluctuating natural or laboratory conditions were more successful in locating food under cool conditions in the field, while constant cool rearing conditions led to high cold resistance. The fluctuating- and low-temperature rearing conditions resulted in a similar metabolic profile, while the 24°C rearing profile was distinct and showed a lack of plasticity. The effects of developmental acclimation on performance are therefore complex and cannot be captured through experimental comparisons of constant environments.

**Keywords:** beneficial acclimation hypothesis, cold tolerance, fluctuating vs. constant temperatures, life-history traits, metabolomics, plasticity, semi-natural conditions.
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