Effects of rain and foot disturbances on antlion (*Myrmeleon immaculatus)* pit size and relocation

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Abstract

The purpose of this experiment was to determine the effects of rain and foot disturbances on the pit size and relocation preference of antlion larvae (*Myrmeleon immaculatus*). Antlions were placed in sand filled aquaria to build pits in a 24-hour period and pit size and location (exposed or sheltered) was measured. Rain and foot traffic treatments were performed and relocation and pit size was measured after a 24-hour period. The mean pit diameter of the antlions exposed to treatments of dry and foot traffic were significantly larger than the mean pit diameter of antlions with the rain treatment. The number of antlions that relocated to shelter after the no treatment and foot traffic treatment was not significantly greater than the number of antlions that relocated to shelter after the treatment of rain. There was a greater proportion that chose shelter as the number of trials increased for no treatment and foot traffic treatment. There were significantly more pits built in dry conditions than wet conditions. In conclusion, pit size was related to disturbances of rain and foot, and pit size was larger within the trails with out treatment and with foot traffic and rain disturbances.

INTRODUCTION

What factors do sit-and-wait predators take into consideration when deciding where to attempt to intercept prey? Some sit-and-wait predators build traps to enhance success in catching prey, so as foragers, these predators must minimize the energy and time invested in building their traps by seeking the best location for maximal food intake (Aral et al. 1991). Shelter from predators, natural and human disturbances, and intraspecific competition are features that may influence distribution patterns of sit-and-wait predators' trap locations (Day & Zalucki 2000). Since traps require energy to make, it is reasonable that sit-and-wait predators will want their traps to encounter minimal disturbance (Gotelli 1993).

Antlion larvae (*Myrmeleon immaculatus*) are sit-and-wait predators that rely on building sand pits to function as traps to catch prey (Rosenberg 1987). They construct conical pits by burrowing into sand and then tossing it out with their jaws (Barger et al 2003). The pits size are correlated with their body mass (Golan et al. 2009) making the pits able to funnel prey to the antlions, which wait in the sand directly under the bottom of the pit, thus enhancing capture prey frequently (Lucas 1982). Since antlions invest energy into building their pits, they need to limit the susceptibility of their pits to disturbances, both natural disturbances and those from humans.

Rain is a natural disturbance that dampens sand, causing it to be more difficult for antlions to toss the heavier sand particles; a prior study suggests that because of this, they prefer build pits in soil with less moisture (Rosenberg 1987). Antlions will also choose sand with less moisture because after it rains, a crust is formed that the antlions can't penetrate (Gotelli 1993). Although there are no studies on human impacts on antlions, a study on tiger beetles (*Cicindela spp.*) that burrow in the ground have been impacted by human interference of vehicles and pedestrians and will relocate after these disturbances (Hill & Kingsley1992).

The purpose of this study is to determine and compare diameters of pits after disturbances from both rain and human foot traffic as well as to determine whether or not there is a preference in antlions to construct their traps in areas protected from these disturbances. I hypothesize that the antlions pit diameters will be larger under dry conditions (no treatment and foot trafficking disturbance) than rain disturbance because antlions will have to wait until soil moisture decreases following the damp sand (Rosenberg 1987 & Gotelli 2003). Further, because antlions need shelter to protect themselves from disturbances (Gotelli 1993), I predict that antlions will relocate to shelter following disturbances from both human foot traffic and rain. I also predict that the pit diameters of each individual antlion will be the same for the pits rebuilt following disturbance as they were from the original pit since pit size is correlated with body weight (Golan et al. 2009). Finally, since antlions can’t penetrate the crust made from the sand after rain (Gotelli 2003), I predict that there will be fewer antlion pits built in the rain treatment than the dry treatments.

