Effects of rain and foot disturbances on pit size and location preference of antlions (*Myrmeleon immaculatus*)

Angela Feng

University of Michigan Biological Station
EEB 381 Ecology
August 17, 2010
Professor Cathy Bach

Abstract

The purpose of this study was to examine how disturbances caused by rain and human foot traffic affect antlion (*Myrmeleon immaculatus*) pit size and location preference. We assessed this by placing antlions in aquaria one side sheltered and the other side in the open in a greenhouse at University of Michigan Biological Station in Pellston, Michigan with three different treatments: no treatment, foot traffic, and rain. For the foot traffic treatment, we damaged the pits with a sandal, and for rain treatment, we poured water on the pits. We measured pit size and location after 24 hours and conducted three trials. The results of this study showed that antlions constructed pits that were 18.5% and 29.4% larger without disturbance and following foot disturbance respectively than following rain disturbance; this difference was significant. The data further revealed that antlions built significantly fewer pits following rain disturbance because approximately three times more antlions did not build pits following rain disturbance compared to the other treatments. I found that antlions following disturbances had a significantly greater preference to build their pits in shelter than those without disturbances. Lastly, I discovered that significantly more antlions relocated to shelter as trial increased for each treatment except rain. Thus, rain disturbances influence antlions' pit size, decision to construct pits, and location preference; whereas foot disturbances influence location preference.

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 sunlight and disturbances is a feature that may influence distribution patterns of sit-and-wait predators' trap locations; since traps require energy to make, it is reasonable that sit-and-wait predators will choose to build their traps under shelter so as to incur only 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 & Farji-Brener 2003). They construct their conical pits by burrowing into sand and then tossing it out with their jaws. The pits serve to funnel prey to the antlions, which wait in the sand directly under the bottom of the pit, thus enhancing prey capture frequency (Lucas 1982). Aral et. al. found that to further enhance prey capture frequency, antlions will relocate their pits if their current location is of low quality because of disturbances or lack of prey. Scharf (2008) found in addition that antlions had constant pit construction rates as they relocated pits to improve probability of prey capture.

According to the optimal foraging theory, since antlions must invest energy into building their pits, they need to limit the susceptibility of their pits to 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 damp sand particles; a prior study found that because of this, antlions prefer to build pits in soil with less moisture

(Rosenberg 1987). Gotelli (1993) further found that antlions cannot penetrate the crust of rain-soaked sand so they must wait until it dries before they can recreate their pits. Another potential disturbance to antlion pits is human foot traffic, which has been found to reduce distribution and abundance of several species of tiger beetles (*Cicindela spp.*) which, like antlions, are also sendentary predators that live in burrows in the ground of dunes (Knisley & Hill 1992). Previous studies have further determined that antlions abandon their pits following disturbances and relocate in order to evade having their pits damaged again (Scharf & Ovadia 2006) and that when forced to rebuild pits due to disturbances, antlions built smaller pits to reduce energy expenditures (Griffiths 1986) but that despite the possible interference from sand-throwing by neighboring antlions constructing their pits, antlions still aggregate to favorable areas in clumped distributions (Day & Zalucki 2000).

The purpose of this study is to determine antlion pit size after 24 hours without disturbance and antlion pit size 24 hours after disturbances from both rain and human foot traffic as well as to determine whether or not there is a preference in antlions for trap construction in areas protected from these disturbances. I hypothesize that antlions will build smaller pits following rain disturbance than both following foot disturbances and when undisturbed because antlions will have to wait until sand moisture decreases in the damp sand (Rosenberg 1987 & Gotelli 1993). Despite Griffiths' (1986) finding that antlions rebuilt smaller pits following disturbances and because Scharf (2008) found that antlions build their pits at a constant rates following relocation, I predict that the pit sizes for each condition will not change between trials as they recreate their pits. I also predict that more antlions will not build pits following rain treatment than the other treatments since the sand moisture may create an impenetrable crust (Gotelli 1993). Further, because antlions evade disturbances (Scharf & Ovadia 2006), I predict that antlions will show a greater preference for building their pits under shelter for protection following disturbances than they did originally. Lastly, we predict that more antlions will relocate under shelter as trial number increases to evade further disturbances (Scharf & Ovadia 2006).

