ABSTRACT

HOT AND HINDERED: HOW HONEYBEES COORDINATE COLLECTIVE THERMOREGULATORY BEHAVIOR UNDER DIVERSE ENVIRONMENTAL CONDITIONS

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Social animals may be poised to deal with environmental challenges because they can engage in collective behavior. As animals face unprecedented environmental change caused by human activity, understanding the mechanisms that influence collective behavior will be vital in predicting the future of biodiversity. Western honeybees (*Apis mellifera*) are eusocial insects that rely on the coordination of thousands of workers to accomplish various tasks and maintain optimal colony conditions, lending themselves to be advantageous models to study how individuals impact collective outcomes. One such necessary task includes maintaining internal colony temperatures for proper brood development. In response to heat, honeybee workers called fanners will coordinate fanning, a behavior where bees stand still and rapidly flap their wings in a specific orientation, to generate airflow through the colony. Fanning is dependent on both thermal and social contexts, as fanners rarely fan on their own when heated but will fan in the presence of other workers under rising temperatures. However, the robustness of the fanning response even after physiological perturbation at multiple social scales in the honeybee remains underexplored. Elucidating the mechanisms that drive fanning despite perturbation will lend further valuable insight into how social animals collectively coordinate under more ecologically relevant conditions. Here, I hypothesized that the social environment drives individual and group-level resiliency against environmental pollutants, using the honeybee fanning response as a model. In my experiments, I use oxytetracycline, a relevant apiculture antibiotic and environmental pollutant known to interfere with honeybee biology, to disrupt fanning and explore the mechanisms that drive the behavior. I find that at the individual-level, the colony environment has the largest contribution in shaping learning behavior. At the group-level, efficient interaction dynamics are key for fanning performance, and that even under partial perturbation, fanners can still coordinate a group fanning response by adjusting social positionality. Finally, overall colony dynamics may be robust against minor perturbations. These results demonstrate that fanning emerges from interaction-level dynamics and remains robust at the group and colony scale, even when individual bees are physiologically perturbed. This work provides a mechanistic framework for linking individual-level disruption to collective resilience in animal societies.