Sex makes them sleepy: host sexual morphs induce parasitoid diapause

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Abstract

When organisms coevolve, any change in one species can induce phenotypic changes in traits and ecology of the other species. To overwinter successfully, parasitoids have to synchronize their life-cycle to both abiotic conditions and their hosts' phenology. Although winter diapause in parasitoids has been shown to be mostly induced by photoperiod and temperature, seasonal host phenotypic variations may also constitute induction cues. To test the effect of host reproductive strategy on parasitoid diapause induction, we used a holocyclic clone of the pea aphid *Acyrthosiphon pisum* producing both asexual and sexual morphs, the latter being only present at the end of the growing season. *Aphidius ervi* parasitoids from contrasted climatic origin (harsh *vs.* mild winter areas) were allowed to parasitize each morph and developing parasitoids were next reared under either fall-like or summer-like temperature-photoperiod conditions. We next examined aspects of the host physiological state by comparing the relative proportion of forty-seven metabolites, using gas chromatography, and lipid reserves in sexual and asexual aphid morphs. We found that sexual aphids are cues *per se* for diapause induction; parasitoids entered diapause at higher levels (19.4 ± 3.0 %) when developing in oviparous aphids than in viviparous aphids (3.6 ± 1.3 %), but only under summer-like conditions. This pattern was only observed in parasitoids from the harsh winter area since no diapause was observed in the other population under summer-like conditions, suggesting local adaptations to overwintering cues. Metabolomics analyses suggest parasitoids' response to be mainly influenced by sexual aphids' physiology, with higher proportion of polyols and sugars, and more fat reserves being found in oviparous aphids. Our results underline strong coevolutionary processes between hosts and parasitoids in their area of origin, leading to phenological synchronization.

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