BIOS 35502-01: Practicum in Field Environmental Biology

Potential Changes of Seed Predation of *Tamias striatus*

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Abstract:

Eastern chipmunk (*Tamias striatus*) is seed predator that has the ability to affect the diversity and abundance of certain tree species in a forest. This study tested the seed preference of eastern chipmunks on the border of Wisconsin and the Upper Peninsula of Michigan at University of Notre Environmental Research Center. Cafeteria style feeding trials were done in a laboratory to test the preference of eastern chipmunks between five seed species. The five seed species used in this study was balsam fir, pin cherry, hazelnut, sugar maple and red maple. Fourteen trials were run on captured eastern chipmunks. A Kruskal-Wallis statistical test was run in order to find significance of preferred seeds. The results observed were significant (p=0.00027378, df= 4) in that eastern chipmunks prefer both hazelnut and sugar maple while they avoid balsam fir and red maple. There were three seed species that showed a significant difference which are sugar maple and balsam fir (p=0.01774961), hazelnut and red maple (p=0.02103917), and red maple and sugar maple (p=0.00123917). Eastern chipmunks prefer hazelnut and sugar maple seeds this will probably cause a negative effect on the hazelnut and sugar maple trees.

Introduction:

Seeds originate on the parent plant and then are dispersed in order to increase the population of tree species. Both abiotic (weather) and biotic factors (interactions with other species) can cause seed mortality and dispersal. Animal species have a large effect on the life of a seed because they either disperse or consume seeds. The foraging of animal species determines the quantity and quality of seed dispersal (Chambers and MacMahon 1994). The quantity of seed dispersal decreases when animal species consume seeds. Seed granivory also detracts from the population of various tree species.

Seed granivory becomes an important factor to an ecosystem by affecting the composition of tree species present in an area. Seed predation by small mammals results in substantial negative effects coniferous forests regeneration (Lobo et al. 2009). Each species of rodents prefers a specific tree seed type and this has the ability to negatively affect the course of forest regeneration through changes in seed bank (Pank 1974). Rodents often exhibit seed preferences when there is an equal abundance of a variety of seeds available (Chambers and MacMahon1994). The preference of a rodent can determine which tree species will be most negatively affected by the seed predation which will eventually cause a decrease in that specific tree species.

Eastern Chipmunk (*Tamias striatus*) is a granivorous small mammal that is abundant in northern hardwood forest. Eastern chipmunks are in the Scuridiae family which consists mainly of other chipmunk species and squirrels (Elliot 1978). Due to the fact that eastern chipmunk is more likely to consume rather than disperse seeds, they are a true generalist seed predator (Schnurr 2002), and are more likely to decrease tree populations. Therefore, the seed preference of eastern chipmunk may have an effect on the possible decrease of tree populations, because the most preferred seed will have the greatest chance of decreasing. The objective of this study was to determine which tree species could be the most affected by eastern chipmunk identifying their seed preferences. Five of the most common wood species in the northern hardwood forest where this study took place are balsam fir (*Abies balsamea)*, pin cherry (*Prunus pensylvanica*), hazelnut (*Corylus cornuta*), sugar maple (*Acer saccharum*), and red maple (*Acer rubrum*) was used (Curtis 1959). *T. striatus* consume a large variety of food items but they consume seeds from dominant deciduous trees of an area the most frequently (Bergeron 2011). Sugar maple is a dominant tree species in the northern hardwood forest and is abundant throughout the area in which this study is conducted (Curtis 1959). I hypothesize that eastern chipmunks will consume *Acer saccharum* the most frequently.

Methods:

This study was conducted at the University of Notre Dame Environmental Research Center (UNDERC), located on the border between Wisconsin and the Upper Peninsula of Michigan, which contains northern hardwood forests (Curtis 1959). Chipmunks were opportunistically captured using Sherman and Tomahawk traps and brought back to the laboratory where they were placed in glass aquaria. The lid of the aquarium was a piece of plywood with a small hinged door in order to easily to move the chipmunk in and out using a Sherman trap. The aquarium was shaded with white cloth and placed near a window to allow light to enter. In addition, cotton bedding, water and wooden bedding covering the bottom of the aquarium were also provided (Lobo et. al 2009). Striped sunflower seeds (*Helianthus annuus*) were used as food in between period of capture and feeding trial.

Before the feeding trial took place there was a brief starvation period which began at 10 pm and ended at 6 am. Eastern chipmunks are strictly diurnal which is why the starvation period took place over-night so that for the majority of this period they were asleep (Snyder 1982). At 10 p.m. all sunflower seeds were removed from the aquarium and at 6 a.m. the five species of seeds used for this study were added. The seed preference was determined using cafeteria-style feeding experiments in the laboratory (Lobo et. al 2009). This style allows observations of which type of seed the eastern chipmunk consume the most frequently. The seeds were placed in an open container so that the eastern chipmunks had easy access to the seeds at all times once the trial began. In order to test the seed preference of all five species of seeds, twenty grams of each seed species was used during each trial. Each individual species of seeds were pre-weighed previous to when the trial began. The feeding trials lasted 12 hours and took place from 6 a.m. to 6 p.m. At the completion of each trial, the chipmunk was released at its site of capture and the bedding was inspected for seeds. Remaining seeds were sorted to species.

