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Rodent Seed Preference Trials of Ecologically Important Plants in Kentucky

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RODENT SEED PREFERENCE TRIALS OF ECOLOGICALLY IMPORTANT PLANTS IN KENTUCKY

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ABSTRACT

Seed predation is an important ecological process that can affect the success of individual plants and plant populations as a whole. However, seed preferences of herbivores have received little detailed attention in comparison to seedling predation studies (Hulme, 1994). In this project I researched how rodents, specifically their seed preferences, affect the recruitment and survival of ecologically important native plants in Western Kentucky. I used traps to catch *Peromyscus leucopus* (white-footed mice). Once caught, each mouse was placed in a trial arena with seeds from *Silphium perfoliatum* (cup plant), *Baptisia australis* (blue false indigo), *Silphium lanciniatum* (compass plant), and the *Arisaema triphyllum* (jack-in-the-pulpit). After 24 hours, the seeds were counted and recorded. After seven trials, the mice were shown to remove the cup plant seeds and the compass plant seeds more frequently than the blue false indigo seeds and the jack-in-the-pulpit seeds. This research will contribute to the plant community restoration efforts at the Green River Preserve. These findings should help promote new management strategies for the native cup and compass plants in Kentucky.

Dedicated to all my professors, friends, and family who supported me at Western Kentucky University

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VITA

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CHAPTER 1

INTRODUCTION

Seed predation is an important ecological process that can affect the success of individual plants, plant populations and communities. Studies on seedling herbivory have become increasingly popular, especially in grasslands; however, seed preferences of herbivores have received little detailed attention in comparison to the seedling studies (Hulme, 1994).

Rodents are frequently used as test subjects to identify the effects of seed predation on the dynamics and distribution of plant populations (Fedriani, 2005). Mice have strong top-down effects on seed survival and seedling establishment. Ostfeld et al. (1997) studied the effects rodents have on tree seeds and seedlings invading old fields. Abundances of *Microtus pennsylvanicus* (meadow voles) and *Peromyscus leucopus* (white-footed mice) were strongly negatively correlated with the survival of experimentally introduced seeds (Ostfeld et al., 1997). Ostfeld's (1997) team observed that the dominant herbivore was the meadow vole, which had an indirect positive effect on survival of seeds, by suppressing density or activity levels of the dominant granivore, the white-footed mouse. These two species also showed distinctly different food preferences (Ostfeld et al, 1997).

Because of these and other studies, I chose the white-footed mouse for my study as its diet is high in seeds. The range of *P. leucopus* extends from southern Alberta, Maine, and Nova Scotia, southward through the eastern half of the United States to

Georgia and westward to central Arizona, then southward through Chihuahua, Mexico. In addition to seeds, their diet consists of berries, insects, and fruits. (Lackey, et al., 1985) This strictly nocturnal mouse prefers woody areas with vine-entangled underbrush in some places and grasslands in others (Buckner, 1972).

Due to its similarity in distribution to the white-footed mouse, I also intended to use *Microtus ochrogaster* (prairie vole) during this study. The prairie vole occurs from northeastern New Mexico, stretching across to northern Alabama and western West Virginia, and north to Alberta. It inhabits open grassy areas where it constructs a network of paths through the grass. The prairie vole is not strictly nocturnal, and often moves about during the day (Buckner, 1972). Prairie voles are also herbivorous, but their diet includes more roots and tubers of grasses in addition to seeds. (Stalling, 1990). This species was intended to be included in this study to present a comparison to the seed preferences of the white-footed mouse.

My study focused on the potential predation by these rodents on the seeds of four native plant species in Western Kentucky. The seeds chosen were *Silphium perfoliatum* (cup plant), *Baptisia australis* (blue false indigo), *Silphium lanciniatum* (compass plant), and *Arisaema triphyllum* (jack-in-the-pulpit). These plants were chosen based on their seed size, similarities in physical appearance, and distributions. I also chose these plants specifically because these are species we hope to return to WKU's Green River Preserve. By focusing on this subset of seeds, I sought to discover how rodents affect the recruitment and survival of these ecologically important native plants in Western Kentucky. This research was approved the WKU IACUC (Institutional Animal Care and Use Committee).

