Journal of Archaeological Science: Reports 18 (2018) 51–58

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

New evidence of ancient parasitism among Late Archaic and Ancestral Puebloan residents of Chaco Canyon

Rachel E. Paseka[a,*], Carrie C. Heitman[b], Karl J. Reinhard[c]

[a] Graduate Program in Ecology and Evolution, Department of Ecology, Evolution, and Natural Resources, Rutgers, The State University of New Jersey, 14 College Farm Road, New Brunswick, NJ 08901, United States

[b] Department of Anthropology, University of Nebraska-Lincoln, 833 Oldfather Hall, PO Box 880368, Lincoln, NE 68588-0368, United States

[c] School of Natural Resources, 719 Hardin Hall, 3310 Holdrege Street, Lincoln, NE 68583-0987, United States

ARTICLE INFO

Keywords:
Archaeoparasitology
Atlatl Cave
Chaco Canyon
Coprolite
Pueblo Bonito
Trichuris trichiura
Whipworm

ABSTRACT

Archaeoparasitology provides a unique perspective on the health and habits of ancient cultures through the identification of parasite remains in archaeological materials. We identified eggs of the human whipworm, *Trichuris trichiura*, in coprolites recovered from Late Archaic (1926–1751 cal. BCE) and Ancestral Puebloan (1039–1163 cal. CE) sites in Chaco Canyon, New Mexico. Our findings represent the earliest record of *T. trichiura* in North America, the first record of the species from Chaco Canyon, and the first record of a macroparasite from a Late Archaic site (Atlatl Cave) on the Colorado Plateau. *T. trichiura* is common in the global archaeoparasitology record, but until now it was not known to have infected Ancestral Puebloans. Environmental barriers to transmission and lack of contact with infected Mesoamerican cultures have previously been used to explain the absence of this species from the Southwest. The new evidence of *T. trichiura* presented here raises questions about the cultural context which led to the arrival and persistence of this parasite in both a Late Archaic cave and an Ancestral Puebloan great house at Chaco Canyon. We propose that the moisture requirements of *T. trichiura* transmission may have been met through anthropogenic modification of the local environment, and that the presence of this species at Chaco Canyon suggests contact with infected Mesoamerican cultures. We also report the presence of the pinworm, *Enterobius vermicularis*, and unidentified larval nematodes in the Chaco Canyon archaeological record.

1. Introduction

Parasite remains identified from archaeological materials provide a unique lens on the health, culture, and ecology of human hosts (Reinhard, 1992). This archaeoparasitological perspective has been especially important in the American Southwest, where the arid climate has led to excellent preservation of parasite eggs and larvae in coprolites from many sites (e.g., Reinhard and Bryant, 2006). Parasites provide information about ancient Southwestern health (Reinhard, 2008a), diet (Fry, 1977; Reinhard et al., 1987), migration (Jiménez et al., 2012; Reinhard et al., 1987), and cultural transitions (Hugot et al., 1999; Reinhard, 1988).

Parasitic infection was common at Ancestral Puebloan sites, where sedentary lifestyles, concentrated populations, irrigation, and communal latrines likely facilitated parasite transmission (Reinhard, 2008a). Substantial variation in the levels of parasitism documented among Ancestral Puebloan sites suggests that local conditions and practices determined disease prevalence. For example, eggs from the pinworm, *Enterobius vermicularis*, were common in a prior analysis of coprolites from Chaco Canyon, New Mexico (Reinhard and Clary, 1986). Pinworm thrives in dense host populations, so its presence at Chaco Canyon suggests that residents experienced crowded living conditions. Although pinworm is not particularly pathogenic, its presence suggests that other infectious diseases caused by parasites and pathogens transmitted through a fecal-oral route may also have occurred at Chaco Canyon.

We conducted parasitological analysis of 19 coprolites from one Late Archaic (Atlatl Cave) and three Ancestral Puebloan (Pueblo Bonito, Kin Kletso and Pueblo Alto) sites within Chaco Canyon, NM. Our aims were to expand upon earlier archaeoparasitology research from Chaco Canyon (Reinhard and Clary, 1986) by analyzing coprolites from additional sites and periods of occupancy and to contribute to broader knowledge of Southwestern archaeoparasitology.

Chaco Canyon was extensively settled by the ancestors of contemporary Pueblo people. Today, its widespread sphere of prehispanic influence makes it one of the most important archaeological regions in

* Corresponding author.
E-mail addresses: rachel.paseka@rutgers.edu (R.E. Paseka), cheitman2@unl.edu (C.C. Heitman), kreinhard1@unl.edu (K.J. Reinhard).

https://doi.org/10.1016/j.jasrep.2018.01.001
Received 4 May 2017; Received in revised form 23 December 2017; Accepted 4 January 2018
2352-409X/

North America. Chaco Canyon is recognized as a National Park and a UNESCO World Heritage Site. During the Archaic (5500–3200 BCE) and the Late Archaic (3000–800 BCE), inhabitants of Chacon Canyon transitioned from mixed gathering and hunting economies to mixed foraging subsistence (Mathien, 2005). By most accounts, the canyon was used seasonally (late spring-early fall) in a limited or sporadic way (Elliott, 1986). Elliott (1986) argues that the water catchments in Chaco Canyon aided maize horticulture and seasonal sedentism, although maize (along with squash) was a minor component of a mixed subsistence base during the Late Archaic. Irwin-Williams (1973) identified larger, seasonal aggregations during this period, possibly consisting of groups between 30 and 50 individuals.