The remains of each seed species were weighed and subtracted from twenty grams (the original weight of the seeds) in order to determine how much of each seed was consumed. Selection ratios were calculated in order to account for unequal amount of seed types (Page et. al 2001). First the total mass of seeds consumed in one trial was calculated. The selection ratio was calculated by using fractions for each seed type of p_c/p_a with p_c being the fraction of all consumed seeds that were type *i* and p_a being the fraction of all available seeds that were type *i* (Page et. al 2001). The selection ratio demonstrates whether a specific seed species is preferred or avoided. If the seed was preferred the selection ratio is greater than one and conversely if the selection ratio is less than one then the seed was avoided (Page et. al 2001). These selection ratios of all five seed species in all fourteen trials was the data used in the statistical tests. All statistical tests were run using SYSTAT 13(Cranes Software).

Results

A Shapiro-Wilk test for normality was run and once it was determined that the data was not normal, it was transformed using log (1+x). The transformation of the data was still not normally distributed and therefore a Kruskal-Wallis statistical test was run in order to determine which seeds were preferred or avoided. The dependent variable in this test was the frequency in which eastern chipmunks consumed each seed species, while the independent variable was the diet or five seed species. There was a significant effect of seed species of selectivity for eastern chipmunks (p=0.00027378, df= 4, Kruskal-Wallis test). Due to the significance of the Kruskal-Wallis test a Dwass-Steel-Chritchlow-Fligner Test was run (Table 1). The relationships between balsam fir and sugar maple (p=0.01774961), hazelnut and red maple (p=0.02103917), and red maple and sugar maple (p=0.00123917) were all significant. The significance was between a seed that was preferred and a seed that was avoided. Red maple and balsam fir was avoided while both sugar maple and hazelnut was preferred (Figure 2).

Discussion

Eastern chipmunks prefer hazelnut and sugar maple and avoid balsam fir and red maple. Other scurids also show preference toward specific seed species if there is a similar amount of seeds available and accessible (McCracken 1999). Chipmunks show a different preference than smaller rodents (for example mice) and partly because they are a part of a different family. Each family has a different effect on various tree species in a forest due to the difference in preference. An increase in the mice population will have a different impact on specific tree species compared to an increase in the sciurid population. The eastern chipmunk population can affect the predation of specific seed species. If populations of eastern chipmunks increase then the population of the seeds they prefer will decrease. The seeds that are avoided by eastern chipmunks increase in population and a decrease of the eastern chipmunk populations will cause an increase in the population of seeds preferred by chipmunks.

Eastern chipmunks had a significant preference towards two types of seeds and avoidance to another two types of seeds. This will probably cause an increase in the amount of hazelnut and sugar maple seeds consumed by eastern chipmunks and a decrease in the amount of balsam fir and red maple seeds consumed. Balsam fir is a small seed that most eastern chipmunks do not prefer probably because of the lack of nutrients compared to sugar maple and hazelnut. Balsam fir is generally avoided just as red maple is by eastern chipmunks. On the other hand smaller mammals such as mice prefer *Acer rubrum* regardless of their small size (McCracken 2009). A possible reason for this is that small-bodied mice are more efficient at opening the smaller seeds and the handling time is too great for them to prefer the larger seeds. Another possible explanation for this is niche differentiation. If mice and eastern chipmunks consume different species of seeds then the two species will not have to compete with one another. In order to avoid the negative effect on population size and growth the eastern chipmunks and mice might have evolved different seed preferences. With less competition, there will be more seeds available for both mice and eastern chipmunks.

Many factors affect the preference of rodents and other seed predators. Types of energy contained within seeds and the ease of handling are some factors that influence seed preferences of rodents (Chambers 1994). Since eastern chipmunks are larger rodents they will probably avoid smaller seeds because they contain lower amount of nutrients compared to a larger seeds. The reward of the large amount of nutrients in a large seed is greater than the work of opening many smaller seeds with fewer amounts of nutrients. Although during the first trial, balsam fir was preferred, this is the only occurrence in which balsam fir was preferred. This probably had an impact on the statistical results of balsam fir only being significant when compared to sugar maple and not hazelnut. More trials would probably cause a decrease in the amount of balsam fir preferred. There is no way to be certain because there is no previous literature on the seed preference on eastern chipmunks from the forests near the Great Lakes. Further studies should be conducted in order to determine the reason why chipmunks favored both hazelnut and sugar maple. It has been suggested that top control of *Tamias striatus* will be increased by the reintroduction of wolves through cascading interactions within the predator guild which is the wolf-coyote-fox cascade. Although predators are not restricted to this diet, on average wolves mostly consume large prey such as deer, coyotes mostly consume intermediate-sized prey such as scurids, and foxes mostly consume small prey such as rodents (Taal and Wilmers 2012). With scurid populations higher than rodent populations, scurids will have a greater effect on tree species in a forest. Figure 3 portrays the negative and positive relationships between wolves, coyotes, scurids and seeds with each column represent an ecosystem with and without the presence of wolves (Based on Berger, et. al 2008). Rodent granivory is at a disadvantage because they are consumed more frequently than scurids. Seed predation by scurids may increase and this new pressure on seeds will possibly affect the diversity of tree species in northern hardwood forests. Populations of tree species preferred by scurids could possibly decrease due to the increase of seed predation. In the future there may be a decline in sugar maple and hazelnut species across the northern hemisphere due to the increase in eastern chipmunk populations that tend to prefer both of these seed species.

