FIRE ANT THERMOREGULATION

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Temperature is a central factor in the life of ant colonies. Colonies experience substantial changes in temperature from season to season, from day to day and even from minute to minute. Because temperature controls colony metabolism, some ants have become very effective thermoregulators.

This paper will focus on two key points of fire ant (*Solenopsis invicta*) thermoregulatory behavior: 1) mound building and 2) temperature tracking. In order to study the thermal benefits of mounds, I measured mound and soil temperatures at four depths (2, 15, 40, and 90 cm) for a year. At 2 cm, mounds averaged 7 °C warmer than the surrounding soil, at 15 cm the difference was 2-3 °C, and at 40 cm the difference essentially disappeared. The importance of the sun in heating the mound was demonstrated by the fact that mounds only provided a thermal benefit on sunny days. On cloudy days, mounds were almost the same temperature as the surrounding soil.

Fire ants regulate colony temperature by cycling up and down in their mound as it warms or cools. In order to study temperature tracking behavior, two colonies were excavated every other week for a year, one in the early morning and the other around midday. The distribution of workers and brood in mounds changed seasonally. Generally, brood were placed in the mounds whenever temperatures were higher than the surrounding soil but less that 35°C. Laboratory studies showed that well-fed colonies consistently preferred brood temperatures of 30-32 °C.

Fire ants clearly invest considerable time and energy in regulating colony temperatures, but how much does this behavior actually benefit colony growth? This question can be addressed by modelling the accumulation of developmental degree-days under different behavioral alternatives. The value of temperature tracking behavior was modeled in hypothetical colonies that tracked temperature changes and those that remained fixed at either 2 cm or 40 cm in the soil column. The results of this model indicated that tracking behavior provides a 13% yearly benefit over remaining stationary at 2 cm and about a 30% yearly benefit over remaining stationary at 40 cm.

The value of building a mound was evaluated by comparing the accumulation of degree-days for colonies living in the soil and colonies living in a mound. Both types of colonies were assumed to track changing temperatures. The thermal benefit of mounds was approximately 10% per year. This seems rather small, but mounds only provided thermal benefits on sunny days when temperatures were within the growth window. Most of the thermal benefit of mounds occurred in the spring and the fall when they warmed into the growth range but the surrounding soil remained too cold for brood development.

Temperature tracking behavior and mound building behavior, taken together, provided approximately a 23% thermal benefit compared to a hypothetical colony that did not thermoregulate but remained stationary in the soil.

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