Natural History and Reproductive Biology of a Hahniid Spider in Southwestern Michigan

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Abstract

The main goal of my research was to determine basic life history features of the numerically dominant spider, *Neoantistea magna* (Hahniidae) that occurs in the dry-mesic forest at Pierce Cedar Creek Institute (PCCI) and the beech-maple forest at the Hope College Nature Preserve (HCNP). The life history traits that were studied were the seasonal timing of maturity by females and males, mating, and egg laying. In contast to all previously known studies, I found males far out numberd females at my study sites. I also observed mating between *N. magna* and found it to lack extensive courtship, however there was some evidence that males use pheromones to find females.

Introduction

Neoantistea magna is a relatively small spider (body length 3.7mm; Opell and Beatty 1976) that is numerically dominant in many northern temperate deciduous forests (Opell and Beatty 1976) and is the most common ground dwelling spider in the dry-mesic forest at PCCI (Bultman and DeWitt, unpubl. data). Even though *N. magna* is very common, very little is known about its biology. It makes small webs in the leaf litter on the forest floor, but it is not known if these webs are used for prey capture and/or a place for *N. magna* to mate.

Interestingly males have seldom been collected in pitfall traps during June-August sampling. Bultman et al. (1982), Brady et al. (1991), Bultman and DeWitt (unpubl. data - 2005), and Brady (unpubl. data - 1995) all found only females in collections taken from June until August from sites in southwestern Michigan. Brady (unpubl. data) did find a

few mature males in June and September in 1986. This suggested to me that males are active before June (with mating likely occurring in April and May) and die off soon after (Opell and Beatty 1976).

A previous study done in the deciduous forests of Tennessee found that each year spiders consume around 43.8% of the arthropod biomass (Moulder and Reichel 1972). Spiders are the most dominant predator in the leaf litter of dry-mesic forests, and since *N. magna* is the numerically the most dominant spider in the leaf litter of theses forests, better understanding the natural history of *N. magna* should enhance the understanding of forest ecosystems in general.

Methods

Field Work

I spent 3 weeks at PCCI collecting *N. magna* in the dry-mesic forest. I established a grid of nine pitfall traps to collect *N. magna*. The grid was nine by nine feet with pitfall traps place every three feet. Four other pitfall traps were also set up, two 50 feet north of the nine by nine grid, and two 50 feet south of the grid. The traps were uncharged (no preservative). Traps were checked twice a day for two weeks, once at 9:30a.m., and once at 5:00p.m. If a *N. magna* was found it was captured in a vial and taken back to the wet lab. The sex of the spider was determined if possible, and then the spiders were placed in separate containers. Five spiders were found the first week, but weather conditions turned cold and wet for much of the 3 weeks and I was unable to capture any additional spiders after that first week.

Once the portion of the study that was conducted at PCCI was over, work at Hope College's field station was continued for eight more weeks. While at the Hope College Nature Preserve (HCNP), 40 pitfall traps were put out. The traps were checked twice a day, once in the morning, and once at night. When a *N. magna* was found in one of the traps it was brought back to the lab for rearing.

I attempted to assess activity levels of spiders by using a grid of uncharged pitfall traps (separated by 10' in a 4x4 grid), similar to Sechterova (1992). Spiders were collected twice daily. Spiders were marked (cellulose paint on legs, as in Zuniga et al. 2002) and released.

Laboratory Work

Spiders were housed in 7.6cm dia plastic cups with a mixture of plaster-o-paris and charcoal in the bottom. Spiders were fed pinhead crickets, spring tails (Collembola) or *Drosophila* every other day and housed in an environmental room at 26^{o} C, 60% relative humidty, and a 14:10 L:D cycle. Captive pairs of males and females housed in plastic containers with litter substrate were observed for mating behavior. Components of the behaviors were identified.

Experiments were conducted to determine the importance of olfactory cues for males in mating. In the laboratory pheromone tests were performed by placing mature female spider on a three inch piece of filter paper for one hour. Next, using latex gloves, a 1x1 cm square of filter paper was cut out of the filter paper that the female was on. A duplicate 1x1 cm square of clean filter paper was also cut out. Next a clean piece of filter paper was put in a sterilized Petri dish. Then the two 1x1 cm squares of filter paper were

placed in the Petri dish. Once the Petri dish was set up a mature male spider was put in the Petri dish for one hour. Every minute the position of the male spider was recorded to see if it was on the control filter paper, the filter paper with the female's pheromones, or neither of the two pieces.