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Figures and Tables:

Table 1: Dwass-Steel-Chrtichlow-Figner Test for all pairwise comparisons which shows the statistical significance between each five seed species to each other.

Group(i)	Group(j)	Statistic	p-Value
PC	BF	-0.74737035	0.98446743
PC	HN	1.85217868	0.68519136
PC	RM	-3.33041806	0.12790768
BC	SM	2.59919329	0.35161903
BF	HN	3.08696447	0.18613467
BF	RM	-3.10143137	0.18222376
BF	SM	4.35364876	0.01774961
HN	RM	-4.27671063	0.02103917
HN	SM	0.06497983	0.99999899
RM	SM	5.40814701	0.00123917

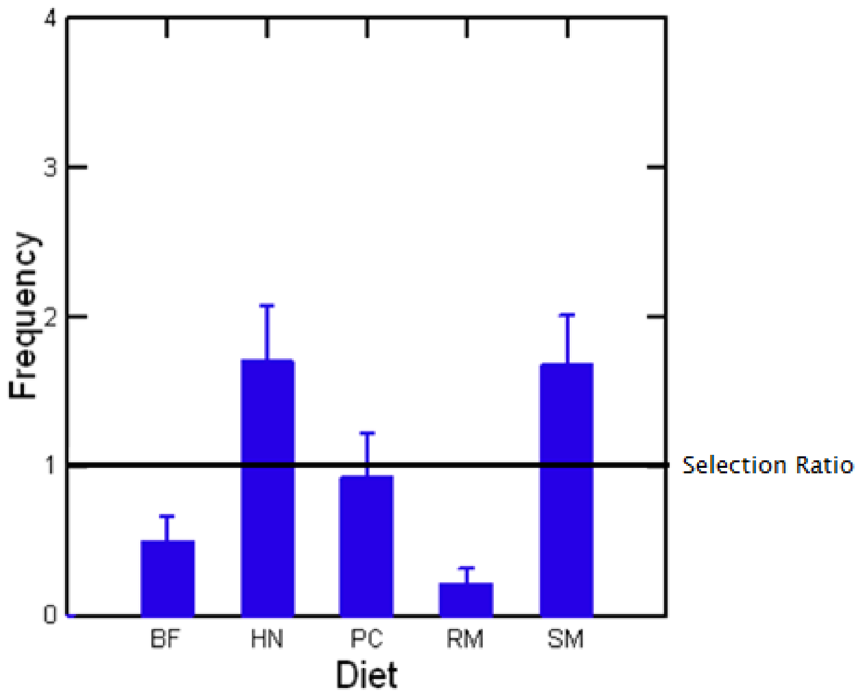

Figure 1: Graph of the statistical differences between each species of seeds. The line represents the selection ratio. Everything above the line was preferred by *Tamias striatus* while everything below was avoided.

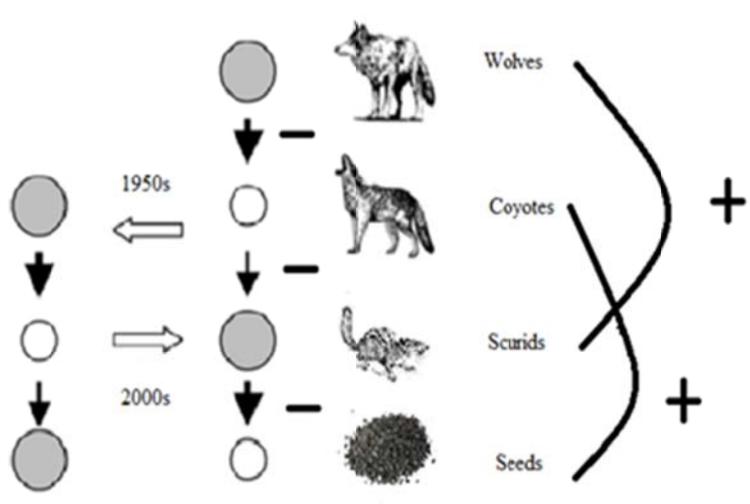

Figure 2: Representation of the wolf-coyote-fox-rodent cascade. The column on the right represents an ecosystem with the presence of wolves. The left column represents an ecosystem with a wolf present while on the left there is no wolf present which leaves the coyote as the top predator.