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LINKS TO THE PAST AND THE FUTURE: HABITATS FOR PLEISTOCENE RELICT PLANTS IN SOUTHERN MISSOURI

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1. ABSTRACT

In this study, I measured microclimate variables in three sites supporting Pleistocene relict plant populations using Hobo® data loggers to continually record air temperature and humidity from May 1999 through July 2002. Microclimate data from the study sites were compared to climate data from a nearby automated weather station. Sites that harbor relict plants are not necessarily more cool than the surrounding area during the growing season, but rather they are buffered from wide variation in daily temperature.

2. INTRODUCTION

Contemporary plant communities may contain clues to historic flora. Unusual habitats with microclimates that differ from the surrounding landscape can support populations of locally rare species far from the core of their common range. When these disjunct populations occur far south of their core range in sites that are typically cooler than surrounding habitat, they are often considered to be Pleistocene relicts. That is, the species is presumed to have been locally more abundant during the Pleistocene, but warming climates eliminated populations from all but the most climatically favorable sites as the species migrated moved north. Little is known about the abiotic conditions that maintain Pleistocene relict species in their refugia.

In southern Missouri, populations of three Pleistocene relict plant species (*Zigadenus elegans, Campanula rotundifolia,* and *Galium boreale)* occur on north-facing bluffs along the Jacks Fork River in the Ozark National Scenic Riverways. These populations are presumed to have persisted for thousands of years in what is assumed to be a very localized cool, moist microclimate atypical of the surrounding habitat (Steyermark 1963, Nigh 1988). The Missouri Department of Conservation and the National Park Service are charged with the protection of these particular populations, and they are concerned that stochastic habitat changes, especially extreme weather years, could result in extirpation of some or all of the populations. They are therefore interested in characterizing microclimate variables that may be important to the persistence of these plant populations.

3. STUDY SITES

The study sites are three north-facing bluffs along the Jacks Fork River in Shannon County, Missouri. The bluffs range in height from 11 to 40 meters, and the river runs along the base or within 10 meters of the base of each bluff. All bluffs have the same geologic parent material, and little variation is likely in soil characteristics. In fact, very little soil collects on the vertical bluff face; plants grow from crevices in the rock. In some places on the bluffs, little vegetation exists because there are no crevices. Other plant species may grow anywhere on the bluff face where crevices are present, but relict species are absent from the easternmost and westernmost ends of the bluffs, where aspects are less north-facing. Although three relict species grow on the bluffs, I chose to monitor microclimate conditions associated with *Zigadenus elegans* because it is the most widely distributed relict species on each of the bluffs and presumably the least restricted in its habitat requirements. On each bluff, clumps of *Z. elegans* are easily observed with binoculars or the naked eye. Outermost clumps of *Z. elegans* are readily evident, so that population boundaries on a given bluff are easily identified.

4. METHODS

I measured microclimate variables at six points on each bluff corresponding to points inside, on the edges of, and outside *Z. elegans* population boundaries. I selected two monitoring points near centrally located clumps, one each near the easternmost and westernmost clumps on each bluff, and one each beyond the eastern and western peripheral clumps.

Each microclimate monitoring station consisted of two small Hobo® data loggers; one data logger recorded light intensity; the other recorded air temperature and humidity. In order to protect sensors from direct sunlight, I placed the temperature/humidity data logger inside a mixed plastic resin box painted brownish-gray to match the bluff; the box was open on the bottom side. I accessed monitoring points on each bluff by rappelling from the top. I secured monitoring stations to the bluffs by pounding eyebolts into crevices and tying the boxes on with nylon cord. From May 1999 until July 2002, temperature/humidity data loggers took readings every

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fifteen minutes year-round. Data were downloaded several times each year.

5. RESULTS

Within a given bluff, microclimate patterns remained consistent from year to year. For example, rank order of the six monitoring points changed little or not at all for mean daily temperature from year to year within a study site (data not shown). This consistency of pattern within a given bluff also held for mean daily humidity (data not shown).

In each growing season, the study sites themselves retained the same rank order overall for mean daily temperature; Jamup Cave bluff had the highest values, followed by Bear Hollow bluff and Belew Hollow bluff. In all cases, growing season daily mean temperatures differed by less than 1.0 degree Celsius. A nearby automated weather station at Alley Spring where no relict plants exist recorded mean daily temperature values that barely exceeded those recorded on the bluffs (Table 1).

Table 1. Growing season (April – July) mean daily temperature for all bluffs and a nearby automated weather station at Alley Spring. (1999 values and are for May – July). No significant differences were found between any sites for alpha = 0.05.

Growing Season	Bear Hollow	Belew Hollow	Jamup Cave	Alley Spring
1999	23.20	22.71	23.38	24.38
2000	19.72	19.22	19.68	19.77
2001	20.29	19.79	20.30	20.75

Although there was no significant difference in growing season daily temperature means, growing season daily maximum temperatures were significantly lower in the study sites than at the nearby weather station at Alley Spring (Table 2). In contrast, growing season daily minimum temperatures were significantly higher in the study sites than at the nearby automated weather station (data not shown).

During the winter months of October through February, study sites continued to exhibit higher daily minimum temperatures and lower daily maximum temperatures compared to the surrounding area (data not shown).

6. DISCUSSION

Study sites exhibit lower daily maximum temperatures and higher daily minimum temperatures during the growing season compared to the surrounding area; they are thus protected from large swings in daily temperature during the growing season. This provides a physiologically less stressful habitat for these plants and may explain their ability to persist in an otherwise apparently unsuitable habitat. The sites are also buffered from wide daily temperature swings during winter months when the plants are dormant. Because these are perennial plants, protection from freeze/thaw activity provides a physiologically less stressful environment for the over-wintering underground bulbs. The close proximity of the bluffs to the flowing water of the Jacks Fork River explains ability of the sites to provide sufficient buffering from temperature variation. Continued sufficient buffering in extreme years or under climate change scenarios is important for the continued persistence of these rare communities of Pleistocene relict plants.

Table 2. Growing season (April – July) mean daily maximum temperature for all bluffs and a nearby automated weather station at Alley Spring. (1999 values and are for May – July. Within a growing season, values indicated by * are significantly different for $p < 0.01$ and $\alpha = 0.05$; those indicated by *** are significantly different for $p < 0.0001$ and $\alpha = 0.05$).

Growing Season	Bear Hollow	Belew Hollow	Jamup Cave	Alley Spring
1999	29.12	28.27	30.86	35.34***
2000	25.32	24.85	27.25	29.74*
2001	26.48	25.26	27.72	31.14***

7. REFERENCES

Nigh, T. 1988: Missouri Natural Features Inventory: Carter County, Oregon County, Ripley County, Shannon County. MO Department of Conservation, Jefferson City, MO.

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