The other half of the laboratory work consisted of observing mating behavior of *N. magna*. First the male and female spiders that were used in this experiment were fed so that they would not be hungry and possibly try to eat each other during the experiment. To observe mating the female was first put in a 6"x6" plastic arena. The female was left alone in the container for one hour to become acclimated to her surroundings. After an hour the male spider was introduced into the 6"x6"arena with the female. The two spiders were observed for an hour and if copulation occurred observations were recorded in the laboratory notebook.

Analysis

A phenological time line was constructed for *N. magna* that shows immature, penultimate, and mature spiders were caught. A bar graph of the pheromone data was also constructed to show whether or not the males detect pheromones during reproduction.

Results

An analysis of the phenological timeline data shows that mostly males were caught for the first seven weeks (Fig. 1). The last three weeks of the graph also show a decrease in penultimate males and an increase in mature males. The last five weeks also show a peaking in the occurrence of immature *N. magna*. Oddly, almost no females were

collected. Only four females were collected and they were collected as immatures that matured in the lab.

I found that male spiders showed some response to filter paper that females had contacted (Fig. 2), however the response was not striking. Most males spent most of their time off either control or experimental filter paper. Yet, my results do suggest that males detect and respond to some pheromones that female spiders produce.

Observations of mating behavior (n=2) revealed that the male approached the female. The spiders touched each other with their legs. The female remained stationary as the male crawled under or along side of female and inserted one palp. The male held the female with first two pairs of legs. The pair adopted mating position V (Kaston 1948). After 5-10 min the female tried to run away, but male remained attached. The pair remained *in copula* for 30 minutes or more.

Recapturing spiders in a grid system of pitfall traps was only partially successful. Three spiders were recaptured and indicated that male spiders can move at least 10' during the course of a 24 hr period.

Discussion

The results for the phenological life history data were much different than what I expected to see. I expected to catch mostly female *N. magna* throughout the course of my research, but I found just the opposite. According to previous studies, female *N. magna* dominate from June through August (Bultman et al. 1982; Brady et al. 1991; Brady unpubl. data; Bultman and DeWitt, unpubl. data). I expected to find males in May, since previous workers had found almost entirely females after May. While I did find

males (actually immatures that later molted into mature males in the lab) in May, I also found almost all males the rest of the summer. A female *N. magna* was not caught until the week of June 19th. Not only were the females caught late, they were penultimate females. Since these females were one molt away from maturity, mating would not occur until late July or early August. Figure 1 shows that spiders caught through the seventh week were primarily penultimate males, and then mature males were primarily caught for the remainder of the project. This shows that the majority of male spiders molted during the last week of June. Figure 1 also shows that the number of immatures peaked during the week of June 19th. One possible reason for th emale doinated sex ratio could be weather - we had an unsually cool and wet spring. Yet, it is not known if or how these conditions would result in a preponderance of males. Another possible explanation could be that females are simply better at crawling out of pit fall traps than males. Since all previous studies caught *N. magna* using pitfall traps with preservative in the bottom of them, the spiders never had a chance to crawl out, but since the spiders in this experiment needed to be kept alive, no preservative was used in the bottom of the traps, so the spiders had time to at least try and crawl out, even though this particular species cannot climb on smooth surfaces. These explanations are merely speculation and further research would need to be undertaken in future summers to better understand why the number of females that were caught this summer was so low.

Sex ratios skewed toward female spiders have been previously reported (see Goodacre et al. 2006). These have been in favor of females and may be due to *Wolbachia* and other endosymbionts that are known to infect spiders and can skew sex ratios of their host in favor of females. This could be the cause of the commonly

observed female biased ratio in *N. magna*, but would not explain the pronounced male biased sex ratio I observed. The cause and extend of varied sex ratios in *N. magna* present an intriguing question for future researchers.

