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Effects of Vertebrate Herbivory on *Clematis morefieldii*, a Federally Endangered Plant

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ABSTRACT: This study focuses on how vertebrate herbivory affects the reproductive success of Morefield's leather flower, *Clematis morefieldii*, from plant emergence in spring to after fruit dispersal in autumn. Morefield's leather flower is an endangered perennial vine found in only three counties in northeast Alabama and south Tennessee. High levels of vertebrate herbivory damage have been observed on these plants. Suspected leaf and seed herbivores include white-tailed deer, rabbits, and small rodents. High levels of herbivory have the potential to reduce plant vigor, fruit production, and regeneration, thereby posing a serious threat to the future viability of plant populations. Herbivory studies include a reproductive attrition and post dispersal achene predation study along with herbivory surveys at all accessible sites. The reproductive attrition and post-dispersal achene predation studies are all conducted at a large population in Madison Co., AL, and the herbivory surveys should give insight into whether or not similar herbivory problems are occurring at other populations. The reproductive attrition study documents the number of flower buds producing achenes and also records the probable cause for those buds that were not successful. Vegetative herbivory has also been recorded for plants in the reproductive attrition study in an attempt to correlate high levels of herbivory with reduced reproductive effort. Achenes in the post-dispersal achene study are being eaten by unknown herbivores, and documentation of these herbivores is being attempted. Information gathered in this study will allow managers of this species to understand some of the factors that ultimately can limit the long-term viability of Morefield's leather flower populations.

KEY WORDS: Alabama, *Clematis morefieldii*, endangered plant, herbivory, Morefield's leather flower, rabbits, rodents, seed predation, white-tailed deer

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INTRODUCTION

Clematis morefieldii Kral (Morefield's leather flower) is a perennial climbing vine in the Ranunculaceae growing in excess of 5 meters long. It has small pink to green, urn-shaped flowers (Figure 1) that bloom from late April through early July. Each flower contains multiple pistils, maturing in to an aggregate of achenes (Figure 2). The plant is endemic to the Plateau Escarpment ecoregion (Figure 3) and is known to occur in Jackson and Madison

Counties of northeast Alabama and in Franklin County of south Tennessee (Estes and Fleming 2006). All populations are within 55 km of Huntsville, AL (Schotz 2007).

Clematis morefieldii was discovered in 1982 (Kral 1987) and was federally protected as an endangered species by 1992 (USFWS 1992). There are 20 surviv-



Figure 1. *Clematis morefieldii* (Morefield's leather flower) is a perennial climber with small pink to green, urn-shaped flowers.

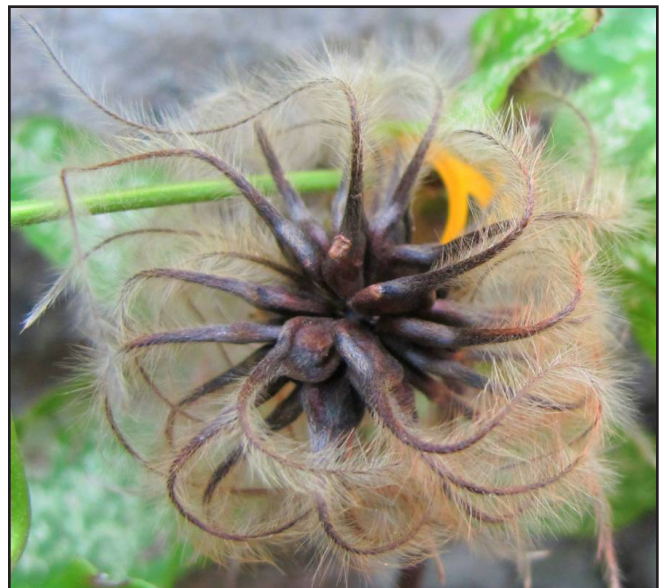


Figure 2. Each flower contains multiple pistils, maturing into an aggregate of achenes.



Figure 3. Example of the landscape in the Plateau Escarpment ecoregion, northeast Alabama and south Tennessee.

ing populations, and at least 3 populations have already been extirpated since its discovery. Populations are still in danger and Schotz (2007) identifies development as the primary threat to urban populations. Populations in more rural areas can also be threatened due to incompatible forestry practices. Data collected in this study suggest that vertebrate herbivory is common, and therefore could be a threat to the long-term success of small populations.

METHODS

Herbivory studies of *Clematis morefieldii* are centered at The Nature Conservancy owned Keel Mountain Preserve in Madison County, AL. Reproductive attrition studies record the state of all flower buds produced by 40 reproductive plants throughout the growing season, documenting fruit production and identifying pre-dispersal reproductive bottlenecks. Various types of herbivory, both vertebrate and invertebrate, were also recorded throughout the growing season.

