Changes in feeding and defensive behavior of *Pseudomyrmex spinicola* with time of day and ambient temperature

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Abstract: Pseudomyrmex spinicola is an obligate mutualist with *Acacia collinsii*, which it defends aggressively from intruders in exchange for food and shelter. We predicted that *P. spinicola* feeding activity would vary over the day with temperature fluctuations, but that patrolling activity and response to disturbance (i.e. services provided to the plant host) would remain constant. We found ant activity was greatest in the mid-morning due to increased feeding, whilst the patrolling activity and response to disturbance stayed fairly constant over the diurnal cycle.

Key Words: Acacia collinsii, *diurnal cycles, patrolling behavior*

Introduction

The *Pseudomyrmex spinicola* ant is an obligate mutualist with the tree *Acacia collinsii*, aggressively defending it against herbivores and encroaching vines, in exchange for food provided via nectaries and protein-rich Beltian bodies (Janzen 1983). Presumably, the threat of herbivory or vine encroachment is relatively constant throughout the day-night cycle, requiring constant patrolling of the tree's branches and consistent defensive response to intruders. Feeding activity, however, may be linked to ant or plant physiological responses to time of day and/or temperature.

We examined how the feeding and defensive behaviors of *P. spinicola* varied over the diurnal cycle. We predicted that feeding behavior would vary with time of day and temperature, while patrolling and defensive behavior would remain constant.

Methods

From 12-14 January, we studied ten 2-5 m tall *A. collinsii* trees colonized by *P. spinicola*, chosen haphazardly in secondary-growth dry forest 1 km southeast of the OTS station in Palo Verde National Park, Costa Rica. We sampled each tree at seven times of day: 06:30, 09:30, 11:30, 12:30, 13:00, 16:00, and 22:00. One branch with visible Beltian bodies and one without Beltian bodies were haphazardly chosen at eye level on each tree for repeated sampling. On each branch, at each time, we counted the number of ants feeding (on nectaries and/or Beltian bodies) and the number patrolling (i.e. moving on branch without eating). To test response to disturbance, we counted the number of ants crossing an imaginary line circumscribing the trunk at its junction with a branch (either with or without Beltian bodies, chosen haphazardly) for 20 s before, and 20 s after tapping the branch (2 cm from the trunk) with a pencil, 20 times. The temperature was recorded at the base of each tree using a Physitemp thermometer.

We used an index of ant activity that was standardized separately for each branch. For the counts described above we calculated the proportion of the number of ants feeding on a given branch at a given time to the sum of ants counted feeding on that branch over all seven counts. Patrolling activity was indexed similarly. Response to disturbance was quantified as the percentage change in ant abundance following disturbance. Time and temperature correlations were tested with linear regressions while one-way ANOVAs were performed for ant activity indices across the seven time samples.

Results

The mean index of overall ant activity varied significantly over the course of the seven counts (ANOVA, $F = 19.21$, $df = 8$, $P < 0.0001$), tripling between 06:30 (0.04; SE = 0.01) and 09:30 (0.52; SE = 0.08), and falling dramatically by 11:30 (Fig. 1).

The proportion of ants feeding also varied significantly between counts (ANOVA, $F = 41.81$, $df = 9$, $P < 0.001$), increasing from 7% to 80% from 06:30 to 09:30. There was no significant change in the number of ants patrolling over the seven counts ($F = 0.36$, $df = 1$, $P = 0.80$).

Temperature correlated strongly with time of day ($r^2 = 0.95$, $df = 3$, $P < 0.0001$); and a 3-degree polynomial fit of ant activity to temperature placed peak ant activity between 32 and 35 °C ($r^2 = 0.77$, $df = 3$, $P = 0.025$). There was no correlation between response to disturbance and time of day ($r^2 = 0.002$, $df = 1$, $P = 0.78$) or temperature ($r^2 = 0.02$, $df = 3$, $P = 0.81$). The presence of Beltian bodies on branches did not affect ant activity (ANOVA, $F = 0.001$, $df = 1$, $P = 0.99$), relative feeding activity (ANOVA, $F = 0.40$ $df = 1$, $P = 0.53$), or response to disturbance (ANOVA, $F = 0.15$, $df = 1$, $P = 0.70$).

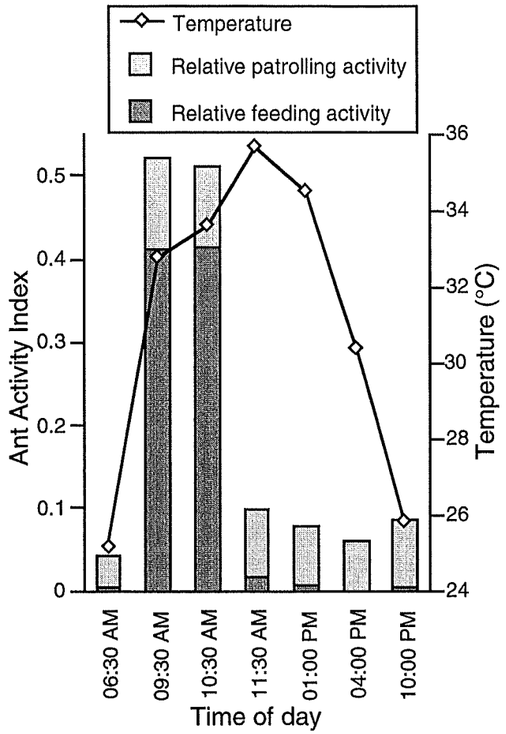

Fig. 1. The mean activity index of *Psuedomyrmex spinicola* ants on *Acacia collinsii* trees (n = 10) and mean ambient temperature at seven times of day in Palo Verde National Park, Costa Rica. Ant activity (feeding or patrolling) was indexed as the proportion of the number of ants counted on a sampled tree's branch at one time to the sum of ants counted on that branch over all seven counts (see text for details). Temperatures were taken at the base of each tree at each count and then averaged for each time of day.

Discussion

We found that *P. spinicola* activity varied with the time of day and temperature. Since the number of ants patrolling remained fairly constant over time of day, variation in activity was mainly due to high feeding activity between 09:30 and 11:30. Further study could investigate whether this increased feeding activity is more attributable to physiological responses of the ants to time and/or temperature, or to diurnal variations in the amount nectar provided by *A. collinsii*.

That patrolling and response to disturbance remain fairly constant throughout the day supports our original hypothesis. Such behavior may prevent opportunistic herbivores from feeding on *A. collinsii* at any time of day or night, and provides additional evidence for ant behavior that benefits the host tree.

Literature Cited

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