I had intended to assess activity levels in males and females to determine the extent to which both sex moves within its leaf litter habitat. *Neoantistea magna* is a bit of an enigma because it builds webs but apparently does not stay at the web all the time. Evidence for this conclusion comes from previous pitfall trapping efforts (Bultman et al. 1982, Brady et al. 1991, Bultman and DeWitt unpubl. data, and Brady unpubl. data) which have captured the spider in large numbers. Because pitfall traps only capture mobile arthropods, *N. magna's* occurrence in them shows that it moves withiin its habitat. I did recapture 3 spiders (all males) in a 9x9 grid of pitfall traps. The spiders had moved from one pitfall to another (a distance of 10') during the course of 24 hrs. Unfortunately, I could not compare movement patterns between the sexes because no females were captured. Noneless, I can conclude that males do move at least 5' from their webs.

Once I had enough mature females, mating observations and pheromone tests could be performed. I hypothesized that male *N. magna* would spend more time on the female scented filter paper than on the unscented filter paper. Males spent the majority of their time on neither the female scented filter paper or on the unscented piece of filter paper (Fig. 2). Even though the male did not spend the majority of his time on the female scented filter paper, he did spend more time on the scented paper than on the unscented paper. It should also be noted that most of the time males were on neither pieces of filter paper they were within 1cm of the female scented paper. Although the males seem to be attracted to the female scented paper, more data need to be collected in future studies.

One thing that could be taken into account in future studies is determining how much time is spent near the scented or unscented pieces of filter paper.

Reproduction was observed in the laboratory in late August and likely also took place at this time in the field. In addition, it likely occurs in early summer/late spring since mature males and females have been found at this time (Brady unpubl. data) and I found immatures in June which presumably were from late spring matings. If the sex ratio varies widely from year to year, as my study suggests it may, the period of mating may also vary.

The mating position adopted was similar to that observed for the confamilial spider, *Antistea* (Kaston 1948). Mating involved almost no courtship with the male approaching the female. Contact with the front legs preceded copulation. More observations of mating behavior should be conducted in the future to better describe its features.

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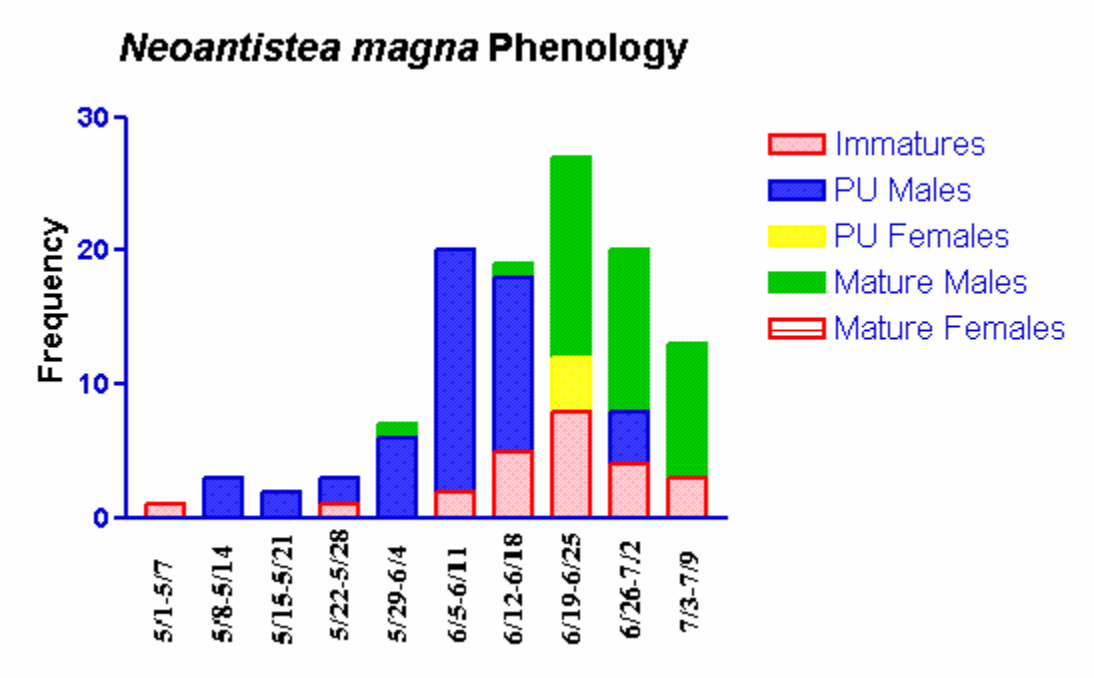

Figure 1: Figure 1 is a phonological timeline that the occurrence of male and female *N. magna* at immature, penultimate, and mature stages.

