

The effect of habitat on intra-generic competition in burying beetles, *Nicrophorus*

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Abstract

Competition and habitat selection have been great topics for ecologists for decades and play a vital role in the study of ecology. In order to avoid competition, organisms partition their niches. Burying beetles (genus: *Nicrophorus*) occupy the small carrion niche and use carcasses as their primary resource, both in feeding and reproduction. In this study I investigated the effects of habitat on intra-generic competition on burying beetles. I found that two of the three prominent species, *Nicrophorus investigator* and *Nicrophorus defodiens* do partition the small carrion niche. *N. investigator* was found primarily in the meadow and *N. defodiens* was found in the aspen. This may be due to the different preferences of soil or amount of shade and temperature. In the case that both *N. defodiens* and *N. investigator* were present at the same carcass, *N. investigator* won all of the carcasses (in both aspen and meadow habitats). Also it appears that burying beetles have a higher reproductive success in the aspen habitats versus the meadow habitats. Whether this is due to the aspen habitat having factors that benefit burying beetles or due to variations in each species reproductive success (*N. investigator* vs. *N. defodiens*) is not well known and needs to be studied further. Further studies will need to be done on *Nicrophorus guttula* to understand its habitat selection.

Introduction

Habitat selection has been a topic of great interest for ecologists for decades. Habitat selection refers to a hierarchical process of behavioral responses that may result in the disproportionate use of habitats to influence survival and fitness of individuals (Jones 2001). There are many factors that determine habitat selection, one of them being resources and another one being competition. In ecology a resource is defined as a substance or object required by a living organism for normal growth, maintenance, and reproduction. Competition is defined as the interaction of two (or more) organisms (or species) such that, for each, the birth or growth rate is depressed and the death rate increased by the presence of the other organisms (or species). In burying beetles, intra-generic competition is fierce for the small carrion niche.

Burying beetles (Silphidae: *Nicrophorus*) use small vertebrate carcasses that they bury and prepare as food for their young. They find the carcass by using their sensitive chemosensors and once they find it they dig beneath it and begin their preparation (Conley 1982). They prepare the carcass by removing its fur or feathers, shaping it into a ball, removing fungi from it and keeping it moist. The eggs are then laid nearby and will hatch into altricial (defenseless) larvae that are fed by one or both parents

(Scott 1989). Beetles with larvae will attack other beetles as well as any other predatory insects that attempt to enter their nesting site. There are three species of burying beetle native to the montane region of Colorado: *Nicrophorus investigator*, *Nicrophorus defodiens*, and *Nicrophorus guttula*.

It is well known that closely related species often differ in either habitat or size, and thereby avoid competitive elimination (Huston 1979). The way in which they differ is related to the specialized ways they have of using resources, which ways in turn control numbers of coexisting species. Given the life-history strategies of burying beetles, which all share the same resource, it would be hypothesized that in order to avoid competitive exclusion each species of burying beetle would occupy a different habitat. It can be assumed that each one of these species have specific requirements and choose their habitats based up these requirements and that this pattern of habitat use is not random.

The purpose of this study is to compare the habitat selection among: *N. investigator*, *N. defodiens*, and *N. guttula*, in aspen and meadow habitats; as well as observe the effects of habitat on intra-generic competition within the *Nicrophorus* genus.

Methods

I obtained *Peromyscus maniculatus* (deer mouse) carcasses that were salvaged from cabins in the Gothic town site. The carcasses were frozen and stored until future use. I weighed and sorted each carcass, using only the carcasses that weighed 16-20.5 grams. The carcasses were then grouped into 4 separate and equal piles determined by weight: Aspen A, Meadow A, Aspen B, and Meadow B. The carcass weight was evenly distributed between the piles (Aspen A got a 16 gram, Meadow A got a 16 gram, Aspen B got a 16 gram, and Meadow B got a 16 gram) until all the mice carcasses were gone. After that I tagged the carcasses with colored string, about 30cm in length, depending on the habitat (the meadow groups got pink string and the aspen group got yellow string).

