The origin of castes in social insects: examining the diapause ground plan hypothesis in bumblebees

Author(s): Etya Amsalem, Etya Amsalem

Institution(s): Pennsylvania State University, USA ; Pennsylvania State University, US

Diapause is a critical period and bottleneck for survival in both social and non-social insects. While the physiological and molecular changes associated with diapause are well conserved, the pathways regulating diapause in social insects are hypothesized to have been co-opted to regulate the divergence of castes, characterized by sterile workers and fecund queens that differ mainly by their size and ability to diapause. The Diapause Ground Plan Hypothesis (DGPH; Hunt, 2006), proposes that caste differentiation is driven by an ancestral diapause genetic and physiological signature, with sterile workers exhibiting a reproductive-like signature of a solitary ancestor that emerged early in the season, and queens exhibiting a diapause-like signature of a solitary ancestor that emerged late in the season. Previous studies have demonstrated the DGPH in Polistes wasps but its applicability to other species remained unclear. Bombus impatiens represents an excellent system to examine the DGPH due to its annual life cycle. The worker force is built progressively, and gynes, which are 3 times larger than workers, are produced towards the end of the season and are capable to survive the winter. We compared gynes, early and late emerging workers across the colony life cycle and hypothesized that early-emerging workers have a larger reproductive capacity, while late-emerging workers and gynes show a diapause-signature, evidenced by increased tolerance to cold, larger lipid reserves, and a genetic signature of genes regulating diapause such as insulin-related and storage proteins. Our findings partially support the DGPH and highlight intrinsic factors in queens that are important for survival during diapause. Bumblebees provide critical worldwide commercial and wild pollination services; however, populations of many bumblebee species are declining. An improved understanding of diapause will be necessary to conserving of both wild and managed bumblebee populations.