METHODS

At the south end of Pine Point trail along Douglas Lake at the University of Michigan Biological Station in Pellston, Michigan, I collected 24 antlions with a body weight of 0.06 ± 0.02 g. To ensure exposure to sunlight but also protection from natural disturbances, in a greenhouse at UMBS I filled six 10-gallon aquaria with 7.62 cm deep of sand from the Douglas Lake beach across from the UMBS campus. Into each aquarium, I aligned two 23x13x3 cm pieces of firewood against the lengths of the tank parallel to each so they abutted one end. Two pieces of 23x13x3 cm firewood were placed on top of those such that half of the tank was shaded.

Into the center of each aquarium, I placed four antlions and let them disperse. After 24 hours I measured the distance of each pits' center from the central point of its aquarium where I had originally placed the antlions; I measured positive and negative displacement parallel to both the length and the width of the aquarium to note whether the pits were built in the sun (exposed) or under shade (shelter). I also measured the diameter of each pit parallel to the length of its aquarium.

Into three aquaria, I duplicated the natural disturbance of rain by pouring 0.2 L of water evenly over the entire tank with a small watering can where the pits under the log were protected. In the other three aquaria, I duplicated human foot disturbance by stomping the pits five times each with a woman's size 5 sandal until the pits were flattened. After following another 24 hours, for pit reconstruction I again measured pit location and diameter as I described before.

I replaced the wet sand of the three rain disturbance aquaria with dry sand from the Douglas Lake beach at UMBS and repeated the full experiment with the same antlions with the same number of replicates. I also fed the antlions one ant per day and fed them when relative to measuring.

I used the one-way ANOVA analysis and Chi-squared test of analysis to test my hypotheses. For pit diameter and the Chi squared test of analysis to test the numbers of pits built and pit location.

RESULTS

There was no significant relationship between pit diameters in the three treatments ($F=9.76$, $df=2,125$, $p<0.001$). The mean pit diameter made by the antlions decreased for the rain treatment and increased for the treatment of foot traffic (Fig. 1) The mean pit diameter of the antlions with treatments of foot traffic and without treatment were significantly larger than the mean pit diameter of antlions with the rain (Tukey $p<0.05$). The mean pit diameter of antlions without treatment was not significantly larger than the mean pit diameter of the antlions with the foot traffic treatment (Tukey $p=0.13$).

The numbers of antlions building pits in the sheltered area increased after the treatments of foot traffic and rain (Fig. 2). There were significantly more antlions located in shelter after the treatments of rain and foot traffic ($X^2= 8.38$, $df=2$,$p=0.015$). The proportion of antlions that relocated to shelter after the foot traffic treatment was not significantly greater than the number of antlions that relocated to shelter after the treatment of rain ($X^2=0.268$, $df=1$, $p=0.605$).

The pit diameter of the antlions was not significantly different within the three trials for the rain, foot traffic and no treatments ($F=0.203$, $df= 2,26$, $p=0.817$, $F=0.658$, df-2,31, $p=0.525$, $F=1.75$, $df=2,62$, $p=0.182$).

The tendency of antlions to build pits in the shade in the foot traffic treatment went from 55%, 78%, to 100% and no treatment went from 37%, 41%, to 71% as the number of trials increased (Fig. 3 & 4). The tendency of antlions to build pits in the shade of the foot traffic treatment significantly increased with the number of trials ($X^2=6.94$, $df=2$, $p=0.031$).

The proportion of antlion pits that were not built increased in the rain treatment but not without treatment and foot traffic treatment (Fig. 5). The proportion of pits not built in rain treatment was significantly greater than pits not built with no treatment and foot traffic treatment (X^2=6.19, df=2, p=0.0453).

DISCUSSION

My results show that mean pit diameter of the antlions without treatment and foot traffic treatments were significantly larger than the mean pit diameter of antlions with the rain treatment, however the diameter of foot traffic treatment was significantly larger than without treatment. My hypothesis that mean pit diameter would be larger for dry conditions than wet conditions was supported however it was expected that foot trafficking treatments would have smaller pit diameters as well. These results with rain disturbance agree with the findings of Gotelli (1993), who stated that antlions cannot dig in rain soaked soil and will wait for higher temperatures to dry the sand in order to dig their pit. This explains why the treatments with rain have smaller diameter pits than dry treatments in a 24-hour period. Although there are no antlion studies to compare foot traffic pit size, I believe that the foot traffic pits were larger because the antlions that located to the shade prior to the treatment were unharmed and had more time to make their pits larger. I propose that if there were separate aquaria that had no disturbance their pits size would grow as well as making the average pit diameter of foot traffic smaller.