METHODS

From Pine Point trail at the University of Michigan Biological Station in Pellston, Michigan, I collected 24 antlions of approximately the same mass (0.06 +/- 0.02g). In a greenhouse, I prepared six aquaria (size 10) with a log set (one approximately 23x25x4cm log and two approximately 13x23x4cm logs where the larger log is propped about 20cm above the sand by the other two logs) on one side filled with 10cm of sand from the Douglas Lake beach on the University of Michigan Biological Station campus. We added four antlions to the center of each aquarium, allowed them to disperse and begin pit construction.

After allowing the antlions to build their pits for 24 hours, I recorded the location (open or sheltered) and the largest diameter of each pi. Then I damaged the pits in three of the aquaria by pouring 0.2L of water evenly over each aquarium with a small watering can (pits under the log were not watered on) and damaged the pits in the remaining three aquaria by stomping them five times with a sandal with high pressure. Both disturbances completely destroyed the pits. After allowing another 24 hours for pit construction, I then measured the locations and pit diameters again. I completed three trials of the full experiment using the same antlions and sand each time. I also fed the antlions 1 ant per day about an hour before damaging their pits.

To analyze my data, I used ANOVA tests for pit diameter and Chi Square tests for numbers of pits built and pit location. Data from the three trials were evaluated both together and separately.

RESULTS

There was a significant difference in the pit diameters in my three treatments(F=9.76, df=2,125, p<0.001). Pits built with no treatment and foot traffic treatment were significantly larger than with rain treatment (Tukey p<0.05).Mean diameters of pits built by antlions with no treatment and foot traffic treatment were 18.5% and 29.4% bigger than the mean pit diameter with rain treatment respectively (Fig. 1). Despite the mean pit diameter with foot traffic treatment being 9.16% larger than with rain treatment, there was no significant difference in mean pit diameter between no treatment and foot traffic treatment (Tukey p=0.133).

I found that there was no significant difference in pit diameter for each trials within all the conditions of no treatment (F=1.75, df=2,62, p=0.182), foot traffic (F=0.658, df=2,31, p=0.525), and rain (F=0.204, df=2,26, p=0.817) treatments.

Significantly more antlions did not build pits with rain treatment than with no treatment and foot traffic treatment (x^2 =6.19, df=2, p=0.0453). Approximately 8.33%, 5.56%, and 22.2%, of antlions with no treatment, foot traffic, and rain treatment did not build pits respectively (Fig. 2).

Significantly more antlions built pits in the open with no treatment than in both foot traffic and rain treatments (x^2 =8.38, df=2, p=0.015). Approximately 50.7%, 78.1%, and 72.4% of antlions with no treatment, foot traffic, and wet treatment respectively built their pits in the shelter (Fig. 3). However, there was no significant difference in where antlions built their pits between foot traffic and rain treatments (x^2=0.268, df=1, p=0.605).

Lastly, significantly more antlions relocated in the shelter as trials went on with no treatment (x^2=6.20, df=2, p=0.045) and foot traffic treatment (x^2=6.94, df=2, p=0.031). I discovered that with no treatment, 36.8%, 69.2%, and 70.8% of antlions located in the shelter as trial number increased while with foot traffic treatment, 54.5%, 77.8%, and 100% of antlions located in the shelter as trial number increased (Fig. 4 & 5). However, there was no significant difference in where antlions located between trials with rain treatment (x^2=2.87, df=2, p=0.239).

DISCUSSION

The antlions built significantly larger pits with no treatment and foot traffic treatment than with rain treatment with no significant difference in pit size between no treatment and foot traffic treatment. This supports my hypothesis that antlions will build smaller pits following rain disturbances. My result is consistent with Rosenberg (1987) who found that damp sand requires more energy for antlion pit construction. According to the optimal foraging theory, it would require antlions more energy to build a pit in damp sand than a similar sized pit in dry sand. Therefore, the antlions would be able to build larger pits following no disturbance and foot traffic than following rain disturbance in a given period of time.

The antlions' pit sizes did not vary significantly for the three trials with each treatment, supporting my hypothesis that antlion pit size would not change as they recreated their pits under similar conditions. My result is consistent with Scharf's (2008) findings that antlion pit construction rate remains constant as they relocate. Since antlion pit size did not differ significantly between each trial, the analyses combining the trials are justified.

