Late Quaternary Vegetation History and Paleoclimate of the U.S.A.-Mexico Borderlands Region From Packrat Midden Series

1. Introduction:

Two new packrat middens (Neotoma spp.) sampled reveal glacial to interglacial changes in vegetation and climate in the Playas and San Simon Valleys in the USA-Mexico Borderlands. The Borderlands, where the states of Arizona and New Mexico intersect with each other and the Mexican states of Chihuahua and Sonora, are characterized by several north-south-oriented and north-south-directed ranges separated by closed topographic basins. These basins now contain ephemeral playas, but held pluvial lakes (Animas, Cloverdale, Coches, Goodwin, Hueco, Palomas, Playas) during the Pleistocene and lesser lakes sporadically in the Holocene. The valleys receive an annual average of 240-350 mm of precipitation, roughly half of which occurs during summer. Average precipitation is highly variable, with a 20% seasonal and interannual precipitation variability in a dimension of 3-4 mm. The mid-Holocene (c. 6000 BP) to present climate is marked by high summer precipitation and a shift to winter precipitation dominated by C4 grasses, increasing in winter from 30% to 80%.

Packrat middens are deposits of plant materials (seeds, leaves, twigs), bones, pollen, and fecal pellets representing the den of Neotoma spp. (Figure 1). These deposits are abundantly preserved in rock crevices and caves in arid areas of the western U.S., where pollen is poorly preserved. Middens are composed of a large number of specimens from which fossil grains are collected and dated via radiocarbon, providing a “snapshot” of floral assemblages through time. Our study provides insights into past vegetation history and paleoclimate in the Borderlands.

- How has vegetation changed from the late Pleistocene to present?
- What was the timing of major vegetation-climate changes?
- How have desert scrub species changed over time?
- What are the implications of these changes for the present-day vegetation?

2. Methods:

Nine middens from Playas Valley, NM and 60 middens from the Peloncillo Mountains in San Simon Valley, AZ were collected from areas that currently support desert scrub vegetation. Middens were extracted with a hammer and chisel and the external weathering rind removed. Middens were soaked in water to disaggregate the matrix of crystallized urine and release the macrofossils. Midden materials were wet-sieved, and macrofossils identified. Macrofossil abundances were quantitated using a relative abundance scale of 1 to 5, where 0 = 0 fragments, 1 = 1 fragment, 2 = 2-25, 3 = 26-50, 4 = 51-75, 5 = 76-100, 6 = 101-150, 7 = 151-200, and 8 = >200 fragments. Macrofossils were radiocarbon dated to provide chronological control.

3. Results & Discussion:

- Pluvial lake sediments reveal a history of climate change in the Borderlands, with fluctuations in lake level and vegetation composition. The late Holocene is marked by the arrival of Chihuahuan Desert scrub elements and few departures. Desert scrub elements begin to appear by about 6000 BP, marking the transition to present-day vegetation. Desert scrub elements are characterized by high summer precipitation and a shift to winter precipitation dominated by C4 grasses, increasing in winter from 30% to 80%.

4. Conclusions:

- The mid-Holocene to present climate is marked by high summer precipitation and a shift to winter precipitation dominated by C4 grasses, increasing in winter from 30% to 80%.

5. References:

- Haynes, C. V. (1991). Geoarchaeological and Paleohydrological evidence for a Clovis-age drought in North America and its bearing on questions of human migration: A Clovis-age drought. 6000 BP. Desert scrub elements begin to appear, marking the transition to present-day vegetation. Future work will include study of pollen samples from the Peloncillo Mountains middens to identify regional vegetation, including vegetation from the valley floor. Climate envelopes for key C4 and summer-flowering annuals will be constructed, in an attempt to quantify the amount of summer precipitation that fell during the Pleistocene.