AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 146:474–480 (2011)

Brief Communication: New Evidence on the Spatiotemporal Distribution and Evolution of the Uto-Aztecan Premolar

Kent M. Johnson,[1]* Christopher M. Stojanowski,[1] Kathryn O'D. Miyar,[2] Glen H. Doran,[2] and Robert A. Ricklis[3]

[1]*Center for Bioarchaeological Research, School of Human Evolution and Social Change, Arizona State University, Tempe, AZ 85287*
[2]*Department of Anthropology, Florida State University, Tallahassee, FL*
[3]*Cultural Resources Management TRC Environmental Corporation, Austin, TX*

KEY WORDS dental anomaly; North American Archaic; Paleoindian

ABSTRACT Uto-Aztecan premolar (UAP) is a rare morphological feature of the maxillary first premolar that occurs in Native American populations with frequencies ranging 0–16.7%. A recent summary of UAP by Delgado-Burbano et al. (2010) suggests the trait evolved around 4,000 BP in the American Southwest where the earliest cases occur and where the trait exists at the highest frequencies among contemporary populations. In this article, we present new data on UAP prevalence from an Archaic North American sample from Buckeye Knoll, Texas (circa 7,500–6,200 cal BP). Buckeye Knoll preserves a single case of UAP, and a sample frequency of 3.6%. In addition, we confirm the presence of UAP in other eastern North American Archaic skeletal samples from the Windover and Harris Creek at Tick Island sites in Florida. We also review the dental morphological literature to assess: 1) whether UAP prevalence is limited to New World populations, and 2) whether the trait's antiquity can be extended further into the Early Holocene Paleoindian period. Additional cases of UAP are presented from the Pacific coast of South America, Europe, Asia, and Australia. Combined, these data greatly expand the spatial and temporal distribution of UAP and suggest the trait evolved considerably earlier than previously thought. Am J Phys Anthropol 146:474–480, 2011.

Variation in the size and shape of the dentition provides the basis for a number of evolutionary inferences in past populations, varying from global and continental population history to regional population structure and intracemetery kinship analyses. Although these analyses often use dental polymorphisms (traits that vary in frequency among *most* human populations), rare dental "anomalies" also have inferential value for human microevolutionary studies. Rare dental traits have been used to reconstruct genealogical relationships among burials within cemeteries (Alt and Vach, 1998; Stojanowski and Schillaci, 2006) and have also been used as "private" dental markers, i.e., dental morphological traits found only in certain, closely related subpopulations (Scott and Turner, 1997). Both intracemetery kinship analyses and private dental marker approaches require accurate information on the geographical and temporal distribution and population frequency of rare anatomical variants.

One such variant is the Uto-Aztecan premolar (UAP) which, as the name implies, denotes a specific biocultural (in this case linguistic) affinity (Morris et al., 1978). First observed by Hrdlička (1921) and reconsidered by Morris (1967), a recent paper by Delgado-Burbano et al. (2010) provides a more thorough description of the anatomical variant. The trait initially was thought to occur only in populations representing the Uto-Aztecan linguistic family (Morris et al., 1978), but has since been documented in a variety of New World populations, including skeletal samples from eastern North America (Turner, 1984, 1985; Powell, 1995; Johnston and Sciulli, 1996), Mesoamerica (Turner, 1984; Haydenblit, 1996; LeBlanc et al., 2008), and South America (Turner, 1984; Sutter, 1997; Reyes et al., 2008). As such, the more inclusive designation "distosagittal ridge" (Turner et al., 1991) has been proposed and may reflect more appropriate usage; however, the term Uto-Aztecan premolar continues in the literature, perhaps reflecting its historical precedent (Delgado-Burbano et al., 2010). A southwestern US origin for UAP was suggested in early accounts (Morris, 1967; Morris et al., 1978; Kobori et al., 1980), and this reconstruction of the trait's origins continues to receive support (Delgado-Burbano et al., 2010) in spite of additional cases of UAP and the broader geographic distribution of the trait.

In a recent analysis of the temporal and geographic distribution of UAP, Delgado-Burbano et al. (2010) present new and previously published population frequencies of Uto-Aztecan premolar from a sample of over 5,000 individuals from North and South America. On the basis of this extensive survey, the authors note that UAP

Additional Supporting Information may be found in the online version of this article.

