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SUBSTRATE PREFERENCE AND INTRASPECIFIC COMPETITION IN *MYRMELEON*

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Abstract. Ant lions (*Myrmeleon* sp.) are common inhabitants of sandy soils throughout the tropical dry forest. Previous research has shown that finer soils yield steeper pits. Assuming that increased slope will increase the prey-trapping efficiency of the pits, we hypothesized that ant lions should prefer fine soil to coarse soil. Furthermore, if the preferred substrate is a limited resource, intraspecific competition should result and large ant lions should out compete small ant lions for that substrate. We tested substrate preference by observing the time taken by ant lions to initiate and construct a pit in fine versus coarse soil. Ant lions in coarse soil required almost twice the time to initiate and construct a pit compared than those in fine soil. Observational data and experimental manipulations did not demonstrate competitive exclusion of small ant lions from fine soil, suggesting that intraspecific competition between ant lion size classes may be rare in nature.

Introduction

Ant lions (genus *Myrmeleon*) are a common and fascinating insect inhabiting the tropical dry forests. Upon hatching, predaceous *Myrmeleon* larvae plow across the substrate ("doodle") in search of a suitable place to dig their characteristic conical traps in which they trap arthropod prey. Our initial observations indicated that trapping efficiency increases with increasing pit slope. In addition, Perlroth et al. (1995) found that pits built in fine soils have steeper walls than those built in coarse soils. Therefore, we hypothesized that ant lions prefer fine soil to coarse soil and that this preference should result in intraspecific competition for that substrate. Specifically, we predicted that doodling time should be smallest for ant lions in fine soil. We further predicted that if fine substrate is preferred, and is a limiting resource, intraspecific competition should result in the exclusion of smaller ant lions from fine soils.

Methods

Our project was conducted on 12-14 January, 1996 at Palo Verde National Wildlife Refuge, Guanacaste Province, Costa Rica. Three sites were chosen along the edge of the main road, between 60 and 200 m east of the OET Estacion Biologica. For all ant lion pits at each site, we recorded the diameter of the pit, distance to nearest neighbor, and texture of substrate. Soil texture was categorized by one of us (SPB) tasting each sample; fine soils dissolved readily and became muddy while all other soils, which were more gritty in texture, were classified as coarse.

To compare doodling time in fine versus coarse soil, we used two experimental tubs measuring 20 x 30 x 5 cm. One was filled with ≈ 4 cm of soil that had been sifted through a fine mesh. The second tub was filled with a similar amount of coarse soil. These soils were somewhat more fine and more coarse, respectively, than most natural soils at the site. Ant lions of similar size were extracted from pits 35-40 mm in diameter and placed in the two tubs. We recorded the time required to initially burrow into soil (assumed to represent a detraumatization period), time of doodling, and time required to construct a pit. Doodling time was taken to represent the degree of preference for a substrate. No ant lion was used more than once, and the larvae were removed after each trial.

We tested the competitive interactions between ant lions of different size classes (assumed to be of the same species) with four experimental plots, each 15 cm in diameter and each filled with half fine soil and half coarse soil to a depth of 2 cm. Preliminary tests indicated that the carrying capacity of the half-plot containing fine soil was 4 pits. Therefore, we carried out the competition experiment with four small (≤ 5 mm) and four large (≥ 9 mm) ant lions. In each of three repetitions, eight individuals were simultaneously placed at the center of the fine half of the plot and allowed to distribute themselves. We recorded the location of each hole and the size of its resident ant lion after 10 hours. No ant lion was included in more than one trial.

Results

Doodling time was less than half as long for ant lions on fine versus coarse substrate ($t = -3.76$, $df = 9$,

P = 0.004; Table 1). Furthermore, the time to construct a pit was almost half as long for ant lions on fine versus coarse substrate (t = -2.29, df = 9, P = 0.047; Table 1). There was no difference between the average size of holes constructed on the two substrates (mean ± SE = 32 ± 2 vs. 29 ± 2 mm; t = 1.43, df = 67, P = 0.16).