My results that demonstrate that about three times more antlions in the rain treatment did not build pits than antlions with no treatment and foot traffic treatment support my hypothesis that antlions are less likely to build pits following rain disturbances. My result is consistent with a previous study which found that antlions could not penetrate the crust formed in sand following a rain shower, thus preventing pit-building (Gotelli 1993). Since the other treatments did not form impenetrable crusts, the antlions were able to begin constructing their pits immediately.

Furthermore, my results demonstrate that about 25% more antlions built their pits in the shelter with foot traffic and rain treatments than with no treatment and that there was no significant difference between where the antlions were located between foot traffic and rain treatments. This supports my hypothesis that antlions will demonstrate a greater preference to build their pits in the shelter following disturbances than without disturbances. My result is consistent with a prior study which found that antlions aggregate to favorable areas to avoid disturbances such as rain (Day & Zalucki 2000).

Lastly, I discovered that the proportions of antlions relocating to shelter increased significantly with each trial for both the no treatment and foot traffic treatment. This supports my hypothesis that more antlions will relocate to shelter after each trial to evade disturbances since the same antlions were used and had experienced disturbances before. Scharf & Ovadia (2006) also found that antlions relocate to favorable environments following disturbances. However, the antlions in the rain treatment did not significantly demonstrate relocation difference following each trial. This suggests that the antlions may have been unable to relocate to shelter because of the impenetrable crust of rain-soaked sand (Gotelli 1991).

In conclusion, antlions build smaller and fewer pits following rain disturbances but build similar sized pits following foot traffic disturbances as without disturbances, indicating that rain has a stronger effect on antlions than humans. They are able to maintain a constant pit construction rate. Antlions are also affected by disturbances caused by both rain and humans in terms of location preference. Finally, my study suggests that antlions relocate following frequent disturbances.

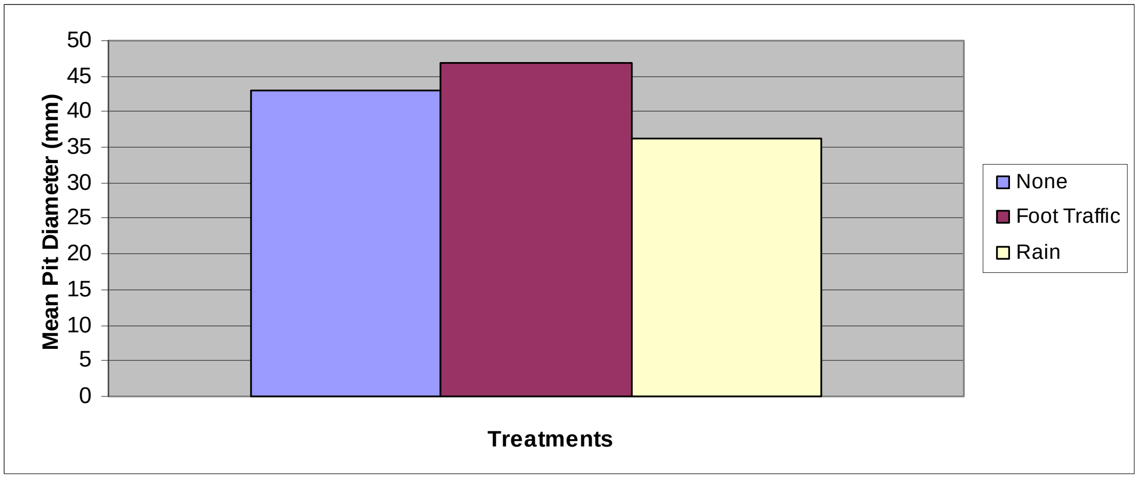

Figure 1: Mean pit diameters (mm) in the no treatment, foot traffic treatment, and rain treatment. Pits were significantly largest with foot traffic treatment, intermediate with no treatment, and smallest with rain treatment ($p<0.001$).