The cup plant is a perennial herb native to North America. (Shang et. al, 2017). The cup plant grows in moist sandy bottomlands and floodplains near streambeds, in or adjacent to open woodland. The seeds are 9-15 mm long, 6-9 mm wide, strongly flattened with a maximum thickness of 1 mm (Stanford, 1990) and one seed weighs ca. 0.0112g.

Figure 1.1 shows the cup plant (*Silphium perfoliatum)* seeds

Blue false indigo is a perennial leguminous shrub native to North America. A mature plant has a broad crown with 1–10 stems growing to a height of 1.0–3.5 m (DeHaan et al., 2005) and one seed weighs ca. 0.035g. The native range of the species extends from southern Canada to northern Mexico, west to California, and east to Florida. Its natural habitats include open wet woods, moist ground near streams and ponds, rocky banks, and ravines (DeHaan et al, 2005).

Figure 1.2 shows the blue false indigo (*Baptisia australis)* plant seeds.

The compass plant is a perennial found in the tallgrass prairie. It is 1−3 m tall with large deeply pinnate leaves, which it aligns north and south, giving it its common name (Williams et. al, 2015). Such an arrangement enables the plant to take full advantage of morning and evening sun, while avoiding the stronger midday sunlight (Oxford Biology, 2019). One seed weighs ca. 0.089g.

Figure 1.3 shows the compass plant (*Silphium lanciniatum)* seeds.

Jack-in-the-pulpit is a unique, shade-requiring species that is found in most deciduous woods and floodplains. It is a long-lived species and with spread and colonize over times. The flower is an unusual green and maroon striped spathe and is pollinated by small flies. The showy berries each contain one to five seeds and ripen in fall (Schultz, 2004) and each seed weighs ca. 0.088g.

Figure 1.4 shows the jack-in-the-pulpit (*Arisaema triphyllum)* plant seeds.

My prediction for the seed preferences from these trials was based on the findings of Lewis et al. 2011, in which they analyzed food selection of *P. leucopus.* The white-footed mouse chose the food with the higher energy content but avoided food with high protein content (Lewis et al, 2011). Therefore, I predicted that the white-footed mice would prefer the larger seeds, such as the cup and compass plant seeds. Osteld's (1997) studies showed that the meadow voles had different food preferences; therefore, I predicted the voles in my trials will have different seed preferences than the white-footed mouse, preferring the blue false indigo and jack-in-the-pulpit plant seeds. As voles also may store their seeds underground, I predicted they would prefer these two seeds because

they are the smaller two out of the four, and thus easier to manage for the vole. By focusing on this subset of seeds, this research sought to discover how rodents affect the recruitment and survival of these ecologically important native plants in Western Kentucky.

CHAPTER 2

METHODS

I conducted research on the Western Kentucky University Green River Preserve (GRP) in Hart County, Kentucky. During October, this area averages 3.6 inches of rain with the temperature ranging 45º- 70º F and 75% relative humidity levels (The Weather Channel, 2020). The Green River Preserve contains more than 1600 acres of land including bottomlands, uplands, barrens, caves, limestone glades, and sections of the Green River (WKU, 2020).

On the GRP, I initially set 40 traps fixed open for six days beginning on November 6th. This allowed the rodents in the area to become accustomed to recognizing bait in the traps. These traps were dispersed throughout a large field of native grasses including *Sorghastrum nutans* (Indiangrass), on the edges of fields close to the tree lines, and in a large *Festuca arundinace* (fescue) field. Traps #1-21 were set in the Indiangrass field, #22-27 were along the edge of the field, #28- 30 were along the tree line edge next to the Indiangrass field, and #31-40 were in the fescue field. Each trap had a bright orange marking tape labeled with the trap number.

Figure 2.1 depicts a sample native Indiangrass field chosen for the traps.

Figure 2.2 shows the fescue grass field where the Sherman LNG Traps were set.