I placed the carcasses in the Site A aspen and meadow habitats on July 9th 2013. Starting at point 1 I placed a mouse carcass on the ground and set a flag to mark its location. Then I walked 20 paces south (each of my paces is about 2.1 meters) and then placed point 2. I continued this until I got to point 10. After this I walked 20 paces east to place point 11. I repeated the same process for points 11-20, except this time I walked north, so that I had 2 parallel lines for my meadow habitat. I repeated

this same process for my aspen habitat. On July 16th I placed the carcasses on my Site B meadow and July 19th for the aspen. I repeated the same methods as Site A, but in 2 parallel "J" shapes.

I checked the carcasses 1 day after I placed them out in the field (assuming that it was not raining) in the morning for several hours, usually lasting from 9-12 and 2-4 to measure beetle arrival. I noted if the carcass was buried, partially buried, not buried, or gone. For each point I noted the species, *Nicrophorus investigator*, *Nicrophorus defodiens*, *Nicrophorus guttula*, *Thanatophilus lapponicus*, ants, or maggots. I measured the pronotum width and elytron length of each of the different *Nicrophorus* species as well as sexing and marking them. The mark was made with a pin. If the carcass was buried I dug it up and re-buried it after I noted the species, trying to place it back in its exact location. If a *Nicrophorus* species was already on a point and buried the carcass the previous day, I did not dig it up and assumed that one of the ones I marked previously at that point had buried the carcass. If the carcass was moved, I moved the flag in order to accurately know where the beetle had buried the carcass. I continued this same process for each day for 3 days at each site and then checked a week later for the results.

One week after day 3 (day 10) I checked all the carcasses again. I dug up all the carcasses and observed which species were present and if any of the *Nicrophorus* species were marked. If they were marked I re-measured and sexed them to see if they were the same ones that I initially observed on that carcass. I also checked to see if any beetle larvae or eggs were present. I repeated this process for each site.

Results

N. investigator was much more abundant than *N. defodiens* and *N. guttula* in the meadow habitat, in both sites as shown in Fig. 1. *N. defodiens* was more abundant than *N. investigator* and *N. guttula* in the aspen habits as shown in Fig. 2. The percentage of *Nicrophorus* varied greatly from habitat for each site: day 3 site A $\chi^2(1, N=30) = 22.97, p<0.0001$; day 10 site A $\chi^2(1, N=29) = 22.77, p<0.0001$; day 3 site B $\chi^2(1, N=30) = 34.11, p<0.0001$; day 10 site B $\chi^2(1, N=29) = 24.35, p<0.0001$.

Discussion

My results indicate that there is habitat selection among *N. defodiens* and *N. investigator*. The meadow habitat was primarily *N. investigator* and the aspen habitat was almost exclusively *N. defodiens*. It also appeared that *N. defodiens* had a higher reproductive success than *N. investigator*.

The life history of *N. defodiens* indicates that its preferred substrate is leaf litter (Trumbo 1992). This could be an indicator of why it is primarily found in the aspen. Being smaller in size than *N. investigator* also appears to play a role (Smith et al 2000). In the occasion when both *N. defodiens* and *N. investigator* occupied the same carcass, *N. investigator* always won the carcass. *N. defodiens* higher reproductive success could be due to the aspen habitat having factors (temperature, substrate, shade, etc...) that decrease interspecific competition or *N. defodiens* having a higher competitive fitness. Further studies will need to be done to observe these effects. Further studies will also need to be done on the habitat selection of *N. guttula*.

These results indicate that there is habitat selection among burying beetles and that habitat selection for each species is not random. Habitat selection is one way to avoid competition and potentially be competitively excluded.

