Eco-physiological aspects of cold tolerance plasticity in Drosophila suzukii

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Abstract

The Spotted Wing *Drosophila* (SWD) is a major invasive insect pest of soft fruits in Europe. The knowledge gap regarding its low temperature biology and overwintering strategies prevents the construction of accurate population dynamics models. In particular, the mechanisms by which SWD modulates cold-tolerance during lifetime in response to environmental variables (i.e. acclimation response) are still largely unknown. We studied how pre-exposures to low temperature during ontogeny and/or during adult stage affected subsequent cold tolerance of SWD. We found that acclimation induced high plasticity in cold tolerance of SWD. Here, we synthetically report some of the physiological mechanisms underlying these acclimatory responses (based on Omics data). Metabolomics revealed that metabolites with supposed cryoprotective functions (sugars, polyols) were mobilized in acclimated SWD. Time-series metabolomics showed that acclimated SWD had the capacity to maintain metabolic homeostasis under cold stress situation, while chill-susceptible counterparts did not; this suggests that acclimation allows metabolic robustness. Loss of metabolic homeostasis in chill-susceptible phenotype may be partly explained by cold-induced protein degradation that releases free amino acids (through proteasome activity), a phenomenon not observed in acclimated flies. Lipidomics showed that acclimated flies modulated phospholipids composition of membranes, likely to better deal with cold-induced rigidifying effects. As found in many species, SWD exposed to prolonged cold stress displayed a typical and gradual loss of ion homeostasis (K+). RNAseq comparing cold acclimated vs control SWD detected extensive transcriptional changes and functional annotation found many GO-terms, among which the most significant were linked to ions' transport. Altered expression of genes functionally related to ions transport during cold acclimation is likely an adaptive response to prevent loss of ions homeostasis at low temperature. Collectively, these data show that SWD possesses a great toolkit of strategies to deal with low temperature stress via plastic and physiological responses.

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