There were significantly more antlions that located to shelter after treatments of rain and foot traffic which supports my hypothesis that antlions relocated under a sheltered area to avoid disturbances. This supports the findings of Gotelli (1993) that antlions choose sheltered areas to avoid rainfall and other disturbances. Antlions will also relocate to a sheltered area when exposed to unsuitable conditions such as rain and sun (Hollender et al. 2008) as in this study with foot traffic and rain.

My data shows that antlions without treatment and with foot traffic treatments significantly increased with the number of trials however there was no significant difference between the rain treatment trials, which supports my hypothesis that with an increasing number of disturbances, the likelihood for antlions to relocate to a shaded, more sheltered area will increase. This is in accordance that antlions will relocate to a sheltered area when exposed to unsuitable conditions (Hollender et al. 2008). Although more antlions did not relocate to the sheltered area after rain disturbance, this could be that since they were unable to penetrate the rain soaked crust (Gotelli 1993), they were not able to build their pits in the sheltered area.

The size of the pits diameter were not significantly different within the trials of rain, foot traffic and no treatment which supports my hypothesis that pit diameter would not change with each trial. The study by Golan et el. (2009) that body mass is correlated with pit diameter, therefore, antlions of a certain size will build there pit in relation their body mass regardless of any disturbances.

The numbers of antlion pits built was significantly greater in the foot traffic treatment and no treatment than in the rain treatment, which supports my hypothesis that there will be more pits built under dry conditions than wet conditions. There were more pits built in the foot traffic and dry treatments than rain because the finer and dryer the sand the less energy antlions need to spend throwing the sand to make their pits (Lucas 1982 & Farji-Brener 2003). Gotelli (1993) also found that antlions are more likely to not build pits in moist sand because they are waiting for the sand to dry to use less energy in constructing their pits.

In conclusion, antlions will relocate to a sheltered area following frequent disturbances of rain and foot trafficking. Smaller pits were constructed in rain treatments than without and foot traffic treatments that indicates that rain had a larger impact on antlions compared to humans. Therefore my study shows that frequent disturbances impacts antlions on both pit construction and location.

