Ant avoidance and escape from antlion pit traps

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Abstract: One common predator of small ground-dwelling invertebrates in the dry soils of tropical forests is the larvae of *Myrmeleon* spp. (order Neuroptera), commonly known as ant lions. These insects excavate pits in the soil in order to trap and consume ants and other small invertebrates. We determined if certain species of ants are better at evading ant lion traps or escaping the traps once captured. We tested two types of ground-associated ants (one large and one small) and two mainly arboreal species of acacia ants (one large, *P. spinicola*, and one small, *Crematogaster* sp.) in trays containing ant lion pits. The large ground ant had the lowest rate of capture and the highest rate of escape. Both species of acacia ants performed poorly in avoiding the traps and never escaped once captured. We concluded that large size and ground-habitat association were important factors allowing ants to avoid *Myrmeleon* predation.

Key Words: Crematogaster *sp.*, Myrmeleon *spp.*, *predation*, Pseudomyrmex spinicola

Introduction

Dynamic relationships between predators and prey often result in adaptations that may facilitate prey capture or predation avoidance. Predators may maximize feeding efficiency by tailoring their predation strategy to easily captured and abundant prey, while prey can evolve characteristics that help them avoid predators common to their environment. Such strategies can be observed in interactions between *Myrmeleon* larvae (order Neuroptera) and their ant prey.

Myrmeleon larvae, commonly known as antlions, build small (1 - 4 cm in diameter) but steep conical pits in the ground to trap prey. These predators build their traps in a variety of soil types (Perlroth et al. 1995) and consume a variety of ant species (Janzen 1983). Antlions cannot directly control the type of ant that falls into their pits. However, the location of their pits and the effort they use to subdue prey may affect their rate of capture of different species of ants.

The environmental adaptations of different ant species may affect their risk of antlion predation. Certain species of ants could be more susceptible prey for antlions due to their inability to negotiate around antlion traps and escape a trap once they have fallen into it.

We hypothesized that the size, speed and behavior of different ant species would affect their risk of capture by antlions. We predicted that ground-associated ants would fall in the pits less often than tree-associated species. Possible reasons for this advantage include familiarity with terrain and ground predators and any associated morphological characteristics (such as longer legs) that might accompany these adaptations. We also predicted that larger ants would escape more often from pit traps than smaller ants due to their ability to climb out of traps.

Methods

This study was conducted on 11 January 2002 near the OTS Biological Station, Palo Verde National Park, Costa Rica. We created two "antlion gauntlets" to test the survival and escape rate of four ant species. We used four ant types – two ground ants (one large, one small) and two arboreal ants (one large – *Pseudomyrmex spinicola*, and one small – *Crematogaster* sp.). Both of the ground ants were common in disturbed areas near human habitation. The large ground ants were ~7 mm in length with long legs and were generally found alone or in small groups. The small ground ants were ~3 mm long and were commonly found in large aggregations moving along trails near the station. The large and small arboreal ants (~6 mm and ~3 mm long, respectively) were acacia ants that spend most of their time in their host tree but are known to spend some time on the ground clearing vegetation (Janzen 1983, Smith 1983).

We estimated the speed of each type of ant by disturbing three individuals of each type and recording the average time it took them to move a certain distance (~0.5 m). Arboreal species were tested for speed on the acacia tree trunks, while ground ants were tested on cement paths or walls.

Two plastic trays (37 x 52 cm) were filled with sand (5 - 8 cm deep), and antlions were placed in each tray where they built pit traps overnight. Both the sand and the antlions were collected from sandy areas along the road near the station. The trays had 15 and 18 pits, respectively. The sand trays were kept shaded and invading insects were removed.

We introduced 10 individuals of each of the four ant species to each tray. Ants were placed one at a time in the center of a tray and allowed to roam freely within it. We recorded the time elapsed before an ant fell into a pit (if applicable), whether it escaped or survived, and the time it took to leave the gauntlet (i.e., when an ant climbed out of the tray). An ant was considered to survive if it climbed out of the tray or was still present after 10 min in the tray without being trapped in a pit. A new trial was not begun until the previous trial ended. To prevent antlion satiation, captured ants were removed before they were eaten.

