Antlion capture efficiency decreases with increasing prey size

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Abstract: Size-dependent predation pressure can cause changes over time in the size structure of a prey population. I hypothesized that prey size would affect the efficiency with which antlions (Neuroptera: *Myremeleon* spp.) capture ants. Predation experiments demonstrated that capture time increased with prey size, but that species-specific traits other than body length also play a role in how often ants escape. These factors might include behaviors such as pit detection or leg morphology adapted for travel on the loose, steep sand of an antlion pit.

Key Words: Capture success, foraging efficiency, Myrmeleon, *predation*

Introduction

In tropical ecosystems, ants comprise a large portion of the invertebrate biomass and diversity. Few predators specialize on ants as a food source, but among those that do are antlions (Neuroptera: *Myrmeleon* spp.) which construct steep-sided conical pits in loose sandy soils. When an ant falls into the pit, the antlion grasps the ant with its pincers, and ultimately pierces the ant's exoskeleton and sucks out its fluids (McClure 1983). It has been suggested that large ants are better able to escape from the pit, and that capture rate would therefore be greater on small ants (Butcher et al. 2002). Consequently, I hypothesized that ant size would be a major factor contributing to capture efficiency of antlions. In this study I tested the prediction that larger ants have higher escape rates than smaller ones, and take longer to capture. In addition, I observed the behavior of several of these ant species to look for factors beyond size that might contribute to their susceptibility to antlion predation.

Methods

My experiment was designed to replicate natural conditions of the ant-antlion interaction once an ant had entered the trap. I collected five different species of ants of varying size from Palo Verde National Park, Costa Rica, in the vicinity of the OTS field station. They were (1) a small black field ant 3 mm in length (subfamily Formicinae), (2) the 5 mm acacia ant *Pseudomyrmex nigrocincta*, (3) the 6 mm acacia ant *P. spinicola*, (4) the 7 mm worker caste of army ants (subfamily Ecitoninae), and (5) a 7 mm species of large black field ant of the subfamily Formicinae. I placed antlions in 25 x 25 cm trays containing 1.5 mm mesh-sifted sand to a depth of 5 cm. Eighty-one antlions were collected from the field, and I dispersed them equally throughout nine trays.

I placed test ants directly into a trap, and recorded the time it took to escape or be captured by the antlion. An escape was defined as when the ant was clear of the pit area and on flat sand. These ants were transferred to a fresh trap for additional trials until they were caught. I recorded the time from introduction to the pit until the ant stopped moving and failed to respond to a light tap with a pin. If the ant was totally submerged in sand, time of death was recorded when the sand stopped moving, since antlions do not move while they feed. Pits undergoing construction or repair, or which still contained dead ants from previous experiments, were not used.

I tested the relationship between prey size and capture time with a linear regression of log-transformed data because the raw data were not normally distributed. I used one-way ANOVA to compare the capture times of the two species of equal length, and Tukey-Kramer HSD to evaluate

differences in capture times between all species.

Results

Capture time was positively related to prey body length (Fig. 1; $r^2 = 0.61$, df = 79, $P < 0.01$). Capture time varied across the species tested from 74.6 ± 5.3 s for the small black ants to 304.1 ± 37 s for the large field ants ($F = 49.8$, df = 4, 67, $P < 0.01$). Tukey-Kramer analysis showed that the capture time for the large field ants was significantly longer than it was for army ants of the same length.

The number of escapes before capture was also related to body length. The 7 mm black ants escaped from antlion pits 9.2 ± 4.3 (95% C.I.) times before capture. The 7 mm army ant workers managed 0.27 escapes ± 0.31 (95% C.I.) escapes until captured. The three smaller species tested never escaped from a trap during the trials.

Discussion

Capture time increased linearly with ant length, in support of my hypothesis and the conclusion of Butcher et al. (2002). This relationship explains 61% of the variation, an indication of how important ant size is to antlion predation success. Factors responsible for the unexplained variation probably include behaviors like pit-avoidance and escape strategies.

Both ant length and species identity influenced escape frequency. The army ants and large black ants I tested were the same size, but the large black ants had significantly longer capture time and a greater escape rate. Since none of the other ant species tested were able to escape at all, it could be that 7 mm is close to the minimum length which allows pit escape. Both of the 7 mm ants were able to escape, but the frequency differed by more than an order of