The traps were LNG non folding live capture humane rodent/ rat traps, made by H.B. Sherman Traps. The traps were initially baited with commercial wild bird seed, then, once the trials began, polyester poly-fil was added as nesting material. Figures 2.3, 2.4, and 2.5 depict the trap set up.

Figure 2.3 depicts the Sherman trap open with the poly-fil nesting material and bird seed.

Figure 2.4 shows an example of the Sherman trap set in the native Indiangrass field.

Figure 2.5 shows an example of the Sherman trap set in the fescue field with the marker tape.

Once I was ready to begin the trials, the traps were set to initiate closure. Over the course of seven nights, seven white footed mice were caught and used in the trials**.** Once the rodents were trapped, I took the individual animal and its corresponding trap to the arenas. The trial arenas were made out of hardware cloth, with 0.5 in. mesh. The perimeter of the arena was dug 12 in. into the ground to provide stabilization for the wire and to prevent the rodent from crawling out under the sides. A hardware cloth top was also attached with zip-ties at multiple points to ensure security. The arenas were located in the open field located next to the two barns at the entrance of the GRP. The four arenas were 3 ft x 2 ft x 2 ft.

Figure 2.6 shows the trial arena open with the seed cups from trial #1 present.

Figure 2.7 depicts the trial arena closed with the rodent trap from trial #1 set open and the seed cups present.

Before placing the rodent in the trial arena, the seeds were placed in cups in the arena. For trial #1, 10 seeds of the cup plant and compass plant seeds were placed in individual cups, 15 jack-in-the pulpit seeds, and 20 blue false indigo seeds. The number of seeds in the cup was based on seed size, the larger the seeds the fewer seeds were given. The remaining trials following were given 10 seeds of each plant species. The order in which seeds were placed in holding cups was randomized each trial. To prevent the rodent from being forced to eat the seeds, a tablespoon of supplemental wild bird seed

was placed within the trap as a positive control. The rodent was also given adequate water and nesting material to suffice for the entire trial period. The rodent was in the trial arena for 24 hours and then the results were recorded. The results were based on how many seeds of each species was taken.

Once one individual trial was completed, the rodent was marked with a non-toxic felt-tipped, permanent marker on its back to ensure it was not recaptured and reused. The rodent was then released back to the location from which it was trapped. Because rodents are dependent on scent marking, the trial arenas were moved to a new location in the field after every individual trial.

CHAPTER 3

RESULTS

Over the course of my trials, I caught two species. These species included *P. leucopus* and *Blarina carolinesis* (southern short-tailed shrew). As the short-tailed shrew is an insectivore, these were immediately released upon capture every time, if found alive. Table 1 shows at which trap each individual was caught, the date it was caught, along with the outcome of the individual.

Table 1

Date	Species	Trap Number	Outcome
11/12	*Peromyscus leucopus*	19	Dead in trap, left out for scavengers
11/12	*Peromyscus leucopus*	22	moribund, released immediately upon capture
11/12	*Peromyscus leucopus*	23	Dead in trap, left out for scavengers
11/12	*Peromyscus leucopus*	30	Lactating female, released immediately upon capture
11/12	*Blarina carolinesis*	2	Dead in trap, kept for educational purposes

11/13	*Peromyscus leucopus*	13	Dead in trap, left out for scavengers
11/13	*Peromyscus leucopus*	25	Alive, taken to arena for trials
11/13	*Blarina carolinesis*	12	Released at site of capture
11/13	*Blarina carolinesis*	19	Dead in trap, left out for scavengers
11/16	*Peromyscus leucopus*	32	Alive, taken to arena for trials
11/16	*Blarina carolinesis*	38	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	33	Dead in trap, left out for scavengers
11/16	*Peromyscus leucopus*	1	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	28	Dead in trap, left out for scavengers
11/16	*Peromyscus leucopus*	2	Dead in trap, left out for scavengers
11/16	*Peromyscus leucopus*	3	Alive, taken to arena for trials

