

Quaternary Paleontology and Paleoenvironmental Research In National Parks on the Colorado Plateau

By Larry Agenbroad and Jim Mead

National parks on the Colorado Plateau have unique resources and data sets for Quaternary research (Pleistocene and Holocene) of the last 1.8 million years of earth history. The Rocky Mountain Regional (RMR) office initiated a limited contract in the mid 1980s to conduct preliminary resource inventory and research of Quaternary deposits in Canyonlands NP (CANY) and Glen Canyon National Recreation Area (GLCA). This initial contract was a companion study to archaeological studies, by several archaeological contractors. Results of this contract and the increasing awareness of the quantity and quality of Quaternary resources in the national parks led to a second contract, beginning Sept. 1, 1991, for all the RMR parks on the Colorado Plateau.

Quaternary research is interdisciplinary in nature, involving biological, geological, geographical, climatological, and anthropological sciences. Quaternary resources recognized in the Plateau parks to date include: Pleistocene paleontological specimens (osteological and scatological) of a variety of extinct fauna (Fig. 1); vertebrate megafauna and microfauna) and invertebrate (mollusks and insects), as well as fossil pollen and macrobotanical remains. Many of these data sets are included in stratified deposits allowing geochronologic control [C14(radiocarbon) (Fig. 2), TL (thermoluminescence) and U-Th (uranium-Thorium) dating techniques]. Hyperarid conditions characteristic of the Colorado Plateau have preserved material such as dung, hair, horn sheaths, hooves, etc., that usually are considered perishable in more mesic conditions and environments.

Absolute chronologies of stratigraphic sequences allow paleohydrologic reconstructions of past envi-

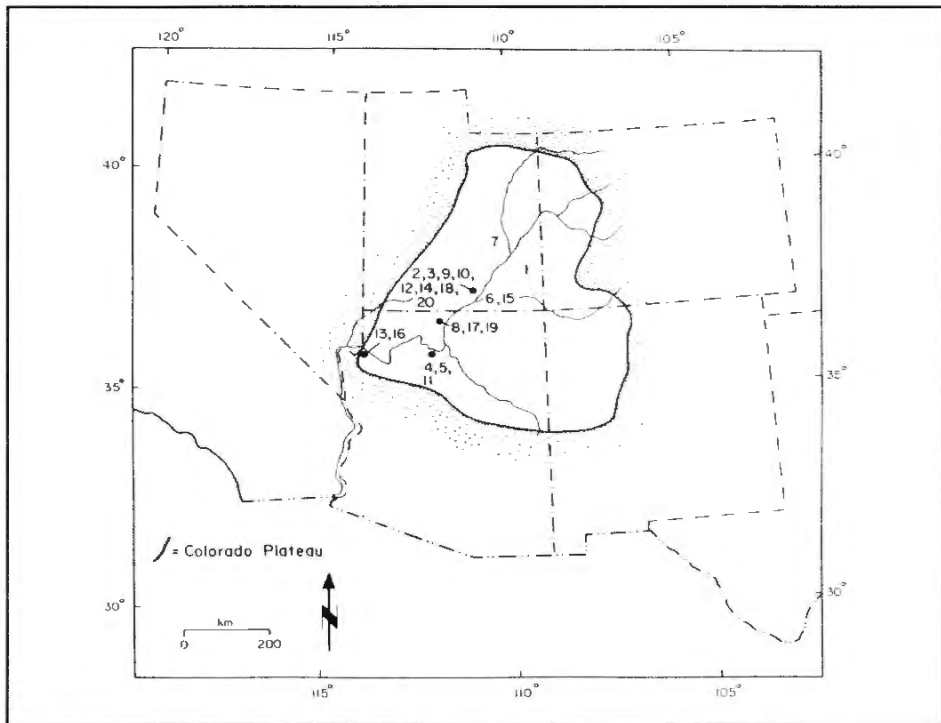


Figure 1. A generalized map of some of the localities of field research covered in this report. (Figure provided by Mead)

ronments, tied to a temporal framework. As such data are gathered and synthesized, we can begin to unravel the formation (and destruction) of soils, geomorphology, etc. Combination of data sets

allows a multifaceted reconstruction of local and regional environments at varied temporal intervals throughout the Quaternary.

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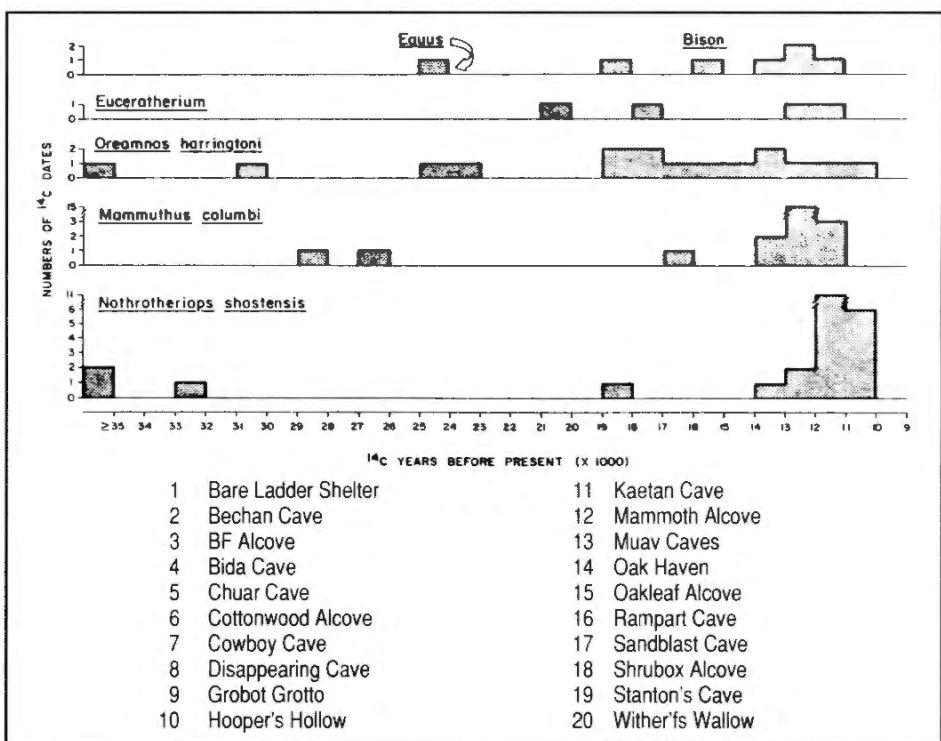