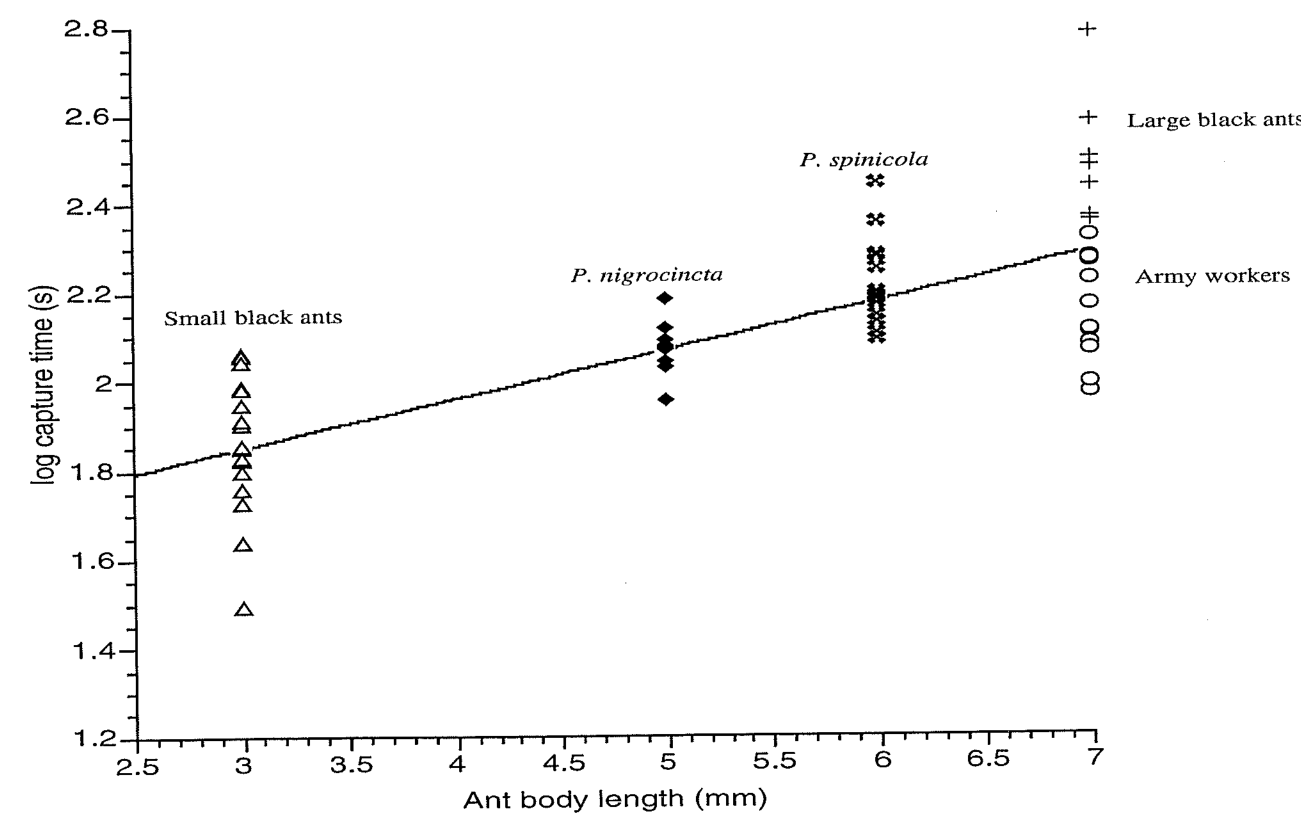

FIG. 1. Time taken for antlions to capture small black ants (n = 20), *P. nigrocincta* (n = 10), *P. spinicola* (n = 17), army ants (n = 15), and large black ants (n = 10), at Palo Verde National Park, Costa Rica.

magnitude. The large black ants are regularly found foraging alone in open sandy areas, ranging widely from their nests. They can minimize losses to antlions only by individual vigilance or adept escape behavior. Their size appears to contribute to escape success, but other factors not examined in this experiment must account for the 30-fold escape advantage the large field ants held over army ants. The particular species of army ants I collected forage in tight columns of mixed soldiers and workers. Since the column works as a unit, workers probably never encounter an antlion pit alone, and do not need solo strategies for pit escape. The column would collapse a pit faster than the antlion could rebuild it, and prevent captures. Their size is probably adapted to the large prey they commonly subdue rather than predator avoidance, based on their relatively low escape rates.

Even though the small black field ants' habitat overlaps that of antlions, they were never able to escape from the traps. The species would suffer heavy losses to the antlions if they had no way of avoiding the pits. In the field, I observed these ants avoiding pits near their nest, indicating that they can detect the trap before entering it. Since my experiment placed them directly in the pit, any behavioral avoidance would have been ineffective.

My experiments showed that size reduces capture by antlions. To escape from the traps, it seems that ants must be above some minimum length. Smaller species likely employ strategies focusing not on escape, but on detection and avoidance of pits. Future studies could address behavioral mechanisms, chemical signals, tactile pit detection, and possibly sand-adapted leg morphologies which might contribute to escape or avoidance of antlion pits.

Literature Cited

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