11/16	*Peromyscus leucopus*	9	Alive, taken to arena for trials
11/16	*Blarina carolinesis*	14	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	15	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	17	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	19	Dead in trap, left out for scavengers
11/16	*Blarina carolinesis*	22	Dead in trap, left out for scavengers
11/17	*Blarina carolinesis*	2	Dead in trap, left out for scavengers
11/17	*Peromyscus leucopus*	1	Dead in trap, left out for scavengers
11/17	*Peromyscus leucopus*	11	Dead in trap, left out for scavengers
11/17	*Blarina carolinesis*	13	Released back to capture spot
11/17	*Blarina carolinesis*	28	Dead in trap, left out for scavengers

11/17	*Peromyscus leucopus*	40	Alive, taken to arena for trials
11/17	*Peromyscus leucopus*	39	Alive, taken to arena for trials

Table 2 lists the rodents used in the trials, date captured and their weight and sex.

Table 2

Date Captured	**Species**	**Trap #**	**Rodent Trial #**	**Weight**	**Sex**
11/13	*Peromyscus leucopus*	25	1	19 grams	Female
11/16	*Peromyscus leucopus*	32	2	12 grams	Male
11/16	*Peromyscus leucopus*	35	3	14 grams	Female
11/16	*Peromyscus leucopus*	3	4	17 grams	Female
11/16	*Peromyscus leucopus*	9	5	15 grams	Female
11/17	*Peromyscus leucopus*	40	6	16 grams	Male
11/17	*Peromyscus leucopus*	39	7	16 grams	Male

Table 3 lists the number of seeds taken after the 24-hour trial.

Table 3

Rodent Trial #	Cup Plant	Compass Plant	Blue False Indigo	Jack-In-The-Pulpit
1	15	15	3	3
2	5	5	2	0
3	5	6	3	1
4	6	4	0	1
5	6	8	0	2
6	4	2	0	0
7	1	3	0	0

As no prairie voles were caught, the white footed mouse was the only species used for my seed preference trials. Overall, the mice tended to prefer the cup and compass plants.

The average number of cup plant seeds taken over the trials was 6. The average number was 6.14 for the compass plant seeds, 1.14 for the blue false indigo plant seeds, and 1for the jack-in-the-pulpit plant seeds.

CHAPTER 4

DISCUSSION

I cannot reject my initial hypothesis that the white-footed mice would prefer the larger seeds. The cup and compass plant seeds were consistently removed more frequently indicating that the white-footed mice had seed preferences. The cup and compass plants are very similar in shape, size, and overall appearance, so it would stand that their energy content and desirability are very similar. These results could explain why it is potentially difficult to get the cup and compass plants to grow, due to predation.

I found that sites 19 and 28 had the highest number of captures of shrews. These sites were in the Indiangrass field and along the edge of the field. The site with the highest number of captures of mice was site 1. This trap site was at the entrance of the Indiangrass field. The sites with the overall highest numbers of captures were 19 and 22. The majority of captures were close to the edges of the Indiangrass field; however, it was shocking that the traps in the fescue field (#31-40) were also very successful. The number of shrews caught during the study was also surprising, alluding to the abundance of this species in the area.

There are a few things I would have changed about my study. Pending permit and financial approvals, I would have trapped the rodents over a longer period of time. This would have given me a better understanding of the diversity and density of rodents in the area. This would have also potentially given me the opportunity to have voles in the study

as well. Larger sample sizes and multiple species would have accommodated more hypotheses and statistical comparisons. Having a longer period of time for the research would have also allowed us to learn if the seed preferences changed with the climate over the course of the semester, or even year.

I believe the cold weather also affected the results of the trials. Even with a large quantity of the polyester poly-fil for nesting material and warmth, the majority of the mice caught were deceased upon arrival when I checked the traps. This can most likely be attributed to the colder temperatures ranging from about 35-45º F at night over the course of the trials.

The results from this trial will help promote studies of more seed preference trials in our area. Knowing that white-footed mice would choose the cup and compass plant seeds over other seeds will help ensure successful reintroduction of these plants. This research will contribute to the plant community restoration efforts. These findings should help promote new management strategies for the native cup and compass plants in Kentucky.

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