Figure 2. Radiocarbon age plot from dated dung samples of late Pleistocene fauna from the Colorado Plateau. (Figure provided by Mead.)

What types of questions can be addressed by these Quaternary data sets? One line of research receiving considerable attention is paleoclimatic reconstruction. The data sets we have begun to discover and interpret from the Plateau parks promises "fine-tuned" information unavailable from other regions. One example is the fecal remains of extinct Pleistocene fauna including mammoths, shrub oxen, sloths (3 species), horses, camels, bison, Harrington's mountain goat (to name some large animals), plus rabbits marmots, packrats, porcupines, and other small fauna.

All these animals are grazers, browsers, or both. A paleobotanical reconstruction based on multiple species with differing ecological adaptation/exploitation provides a more complete paleobotanical reconstruction model than any single line of evidence. Pollen data added to the macrobotanical and histological data from dung further completes the reconstruction. Knowing the variety of plants in a region at a given time period allows estimates of moisture and temperature conditions necessary for such a plant community. Repetition of such analyses at varied temporal intervals can reveal climatic changes tied to a temporal framework.

Added to the data sets described above, a second set of botanical information is preserved in multiple repositories across the Colorado Plateau. These repositories are packrat middens . . . indurated piles of nest material, "collectibles," feces, and packrat urine (amberrat). We have collected and analyzed packrat middens dating from greater than 40,000 B.P. to modern. Midden analysis can generate independent paleoclimatic change models, and added to the reconstruction from fecal remains, as described above, it enhances the overall model and reconstruction.

Paleontological research within the Quaternary temporal interval documents a variety of extinct Pleistocene fauna, in relative abundance across the Plateau. A map by Harris (1985) depicts the Plateau, north of the northern borders of Arizona and New Mexico, as devoid of Pleistocene paleontological localities. That void has largely been filled in the past 7 years of research, most of which was concentrated in national parks. We have shown the relative abundance of mammoth remains (Agenbroad and Mead, 1989). Similarly, we have documented the distribution of shrub oxen, musk oxen,

bison, horses, camels, sloths, tapirs, giant short-faced bears, mountain goats, and bighorn sheep.

Questions to be resolved are:

1. Precisely when did the various species of megafauna (>100 lb. live-body weight) become extinct on the Plateau?
2. Why did at least some of Pleistocene fauna become extinct at $\pm 11,000$ B.P.?
3. When did bighorn sheep, deer, elk populations become established on the Plateau? Was it contemporary with terminal Pleistocene fauna, or did it happen in response to niche vacancies caused by Pleistocene extinction?
4. Was human influence responsible, or partially so, for the extinction of Pleistocene megafauna?
5. What was the late Pleistocene environment on the Colorado Plateau and how has it changed?

To help us begin to answer some of these questions we have enlisted Dr. J. Theis at U.C.A Davis: he has developed a preliminary method of animal identification from chemical bile "signatures." This technique is especially applicable to the pellet-forming animals such as deer, elk, mountain goats, bighorn sheep, camel, and shrub oxen, among others. Theis has used the NMR (nuclear magnetic resonance) techniques to provide bile signatures of various genera. The hyperarid Plateau environment has preserved fossil dung in conditions that make it possible to apply this technique to extinct fauna. This, combined with microhistology, macrobotanical analyses, pellet morphology, absolute dating, and pollen analyses, provides unparalleled information as to extinction, or replacement, of Pleistocene species; as to the competition, replacement of niche-filling of modern species, and when such changes took place.

Microfauna (<100 lb.) analyses provide added data sets – usually on a local basis, to be integrated into the data generated by the methods enumerated above.

Was there climate change stress? Was there nutrient depletion? Or did the arrival of Eurasian megafauna numbers at approximately 11,500 B.P. cause the extinction of large Pleistocene forms? Until recently, the presence of human cultures predating the Archaic cultures ($\pm 8,000$ - 2,000 B.P.) was not accepted for the Colorado Plateau, with the general rationale in the category of "there was not a megafaunal game base for Paleoindian hunters on the Colorado Plateau." Dot map compilations of

mammoth and bison and the artifact scatter of mammoth and bison hunters for the Colorado Plateau nullifies that reasoning. To date we have not found primary association of humans and Pleistocene megafauna on the Plateau, but we feel this is due to the lack of serious search for such localities. (The dot maps indicate relatively high populations of both the hunters and the hunted for late Pleistocene and early Holocene time periods.)

We have begun to realize that each national park on the Plateau has its own unique set, or sets, of data. Yet as an integrated whole, they provide information that is unretrievable in other parks in other regions of the country. By completion of the current NPS contract, we feel that collectively we will be able to provide syntheses of the Quaternary environments, fauna, human history, and climate changes that previously have never been envisioned – all this for a unique physiographic province encompassing more than 300,000 square miles and for a temporal period (Quaternary) that has virtually been ignored in this region until the last decade.

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