Grant sponsor: California State University Chancellor's Doctoral Incentive Program Mini Grant.

*Correspondence to: Kent Johnson, School of Human Evolution and Social Change, Center for Bioarchaeological Research, Arizona State University, Tempe, AZ 85287. E-mail: kentjohnson@asu.edu

Received 1 April 2011; accepted 7 July 2011

DOI 10.1002/ajpa.21593
Published online 24 August 2011 in Wiley Online Library (wileyonlinelibrary.com).

TABLE 1. New cases of Uto-Aztecan premolar

Region/location	Sample/site	Chronology	Affected	*N*	Observer/reference
Old World					
Spain	Andalusia	4250–3750 BP	1	–	Gallardo and Pimienta, 2008
Yugoslavia	Multiple	~550–450 BP	1[a]	–	Burnett, 1998
Germany	Clinical	Modern	2	–	Keil, 1966
	Clinical	Modern	2[b]	–	Schulze, 1987
Bengal	Multiple	19th–early 20th[c]	1	97	Hawkey, 1998
Mongolia	Chandman site	2650–2350 BP	1	20	C. Lee
Siberia	Reka Iya (Trans-Baikal)	5350–3650 BP	1	1	Haeussler, 1996
Australia	Historic	19th[c]	1	–	Turner, 1991, 1992
Western Hemisphere					
East US Indigenous	Windover, FL	8120–6990 BP	5	48	Doran and Dickel, 1988b; Powell, 1995
	Eva, TN	7150 ± 500 BP	1	14	Lewis and Kneberg Lewis, 1961; Powell, 1995
	Anderson, TN	7180–6495 BP	1	18	Dowd, 1989; Powell, 1995
	Buckeye Knoll, TX	7500–6200 cal BP	1	28	Ricklis, 2007; Present study
	Black Earth, IL	5900–4860 BP	2	31	Jefferies, 1982; Powell, 1995
	Harris Creek at Tick Island, FL	5450–5030 BP	5	57	Jahn and Bullen, 1978; Powell, 1995
	Bird Island, FL	4570 ± 110 BP	2	12	Powell, 1995; Stojanowski and Doran, 1998
	Texas	Archaic-unspecified	–[c]	–	Taylor, 2010
	Upper Red River, TX (early)	1150–750 BP	1	26	Lee, 1999
	Lower Red River, TX (mid)	750–350 BP	2	29	Lee, 1999
	Lower Red River, TX (late)	350–150 BP	1	6	Lee, 1999
Chile, Indigenous	Azapa Chinchorro	6950–3950 BP	2	26	Sutter, 1997
	Azapa-140	1150–600 BP	1	57	Sutter, 1997
	Azapa-71 (P^3)	1050–600 BP	2	26	Sutter, 1997
	Azapa-71 (P^4)	1050–600 BP	1	19	Sutter, 1997
	Azapa-8	600 BP	1	15	Sutter, 1997
Nonindigenous?	African American	300 BP-modern	2	557[d]	Edgar, 2002

[a] The affected tooth is possibly a P^4 (Burnett, 1998).
[b] One case is an affected P^3, the other case is an affected P^4.
[c] Taylor (2010) reports a frequency of UAP greater than 4%, but does not indicate the number affected or the sample size.
[d] Sample is drawn from multiple cemeteries.

morphology is found only in P^3s (but see Table 1 for cases involving the P^4), and that the trait likely evolved in southwestern US populations around 4,000 BP followed by a rapid and widespread dispersal into South America. This reconstructed evolutionary history is based on several lines of evidence: 1) the lack of UAP in skeletal samples older than 4,000 BP, 2) the only living populations known to exhibit UAP are from the American Southwest, 3) the highest frequencies of UAP are found in North American samples, especially those from the American Southwest and northern Mexico, and 4) South American samples in which UAP is present have the lowest frequencies of UAP.

