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Reconstruction of woodland vegetation and firewood exploitation in Nine Mile Canyon, Utah, based on charcoal and pollen analysis

Peter Kováčik*, Linda Scott Cummings

PaleoResearch Institute, 2675 Youngfield Street, Golden, CO, 80401, USA

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ABSTRACT

Anthracological (charcoal) and pollen analysis conducted on samples from multiple sites in Nine Mile Canyon, Utah, western United States of America, were used to reconstruct the woodlands of this region and interpret firewood exploitation during the Formative period (~ AD 200–1300). The pollen record identifies constituents of the paleoenvironment of this region, reflecting species that grew in the vicinity of the site and in the broader area. Wood charcoal reflects various trees and shrubs that were used as fuel or for construction by the prehistoric occupants settled in Nine Mile Canyon. Pollen results elucidate a portion of the spectrum of wood taxa, which varies in different parts of the canyon, depending on elevation and the canyon's topography. While micro-charcoal analysis has a long and rich tradition in association with pollen analysis, anthracological analysis is different in that it focuses on macroscopic pieces of archaeological charcoal. Here, anthracology, using SEM imagery, helps define local woody taxa by identifying macroscopic pieces of archaeological charcoal. These two analytical tools build a complementary record of local woodland vegetation through aerial pollen transport and fuel wood selection. While the pollen record is affected by aerial transport, the anthracological assemblages, in most cases, reflect species growing in the vicinity of the prehistoric settlements, but can be affected by natural transport within the drainage. Recovery of Douglas-fir (*Pseudotsuga menziesii*) charcoal from the lower portions of the canyon, containing steep walls and natural conditions not favorable for Douglas-fir growth, indicates presence of drift-wood or debris-flow deposits.

1. Introduction

Although wood charcoal is one of the most common, and many times the only, remains recovered from archaeological sites in the western United States, its interpretative value often has been limited to AMS radiocarbon analysis. Archaeobotanical research usually focuses on identification and analysis of food related plants (corn, cucurbits, beans, etc.) and utilization of seeds, fruits, and nuts from wild plants. Paleoenvironmental and paleoclimatic reconstructions, as well as fire history (Whitlock and Larsen, 2001) are conducted using palynology and dendrochronology (Baillie, 1982), and lately also phytolith analysis (Blinnikov, 2005). Systematic anthracological studies (Asouti, 2003, 2013; Asouti and Austin, 2005; Asouti et al., 2015; Elliott, 2012; Salavert and Dufraisse, 2014; Scheel-Ybert, 2001; Wright et al., 2015, 2017) provide proof that wood charcoal analysis is a powerful tool for prehistoric vegetation reconstruction and understanding woodland modification and change, as well as ancient fuel management. Studies that combine anthracological results with pollen, phytolith, carpological, and dendrochronological analysis provide even better understanding of the relationship between prehistoric societies and their environment. In locations where long stratigraphic lake sediment and/or bog records are available macro-charcoal assemblages from archaeological sites may be compared to relevant regional palynological records obtained from radiocarbon-dated cores (Emery-Barbier and Thiébault, 2005; Náfrádi et al., 2012; Nelle et al., 2010; Nocus et al., 2011; Novak et al., 2011).

This paper aims to present the anthracological investigation of prehistoric features excavated along Nine Mile Creek in Nine Mile Canyon, east-central Utah as an environmental proxy. Dense occupation of the canyon during the Formative period (~AD 200–1300) allows spatial examination of woodland composition in relation to topographical settings of the canyon. Conjunction of

* Corresponding author.
E-mail addresses: peterkovacik@hotmail.com, peter@paleoresearch.com (P. Kováčik), linda@paleoresearch.com (L. Scott Cummings).

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Fig. 1. Map of southwestern United States of America, indicating Nine Mile Canyon (short blue line) on Tavaputs Plateau (approximate boundaries indicated with black line) within the Colorado Plateau (approximate boundaries indicated with white line) (compiled by P. Kováčik). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

these data with pollen analysis provides an ideal tool for micro-regional woodland reconstruction and ancient firewood management on the West Tavaputs Plateau.