Results from the competition experiment suggested that ant lions can be excluded from favorable habitats (fine soils) by conspecifics. Of the 24 larvae placed on fine soil, 11 ultimately established pits in coarse soil while one small larvae did not form a pit (Fig. 1). There was no evidence, however, that size differences affected competitive interactions (7 large larvae and 5 small larvae established pits in fine soil; Fig. 1; chi-square = 1.52, df = 1, P > 0.2). In all plots, the density of pits constructed on fine and coarse halves was similar, suggesting that the maximum density at which ant lions establish pits does not vary with substrate texture.

Table 1. Comparison of times required by ant lions to doodle and build pits in experimentally manipulated fine and coarse soils

	Fine soil	Coarse Soil
Doodle time (s)	1285 ± 343	2870 ± 202
Building time (s)	472 ± 98	902 ± 170
n	6	5

behavior in nature. Unquantified observations suggested that doodling time was substantially reuced for ant lions in our experimental plots compared with ant lions on natural substrates, perhaps because substrate depth is much less uniform in nature than it was in our plots. Depth of substrate, as well as texture, may be a factor influencing the location of traps.

Though we observed cases of fierce direct interaction between ant lions, our results refute the existence of a size-based dominance hierarchy (Fig. 1). The lack of experimental plots in which large larvae dominate the fine soil suggests that large ant lions are not necessarily better competitors for that substrate than small ant lions. This is evident from the lack of difference in the size of pits observed on fine and coarse soils as well. However, even if pit size had been correlated with texture, two explanations would remain for why larger ant lions occur on fine soil. Either the largest ant lions might be dominant and thus occupy the best substrate, or the ant lions are large because they occupy the best substrate.

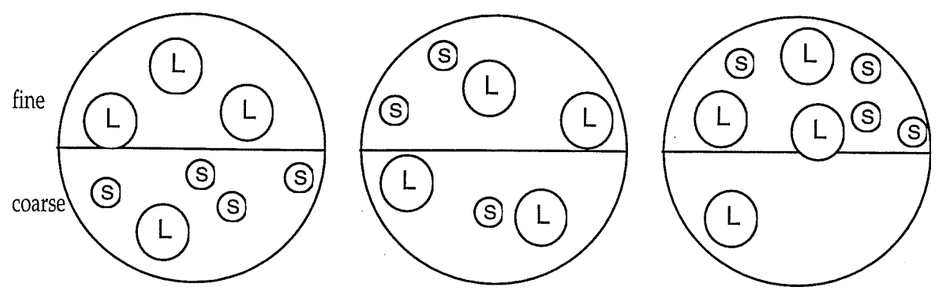

Figure 1. Distribution of large and small ant lion size classes following placement onto fine soil in competition experiment.

Discussion

Ant lions appear to prefer fine substrate over coarse substrate. Under experimental conditions, ant lions spend significantly less time scouting (doodling on) fine substrate than coarse substrate. Apparently, fine substrate not only allows for steeper pits (Perlroth 1995) but also allows for the more rapid construction of pits. By increasing feeding time and efficiency, these factors may confer an advantage to those ant lions that colonize fine soil.

Behavior demonstrated under experimental conditions, however, is not necessarily representative of

The latter may be more accurate. We conducted a small test in which four large ant lions were placed in four small ant lion pits and vice versa. In each case, the intruder immediately burrowed away from the pit suggesting that present occupancy, not size, is the factor determining the distribution of individuals.

Finally, the life history of *Myrmeleon* does not appear to present an opportunity for the intraspecific competition originally hypothesized. The only time that many larvae compete for space may be upon hatching from their eggs when the dispersing larvae are of the same size class. Unless ant lions frequently abandon pits to create new ones, direct interaction between various size classes of larvae is probably rare in nature.

Therefore, while direct competition does not appear to play a large role in the life of *Myrmeleon*, substrate texture, depth, prey density, and the distribution of occupied holes all appear to impact the location of pits. Further study might focus on quantifying the relative importance of these variables and testing for interactions among them. In addition, a thorough understanding of substrate preference in *Myrmeleon* will require knowledge of the oviposition behavior and habitat preferences of adult females.

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