However, the data upon which these findings are based seemingly omit several previously observed cases of UAP that dramatically alter the reconstruction of the trait's origins and evolutionary history. For example, Powell's dissertation (1995) reported high frequencies of UAP among several Early and Middle Archaic (Middle Holocene) samples from eastern North America. These cases have not been independently published and remain undocumented in the literature, hence their exclusion from recent summaries of UAP. These data suggest the antiquity of the trait may extend to the Early Holocene of North America. In addition, a review of the Paleoindian literature reveals two dramatically different assessments of UAP prevalence. Turner (1992a) presented dental morphological data for 35 candidate Paleoindian individuals from North and South America, with an additional 19 individuals from Lagoa Santa, Brazil. Altogether, nine individuals were observable for UAP, and none exhibited the trait. Turner (Turner and Scott, 2007) has subsequently examined additional Paleoindian specimens (Sulphur Springs, Horn Shelter, and Wilson-Leonard II), but did not comment on UAP presence or observability. In contrast, Powell (2002: 99, 2005) reports that "nearly 18% of Paleoamerican skeletons" exhibit P^3 UAP. Unfortunately, Powell (2002-2005) did not identify which Paleoindian specimens he examined or which exhibited UAP. Nonetheless, these statements suggest the antiquity of the trait may extend beyond the Archaic period samples discussed above which may dramatically alter the reconstruction of when and where the trait evolved.

These dissonant findings suggest clarification is needed on the spatiotemporal distribution of UAP. Here, we document a previously unknown example of UAP from the Archaic period skeletal sample from Buckeye Knoll, Texas, the largest and earliest Native American cemetery west of the Mississippi River (Ricklis, 2007). In addition, we report on our efforts to confirm the presence of UAP in three eastern North American Archaic skeletal samples analyzed by Powell (1995), and we review the Paleoindian physical anthropology literature to assess whether the trait's antiquity can be extended further into the Early Holocene. Finally, we consider reported cases of UAP outside of the Americas that suggest a broader distribution of the trait and question its utility as a private dental marker. The implications for reconstructing the trait's origins are discussed within the context of the peopling of the New World.

MATERIALS AND METHODS

Maxillary premolars are highly variable structures (Schulze, 1987; Scott and Turner, 2006; Burnett et al., 2010) and, despite its uniqueness, diagnosis of UAP can be somewhat difficult particularly in worn specimens. UAP involves a pronounced ridge that extends from the apex of the buccal cusp to the distal occlusal border at or near the sagittal sulcus. Typically, a distal fossa sits between the distosagittal ridge and the distal occlusal border of the buccal cusp. Affected teeth also exhibit a mesial rotation of the buccal surface as well as buccolingual expansion of the paracone (Morris et al., 1978; Turner et al., 1991; Delgado-Burbano et al., 2010). It is this latter feature that may allow diagnosis of UAP in highly worn dentitions based on root morphology alone (Schulze, 1987).

Using these diagnostic criteria we observed all P^3s for UAP morphology in Archaic period samples from Buckeye Knoll, Texas (41VT98) and from the Harris Creek at Tick Island (8VO24), Bird Island (8DI52), and Windover (8BR246) sites in Florida. The Early-Middle Archaic Buckeye Knoll site dates to circa 7,500–6,200 cal BP and contains the remains of ~70 individuals (Ricklis, 2007; Stojanowski et al., 2011). These data were collected by CMS and the skeletal material has been repatriated.

We also examined three Archaic period samples from Florida housed either at Florida State University or the Florida Museum of Natural History. The Harris Creek site dates to circa 5,450–5,030 BP with a reported sample size of 175 individuals (Jahn and Bullen, 1978; Quinn et al., 2008). These data were collected by KOM. The Bird Island site dates to circa 4,570 ± 110 BP with a reported sample size of 36 individuals (Stojanowski and Doran, 1998). Finally, the Windover site dates to 8,120–6,990 BP, although most individuals were interred there within a 500 year period circa 7,500 years ago (Doran and Dickel, 1988a,b; Doran, 2002a,b). The sample from Windover represents 168 individuals.

In addition to direct observation, we conducted a thorough review of the dental morphology and physical anthropology gray literature (e.g., unpublished Master's theses, unpublished Ph.D. dissertations, and abstracts from presentations at professional meetings) in order to identify and compile instances of UAP that have been overlooked in previous reviews of the trait. This is not to suggest that our review is exhaustive (it certainly is not), but to highlight the importance of making data available to wider audiences. Accessible (i.e., published) data are imperative to efforts that seek to develop the most probable reconstructions of the evolutionary history of rare dental traits such as UAP. In this light, a review of the Paleoindian physical anthropology literature was undertaken in an attempt to resolve the discrepancy between the reported frequencies of UAP in Paleoindian specimens (Turner, 1992a; Powell, 2002, 2005).