FIGURES

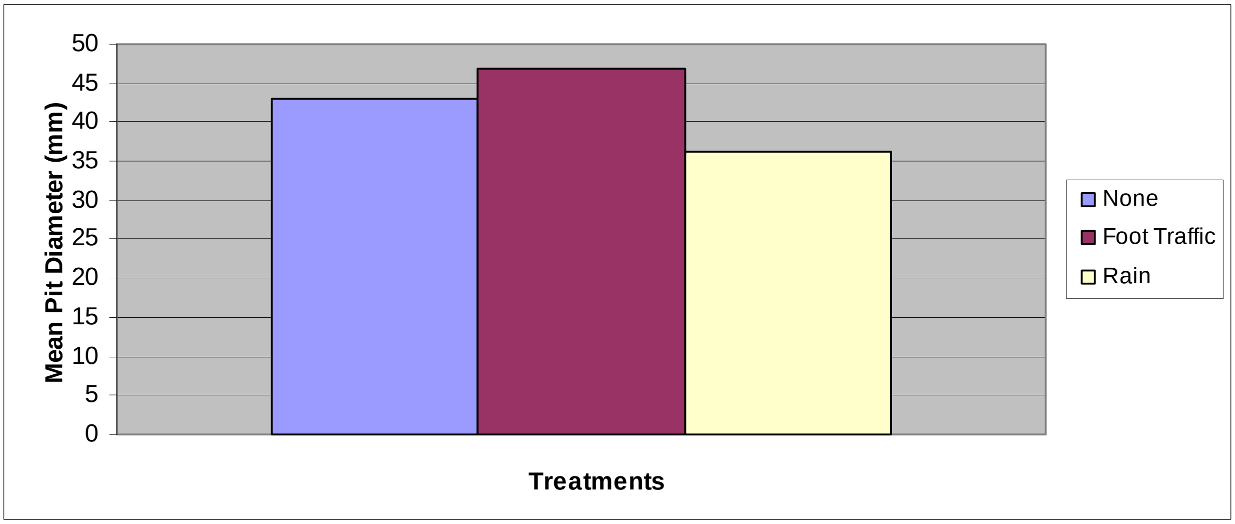

Figure 1: Mean antlion pit diameters without treatment and with foot traffic and rain treatments. Pits with no treatments and foot traffic treatments were significantly larger than pits with rain treatment (p<.001)

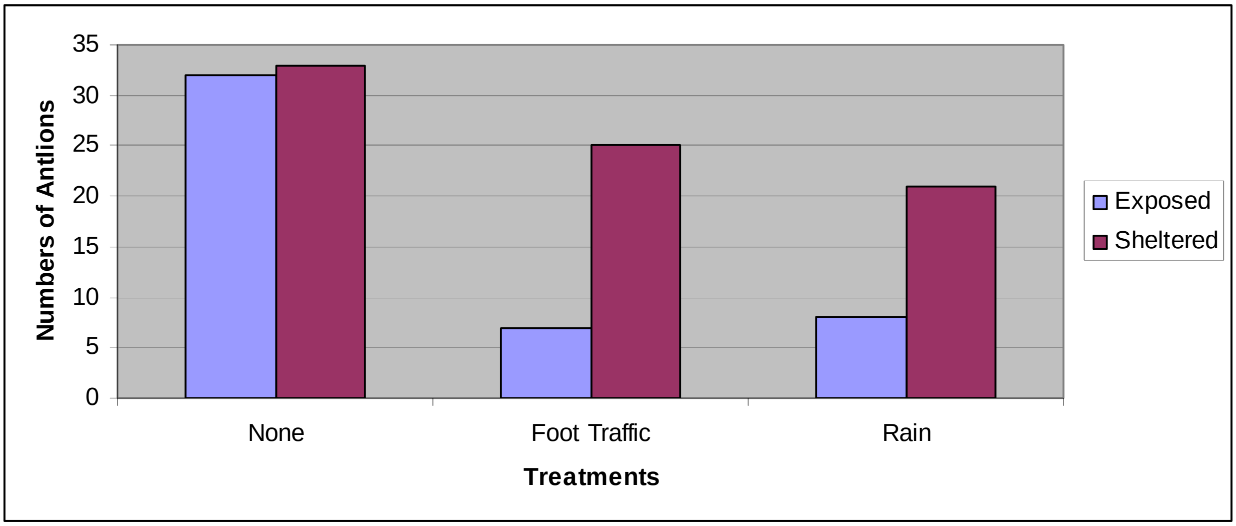

Figure 2: The numbers of antlions located in an exposed and sheltered area with none, foot traffic and rain treatments showing an increase of antlions to shade for all three treatments. There were significantly more antlions located in the shade after the treatments of rain and foot traffic (p=0.015).