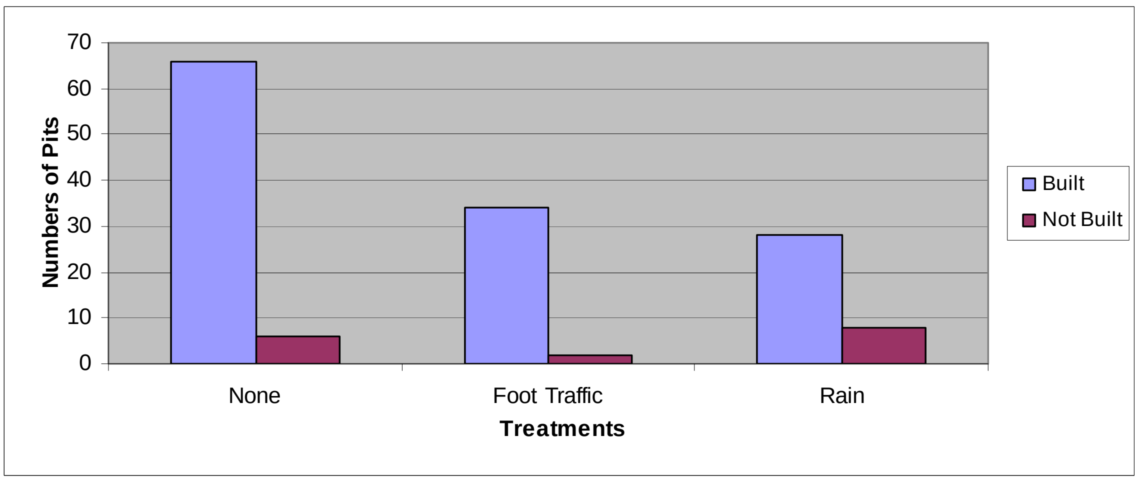

Figure 2: The numbers of pits built and not built in various treatments. More antlions did not build pits with rain treatment than with foot traffic and no treatment ($p=0.0453$).

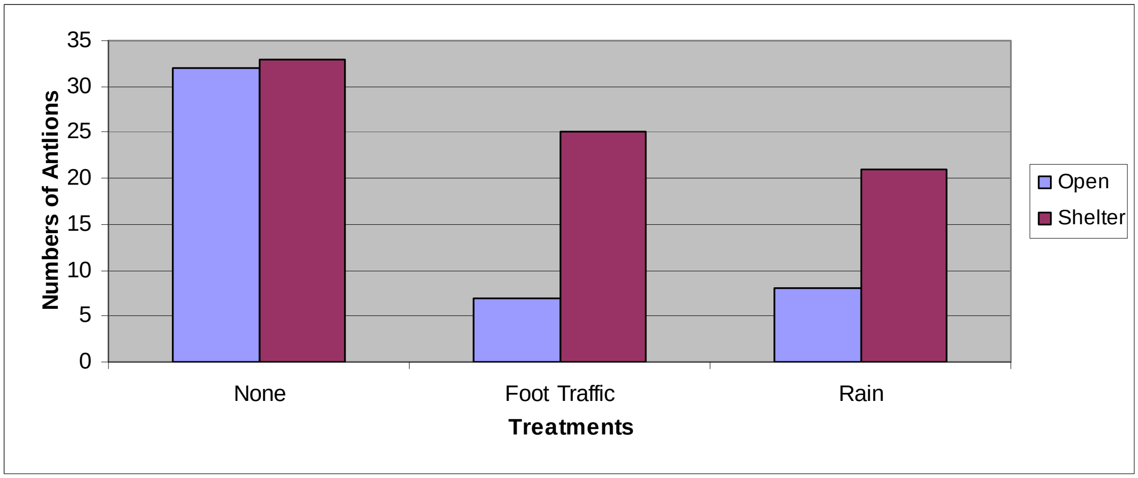

Figure 3: The numbers of antlions located in the open and shelter with various treatments indicate that there were significantly more antlions located in the open with no treatment than to antlions with foot traffic and rain treatments (p=0.015).