RESULTS

New cases from Middle Holocene North America

Table 1 lists a previously unknown case of UAP from the Buckeye Knoll site, as well as cases of UAP identified during our literature review which were not included in previous summaries of the trait. The Buckeye Knoll specimen (Burial 26) is a right P^3 that is lightly worn (wear = 4 following Smith, 1984) and displays typical UAP morphology. Photographs of the remains are not permitted, however we do provide a drawing of the affected tooth for comparative purposes (Supporting Information Fig. S1). There were 28 observable right P^3s (50 maxillary P^3s in total) dating to the Early/Middle Archaic at Buckeye Knoll resulting in a sample frequency of 3.6%. This is the oldest documented example of UAP in Texas (and oldest west of the Mississippi), but our literature review identified other instances of UAP from Archaic samples from the state. For example, Taylor (2010) reports a frequency of UAP over 4% among Archaic hunter-gatherers from Central and South Texas, although it is unclear whether the reported frequency is side specific or inclusive of antimeres or what samples were examined. In addition, Lee (1999) reports a very high frequency (but for a very small sample, 1/6 individuals) of UAP from the Lower Red River area dating to the Woodland period (circa 350–150 BP).

We also confirm the presence of UAP in the Florida Early Archaic. An example of an unworn UAP in a left P^3 from Windover (Specimen 265.36) is presented in Figure 1. The antiquity of the site makes this the oldest documented (photographed) case of UAP in the world. Although definitely fulfilling all criteria for UAP, the distosagittal ridge in this specimen is divided by a furrow on the lingual side of the paracone which originates within the central fossa giving the appearance of three separate structures. However, the tooth does not exhibit the classic morphology of a tri-cusped premolar (Turner et al., 1991); the distosagittal ridge is clearly a ridge and not a cusp, although Powell (1995: 170, Fig. 7.2) apparently considered it tri-cusped. This specimen in particular suggests a morphological continuum between UAP and tri-cusped premolars, as has previously been suggested (Turner et al., 1991). Powell (1995) reports four additional examples of UAP from Windover and an overall frequency of 10.4%.

The presence of UAP was also confirmed at the Harris Creek site at Tick Island where two out of 23 complete maxillae (8.7%) express UAP. Burial 54 had bilateral P^3 expression and Burial 100 had an affected left P^3. Photographs of these cases are not permitted, but drawings are included as supplemental files (Supporting Information Fig. S2). The examples from Burial 54 are particularly interesting because the morphology is so similar among antimeres and the distosagittal ridge appears crenulated (almost like mammelons) along its facial and lingual surfaces with distinct and strong double shoveling on the paracones. Powell (1995) reports a total of five cases of UAP from Harris Creek at Tick Island (he included all loose teeth) and a sample frequency of 8.8%. Finally, we could not verify the presence of UAP at the Late Archaic period Bird Island site, despite the fact that Powell (1995) reported a frequency of 16.7% for this trait (2 of 12), among the highest in the world.

The Paleoindian database

Because of severe attrition and taphonomic processes, few Paleoindian specimens have maxillary premolars that allow for the observation of the trait. Table 2 presents a list of which Paleoindian specimens preserve dentition with sufficiently light wear to make UAP observable. Our literature review identified no conclusive cases of UAP among Paleoindians. This is consistent with Turner's (1992a) findings and at odds with Powell's (2002-2005) reports of high frequency of the trait among Paleoindians. However, this result is tenuous as it is

