When Climate Changes, Bees Do Too: Characterization of Pollinator Foraging Behavior Under Heat Stress Using Remote Motion-Activated Imaging

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Bees are essential to global food production, pollinating roughly one-third of the foods consumed worldwide (USDA, 2023) with an economic value of $200 billion annually in the U.S. from pollination services. However, pollinator populations are declining due to multiple environmental stressors, including climate change and increasing temperature extremes. Understanding how extreme heat affects pollinator foraging is therefore critical for protecting agricultural productivity and ecosystem stability. This study investigates how elevated temperatures influence pollinator activity patterns. Utilizing motion-activated imaging systems, 135,464 pollinator images were collected. The images were analyzed using RStudio and Desmos to evaluate relationships among pollinator taxa, time of day, and thermal conditions. The analysis revealed distinct differences in taxonomic responses to temperature and daily activity periods, as well as defining optimal conditions for the taxa studied. Results support the hypothesis that pollinator activity declines as temperatures approach extreme heat levels. Activity periods were inversely correlated with extreme temperatures and strongly associated with both temperature and time of day. Density analyses identified an optimal activity temperature of 32.54 ± 2.14 °C, with significant variation in thermal and temporal preferences among pollinator taxa. These findings provide evidence that extreme heat alters pollinator foraging behavior and may contribute to reduced pollination services under future climate scenarios. Understanding these temperature thresholds and bee response is a critical step toward developing adaptive strategies to support pollinator survival during thermal stress to ensure food security for all.

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