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HOW SENSITIVE ARE PACKRAT MIDDENS FOR DETECTING TREE COLONIZATION?

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Purpose:
This purpose of this project is to further research on the age and timing of the arrival of Colorado pinyon pine (Pinus edulis) populations in Northeastern Utah.

Research Question:
When did Colorado *Pinus edulis* populations arrive in far Northeastern Utah in the Crawford Mountains? What do these data tell us about the process of tree colonization?

Introduction:

For this research, packrat middens were collected to establish the timing of arrival of this unique pinyon pine population. Pinyon pine has migrated significantly since the last glaciation from locations in southern Arizona, New Mexico, and central Texas, and is established today across the Colorado Plateau. (Coats et al. 2008). The Colorado pinyon population in the Crawford Mountains is the farthest northern population yet found. By collecting macrofossil evidence of pinyon pine (needles, cones, seeds, etc.), as well as other conifer needles, and plant remains from packrat middens, further evidence of past migrations and environments can be established or confirmed. Paleoecology furthers our understanding of trees' responses to changes in climate plus migration patterns (Norris et al., 2015). The study of paleoecology describes what past ecological changes have happened due to variations in climate. It may also help scientists predict how various species may respond to climate change today. Packrat middens have been used to help determine the timing of the arrival of pine species across western North America by searching for macrofossils of conifers in midden samples.

Packrat middens are found in dry, arid climates which help to preserve plant debris such as needles and pollen for thousands of years (Emslie, et al. 2015). Packrats use organic material from their surrounding area to make their nests. If those nests are preserved, radiocarbon dating of the macrofossils can be used to establish the time that organic debris, such as pine needles, lived. Previous research using packrat middens has well established the effectiveness of middens to record the presence or absence of tree species, including Colorado pinyon (Emslie et al., 2015), and ponderosa pine (Norris et al. 2015; Jackson et al. 2005).

Radiocarbon dating of woodrat/packrat middens is a helpful tool for reconstructing the paleo-history of these species during the late Holocene. Using what we know today about these tree species, we can understand what environmental conditions were like during the late Holocene that promoted their migration. This data is also helpful in the construction of models for how tree species may react to anthropogenic climate change in the future.

Methods:

Ten packrat middens were collected from the Crawford Mountains in Northeastern Utah in August of 2018. The middens were then processed at the University of Utah Records of Environment and Disturbance (RED) Lab, by soaking them in a bucket of water to loosen the materials that were stored in the hardened preserved midden. Once the middens were dissolved, and the materials were loose in the bucket, those materials were deposited into a sieve and placed on a drying rack. After two weeks of dying, those sediments were placed into a gallon zip lock bag and were ready to be analyzed. Sediments were sorted through to identify plant microfossils of interest, especially *Pinus edulis* needles. The *Pinus edulis* needles that were found within each packrat midden were then sent to a lab to be radiocarbon dated.

Results and Conclusion:

Predominate macrofossil samples identified from the middens included *Pinus edulis, Juniperus osteosperma* (Utah Juniper), *Juniperus scopulorum* (Rocky Mountain Juniper), *Pseudotsuga menziesii* (Douglas Fir), and *Cercocarpus intricatus* (Mountain Mahogany). The oldest *Pinus edulis* needle was dated with the radiocarbon age of BP 1600 ± 30 14 C yr B.P. These findings suggest that samples do accurately represent the plant community. Overall, the region of *Pinus edulis* has been expanding since the end of the ice age. A record of ongoing age and timing of colonization for *Pinus edulis* is represented at three northernmost sites: Owl Canyon; 700 B.P (Betancourt et al. 1991), Dutch John Mountains; 800 yr B.P, (Gray et al. 2006) and Crawford Mountains; 1600 yr B.P. (this study). Implications of this expansion could be evidence of the climate changing to conditions more favorable for *Pinus edulis* north of its typical distribution. This study might inform us about how *Pinus edulis* may migrate in the future due to anthropogenic climate change.

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