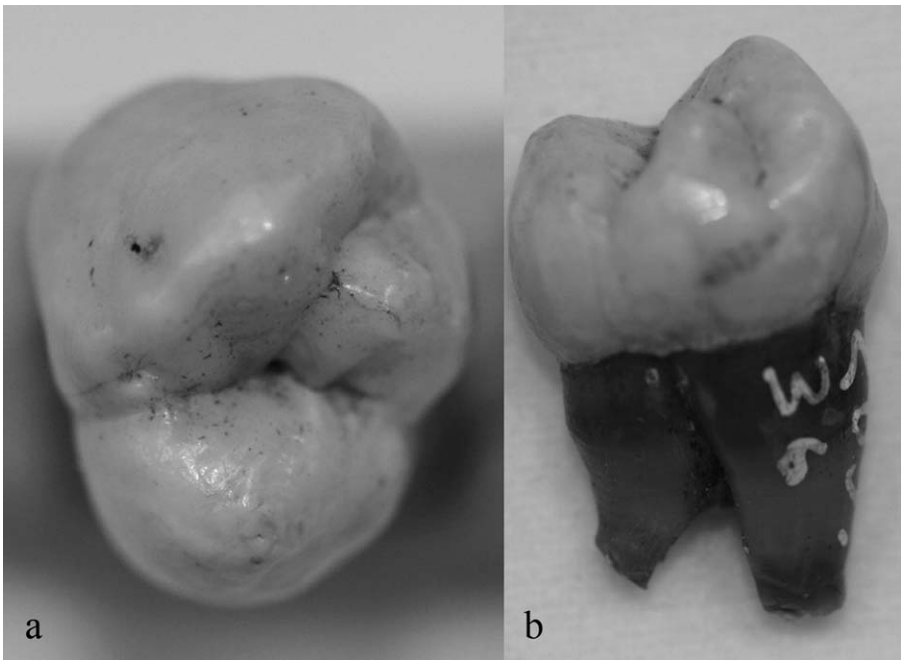

Fig. 1. UAP in the left P^3 from Specimen 265.36 at the Windover site from the occlusal (**a**) and distal (**b**) views.

TABLE 2. Observability of Uto-Aztecan premolar in Early Holocene skeletal remains from North America

Sample/site	Age (^{14}C years BP)	*N*	*n*	Observer/reference
49-PET-408 (On Your Knees Cave), AK	9,820 ± 40 (average)	1	–[a]	Dixon, 1999
Anzick, MT	10,680 ± 50 (average)	1	–[b]	Stafford et al., 1991; Owsley and Hunt, 2001
Arch Lake, NM	10,220 ± 50; 8,870 ± 40	1	1	Owsley et al., 2010
Arlington Springs, CA	10,000 ± 310; 10,080 ± 810; 10,960 ± 110	1	–[a]	Orr, 1962; Berger and Protsch, 1989; Johnson et al., 2002
Browns Valley, MN	8,790–9049 ± 82/110	1	–[c]	Jenks, 1937; Myster and O'Connell, 1997
Buhl, ID	10,675 ± 95	1	–[d]	Green et al., 1998
Fishbone Cave, NV	8,370 ± 50; 8,220 ± 50	1	–[a]	Dansie and Jerrems, 2006
Gordon Creek, CO	9,455 ± 110 (average)	1	1	Breternetz et al., 1971; Turner, 1992
Gore Creek, BC	8,250 ± 115	1	–[a]	Cybulski et al., 1981
Horn Shelter, TX	9,875 ± 110 (average)	2	1	Young, 1988
Kennewick, WA	8,410 ± 35 (average)	1	–[d]	Powell and Rose, 1999
LaBrea, CA	9,000 ± 80	1	–[a]	Kroeber, 1962; Berger, 1975
Pelican Rapids, MN	7,840 ± 70	1	1	Turner, 1992a; Myster and O'Connell, 1997
Spirit Cave, NV	9,415 ± 25 (average)	1	–[d]	Edgar, 1997; Jantz and Owsley, 1997
Upward Sun River, AK	~11,500	1	–[a]	Potter et al., 2011
Warm Mineral Springs, FL	10,260 ± 190	1	1	Clausen et al., 1975; Turner, 1992a
White Water Draw, AZ	10,000–8,000	1	–[e]	Waters, 1986
Wilson-Leonard, TX	10,500–10,000	1	1	Steele, 1998
Wizards Beach, NV	9,225 ± 60 (average)	1	–[d]	Edgar, 1997; Dansie and Jerrems, 2006

[a] No maxillary premolars recovered.
[b] Permanent maxillary premolars had not yet formed.
[c] Unknown whether maxillary premolars were recovered.
[d] Severe wear on maxillary premolars prohibits observation of UAP.
[e] Maxillary premolars are present and display "marked" wear, but it is unclear whether attrition is so severe as to prohibit observation of UAP (Waters, 1986: 364). Specific morphological traits are not discussed.

based on published data and images of Paleoindian dentition rather than direct observation of these specimens. Table 2 should provide a useful guide for further research.