Differences among the four ant species in capture and escape rates were analyzed with chi-square tests. A one-way ANOVA was used to analyze for differences among time to capture and survival between ant species. These data were square root transformed to meet assumptions of parametric tests. All means were compared with Tukey-Kramer tests.

Results

The four ant species differed in their frequencies of falling into ant lion pits, escaping antlion pits and surviving the trials (χ^2 = 9.24, df = 3, P = 0.03). The large ground ants fell into ant lion pits significantly less often than the other three types of ants (Fig. 1). There was no difference in frequency of falling into pits among the three smaller ants (χ^2 = 0.15, df = 2, P = 0.93).

Ant types differed in their rates of escape after falling into antlion pits (Fig. 2). Large ground ants escaped more often than small ground ants, while no arboreal ants escaped (χ^2 = 17.10, df = 3, P < 0.001).

The time to capture and time to escape also differed among ant species (Fig. 3), as did time to survival. Ground ants were caught ($F_{3,43}$ = 46.81, P < 0.001) or escaped ($F_{3,30}$ = 19.14, P < 0.001) the tray more quickly than large or small arboreal ant species.

The four ant species varied in size and speed (Table 1). The small ground ant was fastest at 11.3 cm/s, while the small arboreal ant was the slowest at 0.9 cm/s.

Discussion

Ant size was the most important factor in both avoiding falling in traps and es-

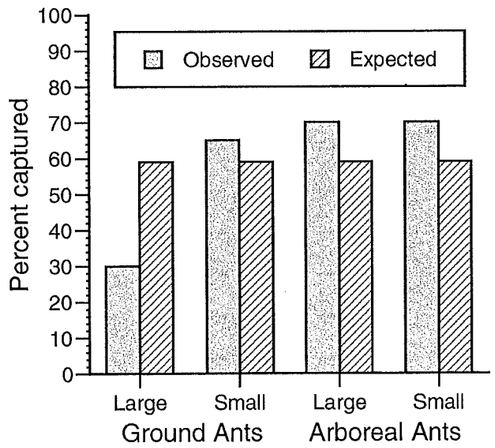


FIG. 1. Capture rate of four types of ants in antlion pits (n = 20 trials for each ant type). Difference in capture rates among ant species was significant (see text).

TABLE 1. Size and speed of the four types of ants used in experiment.

Ant Type	Size (mm)	Approx. speed (cm/s)
Large Ground Ant	7	4.6
Small Ground Ant	3	11.3
Large Arboreal Ant	6	2.8
Small Arboreal Ant	3	0.9

caping them. The large ground ant had a lower capture rate and higher escape rate than the large arboreal or the small ant species (Fig. 1, 2). We observed that larger ant species could climb up the edges of the traps more easily. Given the shallow depth (1 - 4 cm) of antlion traps, a difference in ant length of a few millimeters could influence an ant's ability to escape.

The behavior of an ant and its speed did not seem to influence its potential to avoid traps. The small ground and both arboreal ant species differed in speed (Table 1) and amount of time before capture or escape (Fig. 3), yet did not differ significantly in the rate at which they fell into traps (Fig. 1). The antlions' pit strategy seems to be very effective for capturing these small ant species because most (65 - 70%) of them fell into the pits during the trials.

Both large and small ground ants escaped the pits on at least some occasions, whereas neither arboreal ant species was ever able to escape a trap. The ground species likely have more familiarity with the terrain and their higher speed may be an adaptation for escaping ground predators. Our findings indicate that the arboreal ants are easier prey for ant lions because of their small sizes, slow speeds and unfamiliarity with the ground terrain.

The ability of antlions to exploit these ant types or other easy prey may be important to antlion feeding, growth and reproduction rates. Guerrerio et al. (1992) found that antlion pit density increased under acacia trees inhabited by ants, suggesting that antlions

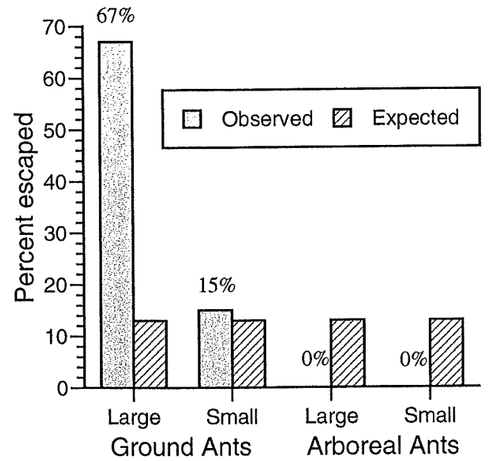


FIG. 2. Escape rates of ants that fell into ant lion pit traps (n = 47 ants). Difference in escape rates among ant species was significant (see text).