Post-dispersal achene (fruit) predation studies used a paired plot design, placing half of the plots in the *Clematis* zone (abundant *C. morefieldii*), and the other half directly upslope in the Non-*Clematis* Zone (*C. morefieldii* absent). Each plot had 7 mature achenes tethered to a piece of hardware cloth (0.5-inch metal mesh) that was staked to the ground using thick copper wire. Plots were visited bimonthly and achene damage/removal was recorded. Twenty-eight Sherman live traps (H. B. Sherman Traps, Tallahassee, FL) were deployed for 4 nights in an attempt to catch possible achene predators.

RESULTS

Vertebrate herbivory is common for *C. morefieldii* with over 40% of study plants experiencing vertebrate leaf herbivory annually. Over 30% of plants experience low levels of herbivory (< 50% leaf removal) and 12% of plants experienced high levels of herbivory ($\geq 50\%$ leaf removal) annually (Figure 4). Suspected herbivores are primarily white-tailed deer (*Odocoileus virginianus*), and to a lesser extent, rabbits (*Sylvilagus floridanus*).

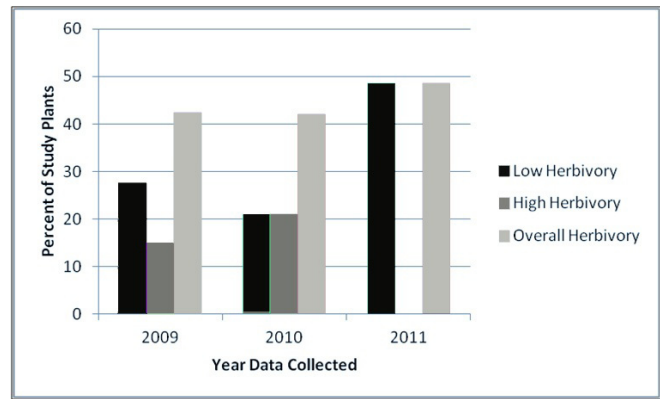


Figure 4. Over 30% of plants experience low levels of herbivory (< 50% leaf removal) and 12% of plants experienced high levels of herbivory ($\geq 50\%$ leaf removal) annually.

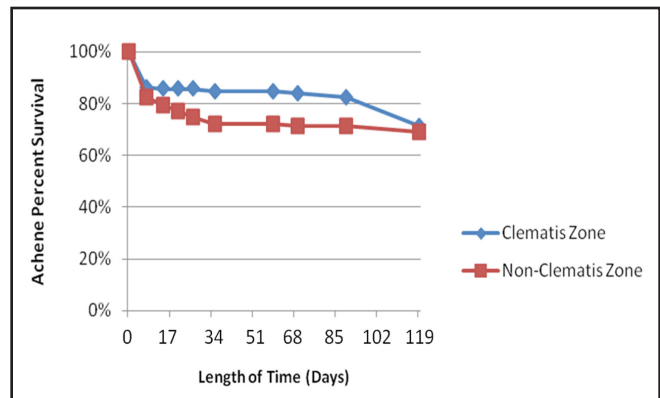


Figure 5. Over a 120-day period, 30% of achenes were removed/eaten.

Post-dispersal achene predation studies found no significant difference between zones. Over a 120-day period, 30% of achenes were removed/eaten (Figure 5). Achene remains suggested small rodent damage (Figure 6), and subsequent trapping produced 4 deer mice (*Peromyscus maniculatus*) (Figure 7).

CONCLUSION

Vertebrate herbivory is common on these plants, therefore it can be assumed that there is some effect on individual plants and overall population success. Reproductive attrition studies over the span of three years resulted in a very large dataset, and therefore interpreting the data has proved difficult. Using multivariate analyses, we hope to better understand the effects vertebrate herbivory has on plant size, plant survival, flowering and fruiting numbers, recruitment, and overall population success within and between years. There is also a large amount of invertebrate herbivory on leaves and flowers, further complicating efforts to single out the effects of vertebrate herbivory.

Post-dispersal achene predation over the course of the winter can possibly remove 30% of viable fruits produced in a year (Figure 6). Though there was no definitive



Figure 6. The appearance of damaged achenes suggest that small rodents were responsible.

evidence, it is possible that *Peromyscus maniculatus* (the only small rodent caught) could be the primary vertebrate achene predator. Grey squirrels (*Sciurus carolinensis*) are also common rodents, and could be responsible for some achene predation.

Vertebrate herbivory could be a serious threat to the long-term viability of small *C. morefieldii* populations. While the population used in this study was inside a nature preserve, hunting does occur in the surrounding area. Most populations of *C. morefieldii* are much smaller (<50 individuals) and are found near the city of Huntsville, AL, where hunting is very uncommon or illegal. This could result in higher levels of large vertebrate herbivory on these populations (Webster et al. 2005). This heightened large herbivory, along with achene predation, could endanger the continued persistence of small urban populations. Future studies hope to quantify herbivory damage at all populations, thereby comparing their herbivory levels with those documented at the Keel Mountain Preserve.



Figure 7. Trapped deer mouse, *Peromyscus maniculatus*.

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