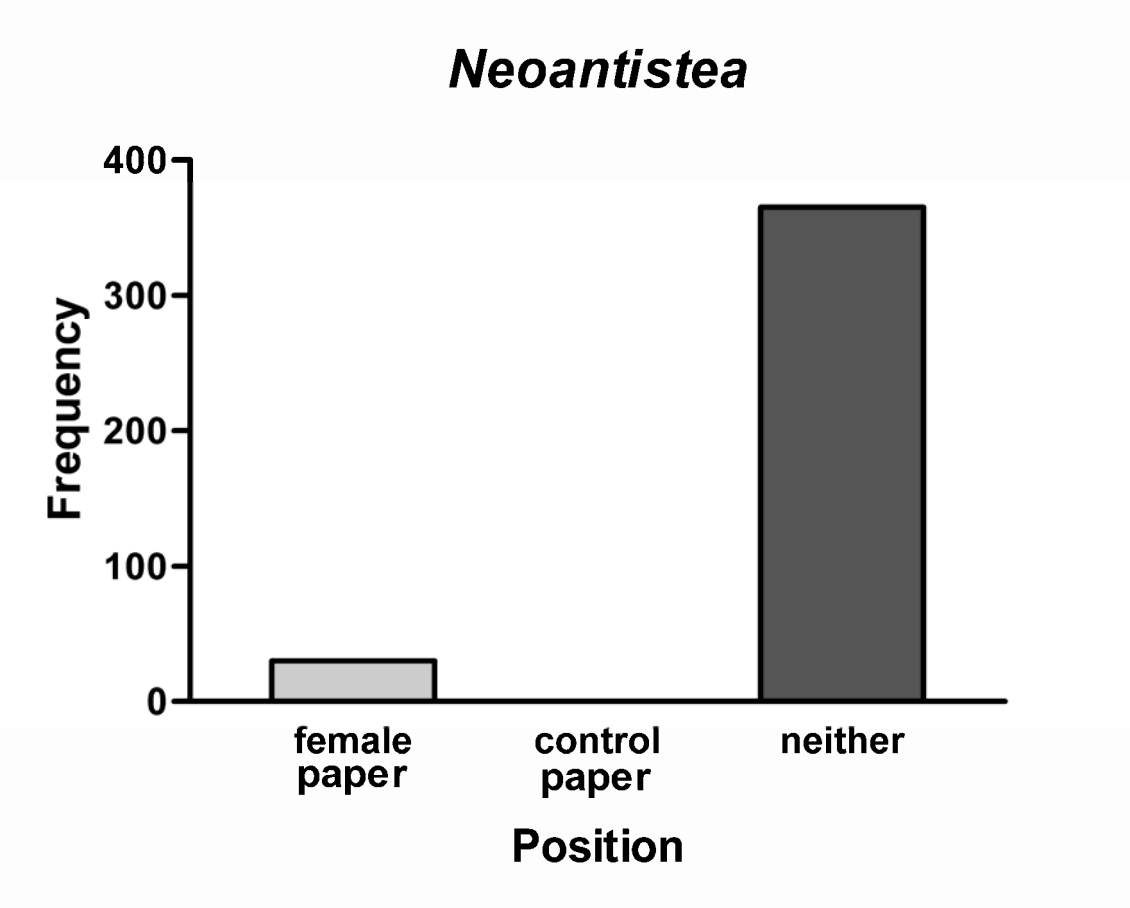

Fig 2. Frequency of observations in which males were observed on: 1) filter paper with which females had been in contact, 2) filter paper with which females had not been in contact, and 3) on neither pieces of filter paper.