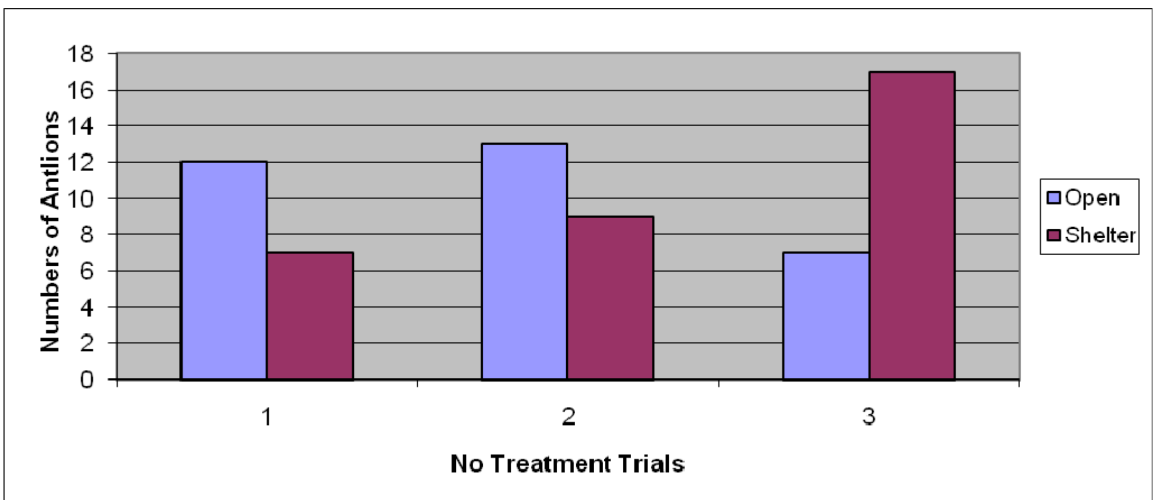

Figure 4: The numbers of antlions located in the open and shelter with no treatment between various trials indicate that significantly more antlions located in shelter following each trial (p=0.045).

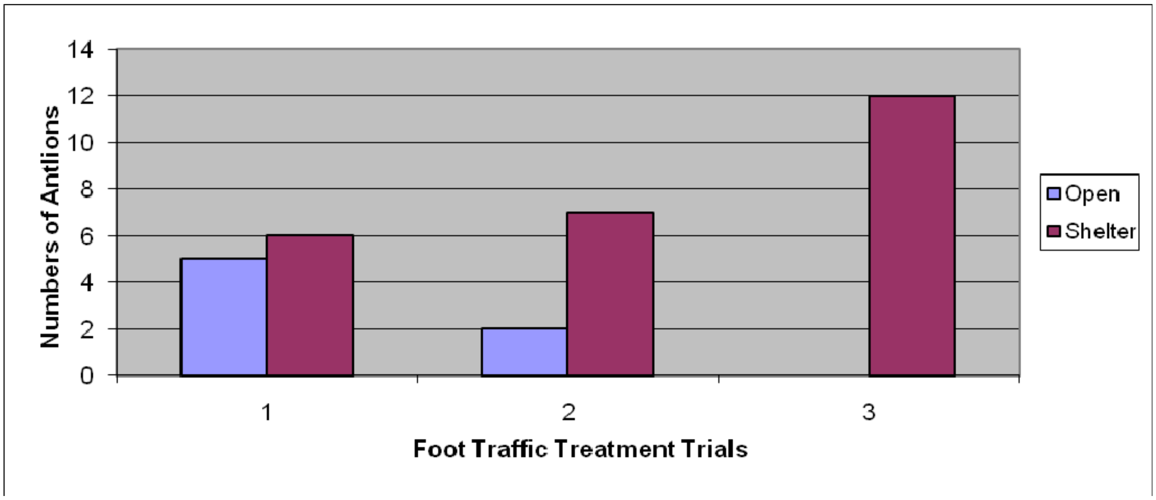

Figure 5: The numbers of antlions located in the open and shelter with foot traffic treatment between various trials indicate that significantly more antlions located in shelter following each trial ($p=0.031$).

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.

Griffiths D., 1986. Pit construction by antlion-larvae: a cost-benefit analysis. Journal of Animal Ecology 55:39-57.

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

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.

Scharf, I. 2008. Effect of spatial pattern and microhabitat on pit. Ecological Entomology 33:337-345.

Scharf, I. and O. Ovadia. 2006. Factors influencing site abandonment and site selection in a sit-and-wait predator: a review of pit-building antlion-larvae. Journal of Insect Behavior 19:197-218.