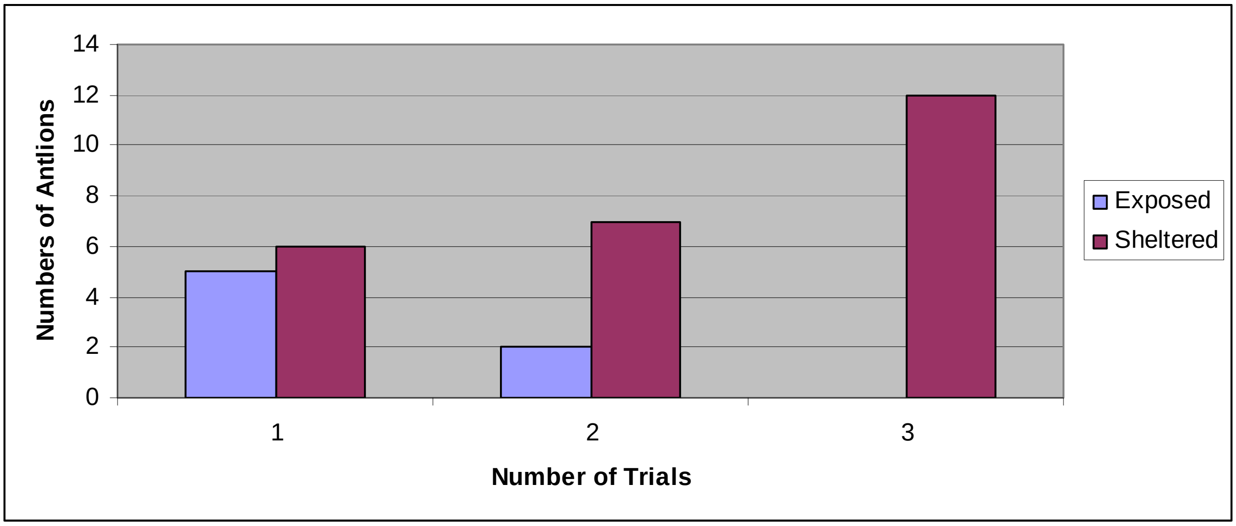

Figure 3: The numbers of antlions located in an exposed and sheltered area during three trials of foot traffic treatment. There was significantly more antlions that located to shelter after each trial (p=0.031).

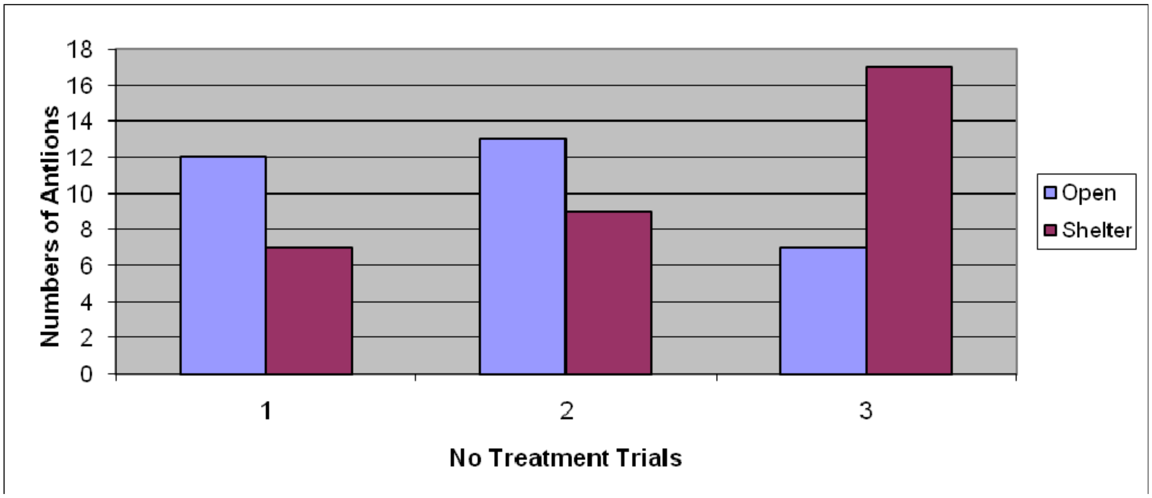

Figure 4: The numbers of antlions located in an exposed and sheltered area during the three trials of no treatment. There was significantly more antlions that located to shelter after each trial (p=0.045).