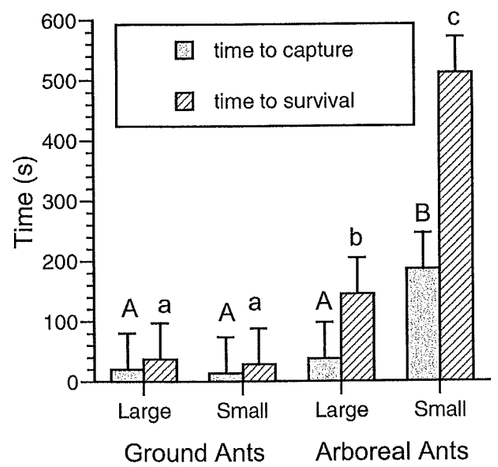


FIG. 3. Mean (± SE) time to capture or survival for each ant species in a tray of 16 - 18 ant lion pits. Different letters (upper case for capture, lower case for survival) signify significant differences as determined by Tukey-Kramer test.

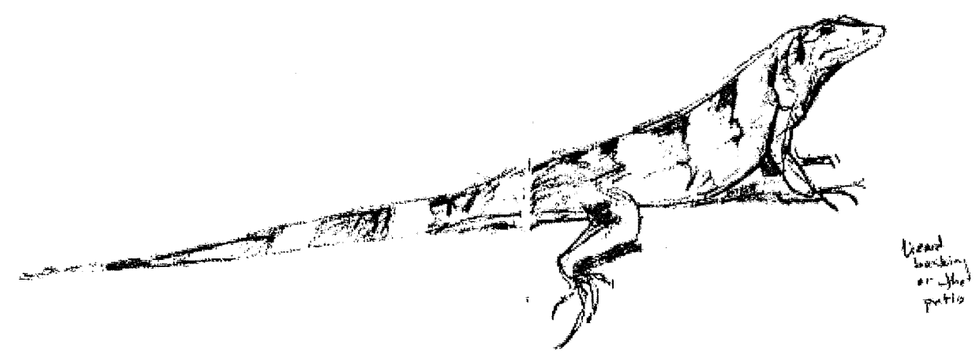
may locate their pits in response to an abundant supply of easily captured prey. Similarly, antlions may maximize feeding efficiency by not attempting to hold and capture prey, such as large ants, which require a large energy expenditure. The differences in ant species demonstrated in this experiment show that ant lions regularly encounter variation in prey. Like other predators, the relative fitness of antlions depends on their ability to identify and adjust to this prey variation.

Literature Cited

Guerrerio, A. L., J. V. Ko and J. J. Stachowicz. 1992. The effects of acacia ant presence on ant lion density. Pp. 16 - 18 *in* J. L. Dudycha and A. B. Shabel, eds. Dartmouth Studies in Tropical Ecology. Dartmouth College, Hanover, NH.

Janzen, D. H. 1983. *Costa Rican Natural History*. Chicago, IL: The University of Chicago Press.

Perlroth, N. E., M. A. Ginsberg, M. J. Glennon, J. A. Kaveeshwar and J. L. Mitchell. 1995. Effect of substrate and individual size on *Myrmeleon* trap size and capture efficiency. Pp. 13 - 15 *in* C. D. Wray, ed. Dartmouth Studies in Tropical Ecology. Dartmouth College, Hanover, NH.

Smith, P. 1983. Ability of ant acacias to limit the growth of other plants around them as a function of their ant associations. *O.T.S. Tropical Biology* 83 - 1: 441.

Swanson, A. N., B. M. Everett and M. E. Berry. 1994. Effects of sunlight, leaf litter, and temperature on habitat selection by ant lions (Neuroptera: Chrysopidae). Pp. 23 - 26 *in* J. L. Bykowski, ed. Dartmouth Studies in Tropical Ecology. Dartmouth College, Hanover, NH.