Literature cited

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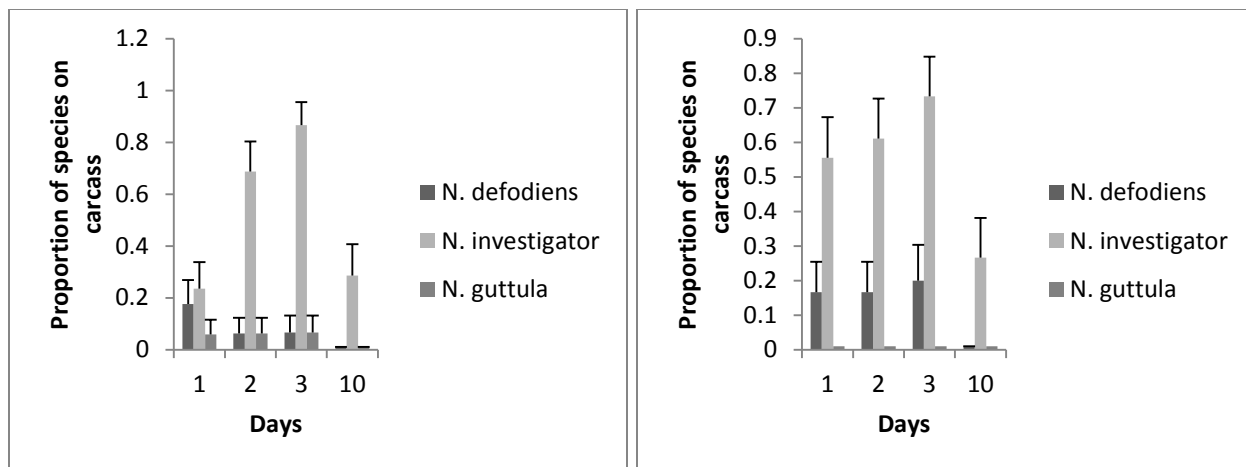


Fig 1. Percent of *N. defodiens*, *N. investigator*, and *N. guttula* occupying the carcasses in the meadow habitats. Site A (left), Site B (right)

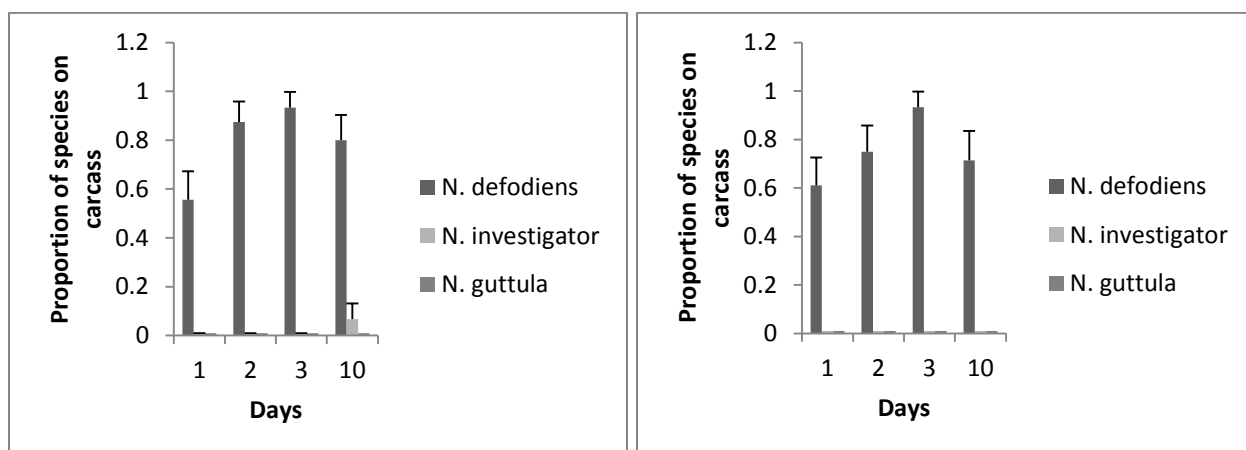


Fig 2. Percent of *N. defodiens*, *N. investigator*, and *N. guttula* occupying a carcass in the aspen habitats. Site A (left), Site B (right)