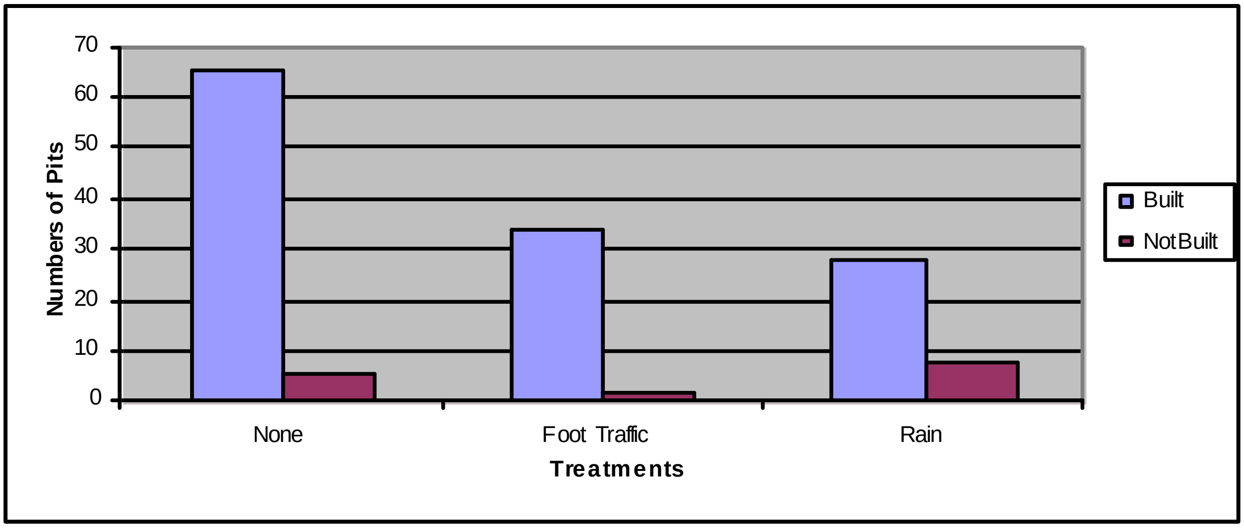

Figure 5: The numbers of pits built and not built in no, foot traffic and rain treatments.

There were significantly more pits built in dry conditions than wet conditions (p=0.0453).

LITERATURE CITED

Aral, H. P. Crowley, P. Dillon, M. Linton, K. Strohmeier, J. Williams, C. Wood, 1991. Pit relocation by antlion larvae: a simple model and laboratory test. Evolutionary Ecology 5:93-104.

Day, M.D. and M.P., Zalucki. 2000. Effect of density on spatial distribution, pit formation and pit diameter of Myrmeleonacer Walker, (*Neuroptera: Myrmeleontidae)*: patterns and processes. Austral Ecology 25:58-64.

Farji-Brener, A.G. 2003. Microhabitat selection by antlion larvae, *Myrmeleon Crudelis*: effect of soil particle size on pit-trap design and prey capture. Journal of Insect Behavior 16:783-796.

Gotelli, N. 1993. Ant Lion Zones: causes of high-density predator aggregations. Ecology 74:226-237.

Golan, B., I. Scharf, O. Ovadia. 2009. The effect of sand depth, feeding regime, density, and body mass on the foraging behaviour of a pit-building antlion. Ecological Entomology 34:26-33.

Hill, J. Knisley, C. 1992. Effects of habitat change from ecological succession and human impact on tiger beetles. Virginia Journal of Science 43:133-142.

Hollender, Y., I. Scharf, A. Subach, O. Ovadia I. 2008. Effect of spatial pattern and microhabitat on pit construction and relocation in *Myrmeleon hyalinus* (Neuroptera: Myrmeleontidae) larvae. Ecological Entomology 33:337-345.

Lucas, J. 1982. The biophysics of pit construction by antlion larvae. Animal Behavior 30:651-664.

Rosenberg, R. 1987. Pit dispersion in antlion larvae (Neuroptera: Myrmeleontidae): is competition important? The Florida Entomologist. 70:175-178