2. Regional setting

2.1. Geographic and environmental setting

Situated at the northern edge of the West Tavaputs Plateau (~40°N longitude), at the border of Carbon and Duchesne Counties in east-central Utah, Nine Mile Canyon is one of the most significant areas associated with the Fremont archaeological complex in the northern portion of the Colorado Plateau (Fig. 1). The west-east trending canyon, with the perennial Nine Mile Creek, drains into Green River in Desolation Canyon. Elevation of the canyon bottom ranges from approximately 2300 m asl (7600 ft) in the west to 1400 m asl (4600 ft) at the confluence of Nine Mile Creek with Green River in the east. Walls of the canyon often rise 150–300 m (~500–1000 ft) above the canyon floor, while plateau peaks reach an altitude of approximately 3100 m asl (10200 ft asl) (Bruin Point). High plateaus and rugged terrain with deep canyons dominate the Tavaputs Plateau. In combination with a semi-arid mid-continental climate with limited, but year-round precipitation (Bureau of Land Management, 2011; Knight et al., 2010:108), the Tavaputs Plateau supports various vegetation types. Pinyon-juniper (*Pinus edulis-Juniperus* spp., but mostly *J. osteosperma*) woodlands and shrublands covering dry and hot south- and east-facing canyon slopes (Fig. 2:A) represent important plant communities for prehistoric people of this region (Lanner, 1975:1, 1981, 1983). Edible pinyon nuts and juniper berries were collected for food and medicinal purposes, while wood was used for construction and fuel. Various grasses (Poaceae), yucca (*Yucca* spp.), pricklypear cactus (*Opuntia* spp.), jointfir (*Ephedra* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.) are mixed within the pinyon-juniper ecosystem. Bottoms of the slopes and dry plains support sagebrush-greasewood (*Artemisia* spp.-*Sarcobatus vermiculatus*) shrublands (Fig. 2:B) (Mozingo, 1987), with rabbitbrush (*Chrysothamnus* spp.), snakeweed (*Gutierrezia* spp.), saltbush (*Atriplex* spp.), and Indian ricegrass (*Achnatherum* spp.). Shrubby willows (*Salix* spp.), cottonwoods (*Populus* spp.), maples (*Acer* spp.), and cattails (*Typha* spp.) grow along the creek (Fig. 2:C). Higher elevations and northern exposures support Douglas-fir (*Pseudotsuga menziesii*) stands (Fig. 2:D), while high altitude montane conifer forests consist of fir (*Abies* spp.) and spruce (*Picea* spp.). Today, the canyon bottom is heavily affected by cattle ranching and natural gas wells, and a small agricultural presence is noted.

2.2. Cultural context

The first archaeological explorations of Nine Mile Canyon quickly followed its discovery by Euroamericans in the second half of the nineteenth century and throughout the twentieth century (Gillin, 1938, 1955; Marwitt, 1986; Morss, 2009; Patterson, 2016; Spangler, 2000a:25–38; 2000b, 2013; Spangler and Spangler, 2010). Fremont villages with pithouses on the canyons bottoms, cliff dwellings and granaries (Fig. 3:A), circular structures (Fig. 3:B) on rock outcrops and mesas, as well as countless rock art panels (Fig. 3:C) evidence active life during the Formative Period associated with spread of farming to the Tavaputs Plateau (Patterson and Flanigan, 2010; Patterson, 2015, 2016; Spangler, 2013:165). Agricultural fields in the canyon floodplains and alluvial fans were used to grow maize (*Zea mays*) and possibly other cultigens including beans (*Phaseolus* spp.) and cucurbits (Cucurbitaceae). Previously, major Fremont occupation of the canyon was presumed around AD 1000 (Spangler, 2013:165). Based on new radiocarbon evidence, Patterson (2015, 2016) suggests a “continuous occupation of Nine Mile Canyon from at least AD 500 to AD 1250”, extending to the Early and Middle Formative periods. Recovery of corn kernels/

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