A profound social transformation took place in Chaco Canyon between 800 and 1100 CE, resulting in unprecedented construction of massive masonry buildings (great houses) located within a dense and central "downtown" precinct. Seventeen multi-story great houses (50–650 rooms; Lekson, 1984) along with numerous great kivas (circular communal structures) were erected within a crowded nine-mile stretch of the canyon. These large structures were surrounded by hundreds of more modestly built small houses along the Chaco Wash (McKenna and Truell, 1986). Research in recent decades has connected this apparent core of great house and small house sites in Chaco Canyon to an expansive network of roads (Kincaid, 1983; Marshall et al., 1979; Nials et al., 1987; Powers et al., 1983) and approximately 290 outlying great house communities (Heitman et al., 2016) over an 110,000 km^2 area of the northern Southwest. Material signatures of the Chacoan culture or its influence can be found across the Four Corners states (Colorado, New Mexico, Arizona and Utah) in an area as large as Ireland. During the peak of its florescence, canyon inhabitants participated in long-distance trade networks to obtain materials such as copper bells (Toll, 1991), macaws (Watson et al., 2015), turquoise (Hull et al., 2014), shell (Mills and Ferguson, 2008), chert (Cameron, 2001), obsidian (Duff et al., 2012) and cacao (Crown and Hurst, 2009).

Our parasitological analyses of Chaco Canyon coprolites revealed that both Late Archaic and later prehispanic residents were infected with the human whipworm, *Trichuris trichiura*, which represents the earliest known record of the species in North America. Whipworm has generally been considered a Mesoamerican species in antiquity, and it has not been detected previously on the Colorado Plateau despite extensive analysis of coprolites from the region (Gonçalves et al., 2003). These new records of *T. trichiura* at both a Late Archaic cave and a Puebloan great house raise questions as to what events led to the arrival of this species at Chaco Canyon and what conditions allowed it to persist. We also report the presence of the pinworm, *Enterobius vermicularis*, and unidentified larval nematodes in the archaeological record of Chaco Canyon.

2. Materials and methods

We obtained 19 coprolites from previous archaeological work in Chaco Canyon National Historic Park, New Mexico. These samples were originally analyzed as part of the Chaco Project in the 1980s (Clary, 1987, 1984, 1983; Toll, 1981). Fragments of these coprolites had been curated in the Laboratory of Palynology and Pathoecology, University of Nebraska-Lincoln. The samples have since been returned to the Chaco Center, Hibben Institute, University of New Mexico. The coprolites analyzed in this study represent four sites that differ in period of occupancy and dwelling size, all of which are located within a one-kilometer radius in Chaco Canyon. Fourteen coprolites were from Chacoan great houses: Pueblo Bonito (10), Pueblo Alto (2), and Kin Kletso (4), and three coprolites were from Atlatl Cave, a Late Archaic site (Table 1).

Prior stratigraphic dating suggests that the Pueblo Bonito samples were deposited from to 1080–1130 CE, the Pueblo Alto coprolites date from 1050 to 1100 CE, and the Kin Kletso coprolites were from 1100 to 1150 CE (Clary, 1984; Reinhard and Clary, 1986). For this study, we obtained eight Accelerator Mass Spectrometer (AMS) radiocarbon dates from seven coprolites (Table 2). Two dates were run on a sample from a single coprolite recovered from Atlatl Cave. This sample was separated into larger (macrobotanicals > 250 μ) and smaller (microbotanicals < 250 μ and feces) fractions in order to obtain multiple dates. Of these two dates, we are more confident of the macrobotanical fraction (D-AMS 015356, Table 2). Six samples from two great house sites (Pueblo Bonito and Kin Kletso) were also dated (Table 2). All samples underwent standard acid-base-acid pre-treatment protocols prior to measurement of carbon isotopes by AMS and subsequent data analysis. Radiocarbon assays were then calculated using OxCal v4.2.4 (Bronk Ramsey, 2013).

Before beginning parasite analysis, we visually examined each coprolite and observed no evidence for fungal growth or bore holes from free-living arthropods or nematodes. We rehydrated coprolites following standard paleoparasitological methods (Callen and Cameron, 1960; Reinhard et al., 1986), also preserving a desiccated portion of each coprolite. We weighed each dry sample and soaked it in a 0.5%

Table 1

Coprolites analyzed in this study. Dates marked with (1) indicate stratigraphic dates reported by Clary (1984). Dates marked with (2) indicate stratigraphic dates reported by Reinhard and Clary (1986). Dates marked with a (3) indicate calibrated AMS radiocarbon dates for that sample. Sample 1 from Atlatl Cave was observed to be non-biological material upon rehydration.

Sample number	Site	Date	Contents
1	Atlatl Cave		Non-coprolite
2	Atlatl Cave	1926–1751 cal. BCE[3]	*Trichuris trichiura;* unidentified nematode larvae
3	Atlatl Cave		
4	Pueblo Bonito	1039–1164 cal. CE[3]	*Enterobius vermicularis*
5	Pueblo Bonito	1080–1130 CE[1]	Unidentified nematode larvae
6	Pueblo Bonito	1080–1130 CE[1]	Unidentified nematode larvae
7	Pueblo Bonito	1080–1130 CE[1]	
8	Pueblo Bonito	1164–1252 cal. CE[3]	
9	Pueblo Bonito	1046–1219 cal. CE[3]	
10	Pueblo Bonito	1080–1130 CE[1]	
11	Pueblo Bonito	1080–1130 CE[1]	
12	Pueblo Bonito	1039–1163 cal. CE[3]	*Trichuris trichiura*
13	Pueblo Bonito	1187–1264 cal. CE[3]	
14	Pueblo Alto		
15	Pueblo Alto	1050–1100 CE[1]	
16	Kin Kletso	1100–1150 CE[2]	*Enterobius vermicularis*
17	Kin Kletso	1100–1150 CE[2]	
18	Kin Kletso	1100–1150 CE[2]	
19	Kin Kletso	1154–1254 cal. CE[3]	