Old World cases of UAP

Old World archaeological specimens (Table 1) demonstrating UAP include a Bronze Age individual from the Trans-Baikal region of Siberia (Turner, 1992b; Haeussler, 1996; Scott and Turner, 2006), a Bronze Age individual from northwestern Mongolia (C. Lee, personal communication), and a single Bronze Age individual from Spain (Gallardo and Pimienta, 2008). More recent Old World specimens include a protohistoric specimen from Australia (Supporting Information Fig. S3) (Turner, 1991, 1992b), an individual from Bengal that dates to the 19th or early 20th century (Hawkey, 1998), and four German

clinical specimens that likely date to the 20th century, including affected monozygotic twins reported by Keil (1966) and two individuals reported by Schulze (1987). The German specimens (Keil, 1966; Schulze, 1987) are noteworthy as they provide clear examples of UAP in living populations from outside the American Southwest.

To date UAP has not been documented in North or Sub-Saharan African populations (Morris et al., 1978; J. Irish, personal communication), making Africa the only continent lacking this feature. Edgar (2002), however, identified two individuals with UAP in a sample of 557 African American individuals. Edgar (2002) suggests that the presence of UAP in African American samples could be due to independent mutation or Native American admixture; additional research is required to evaluate these hypotheses.

DISCUSSION

Initial reconstructions of UAP's evolutionary history were based on a distribution in which the trait had only been documented among populations within the Uto-Aztecan language family (Morris et al., 1978; Kobori et al., 1980). Morris et al. (1978: 75) proposed that UAP appeared as "a mutation in a member of a small band of hunter-gatherers in the American West", during the Late Holocene, and was "carried along in low frequency in subsequent generations." In light of the trait's broader geographic distribution and presence in non-Uto-Aztecan populations, recent reviews either refrain from identifying a specific region of origin (Johnston and Sciulli, 1996; Scott and Turner, 1988, 1997) or base such reconstructions on its spatiotemporal distribution rather than a perceived linguistic association (Delgado-Burbano et al., 2010; Taylor, 2010). Such reconstructions are based on the assumption that the antiquity and frequency of a trait are indicative of its place of origin.

Here, we have documented the presence of UAP in the Early and Middle Archaic of Florida and Texas, doubling the trait's antiquity in the New World from 4,000 to circa 8,000 BP. In addition to the cases presented here, samples reported by Powell (1995) from sites in Illinois (Black Earth) and Tennessee (Anderson and Eva) illustrate UAP had a rather broad spatial distribution during the Archaic period (Table 1). The Black Earth site (11SA87) dates to 5,900–4,860 BP and returned two cases of UAP from a sample of 31 individuals. The Anderson site (40WM9) dates to 7,180–6495 BP, and Powell noted one case of UAP among 18 individuals. The Eva (40BN12) site dates to 7,150 $\pm$ 500 BP and had one case of UAP in a sample of 14 burials. Two cases of UAP were also reported from a Chinchorro sample (6,950–3,950 BP) from Chile by Sutter (1997). The broad age range for the Chinchorro specimens complicates interpretations of the relevance of these South American cases with respect to broader spatiotemporal patterns. It does appear, however, that UAP was present over much of the New World at a very early date, suggesting an earlier age of origin for the trait. Nonetheless, the presence of UAP in Paleoindians remains unresolved but is of critical importance for delineating the antiquity of the feature and its potential relevance to New World population history.

Indeed, the spatiotemporal distribution of UAP is often linked to the colonization of the New World in a very general sense, with scholars suggesting the trait evolved pre-colonization in the Old World and was carried to the New World (Turner, 2002; Scott and Turner, 2006) or it evolved post-colonization in the New World (Morris et al., 1978; Kobori et al., 1980; Delgado-Burbano et al., 2010; Taylor, 2010). Turner's research is the most far-reaching in its conclusions about the meaning of this rare dental trait in Native Americans. Turner (2002) places the evolution and dispersal of UAP within his three-wave model of the peopling of the Americas (Turner, 1984, 1985; Greenberg et al., 1986; Scott and Turner, 1997; Turner and Scott, 2007) and suggests that UAP developed because of a mutation brought to the New World by Paleoindians but not by the other waves of migrants, the ancestors of the Na-Dene and Eskimos and Aleuts. Scott and Turner (2006) suggest the occurrence of UAP at low frequencies in populations from North and South America and its absence in Aleut and Eskimo samples are evidence for at least two migrations into the New World, with an earlier Paleoindian migration followed by a later migration of Aleut and Eskimo ancestors.

The use of a single morphological trait, even a purported private dental marker, to reconstruct major migration events in human history strains the limits of inferential plausibility. Such efforts often rely on overly simplistic understandings of human populations as bounded, discrete entities when, in fact, population histories are typically quite complex (e.g., Moore 1994, 2001; Sattler, 1996; Haley and Wilcoxon, 2005). In addition, the genetic mechanisms underlying these features remain obscure and independent mutation may be as plausible as migration scenarios for the explanation of a private marker's presence in different populations. Even when using all known cases of UAP expression in the New World, these data fail to exclude any of the different hypotheses for the peopling of the Americas (e.g., Goebel et al., 2008; Dillehay, 2009; Hubbe et al., 2010; O'Rourke and Raff, 2010). The presence of UAP in various non-African Old World samples, both modern and ancient, further confounds the meaning of the trait's distribution within and among human populations.

ACKNOWLEDGMENTS

The authors thank Christopher Ruff, the Associate Editor, and two anonymous reviewers for comments that greatly improved the organization of this article. Christine Lee graciously provided unpublished data. Keryn Walshe kindly shared information and images of South Australian Museum Specimen A20656. They also thank Janelle Stokes of the US Army Corps of Engineers Galveston District for supporting this research. Financial support was provided by a mini grant to KMJ by the California State University Chancellor's Doctoral Incentive Program.

LITERATURE CITED

Alt KW, Vach W. 1998. Kinship studies in skeletal remains: concepts and examples. In: Alt KW, Rösing FW, Teschler-Nicola M, editors. Dental anthropology: fundamentals, limits, and prospects. Wien: Springer. p 537–554.

Berger R. 1975. Advances and results in radiocarbon dating: early man in America. World Archaeol 7:174–184.

Berger R, Protsch R. 1989. UCLA radiocarbon dates XI. Radiocarbon 31:55–67.

Breternitz DA, Swedlund AC, Anderson DC. 1971. An early burial from Gordon Creek. Colorado. Am Antiq 36:170–182.

Burnett SE. 1998. Maxillary premolar accessory ridges (MxPAR): worldwide occurrence and utility in population differentiation. M.A. Thesis, Arizona State University, Tempe, AZ.

Burnett SE, Hawkey DE, Turner CG II. 2010. Population variation in human maxillary premolar accessory ridges (MxPAR). Am J Phys Anthropol 141:319–324.

Clausen CJ, Brooks HK, Wesolowsky AB. 1975. The early man site at Warm Mineral Springs. Florida. J Field Archaeol 2:191–213.

Dansie A, Jerrems W. 2006. More bits and pieces: a new look at Lahontan chronology and human occupation. In: Bonnichsen R, Lepper B, Stanford D, Waters M, editors. Paleoamerican origins: beyond Clovis. College Station, TX: Center for the Study of the First Americans. p 51–79.

Delgado-Burbano ME, Scott GR, Turner CG II. 2010. The Uto-Aztecan premolar among North and South Amerindians: geographic variation and genetics. Am J Phys Anthropol 143:570–578.

Dillehay TD. 2009. Probing deeper into first American studies. Proc Natl Acad Sci USA 106:971–978.

Dixon EJ. 1999. Bones, boats and bison: archeology and the first colonization of western North America. Albuquerque: University of New Mexico Press.

Doran GH. 2002a. Windover: multidisciplinary investigations of an Early Archaic Florida cemetery. Gainesville: University Press of Florida.

Doran GH. 2002b. The Windover radiocarbon chronology. In: Doran GH, editor. Windover: multidisciplinary investigations of an Early Archaic Florida cemetery. Gainesville: University Press of Florida. p 59–72.

Doran GH, Dickel DN. 1988a. Multidisciplinary investigations at the Windover site. In: Purdy B, editor. Wet site archaeology. Caldwell, NJ: Telford Press. p 263–289.

Doran GH, Dickel DN. 1988b. Radiometric chronology of the Archaic Windover archaeological site. Fla Anthropol 41:365–380.

Dowd JT. 1989. The Anderson site: Middle Archaic adaptation in Tennessee's central basin. Knoxville: Tennessee Anthropological Association.

Edgar HJH. 1997. Paleopathology of the Wizards Beach Man (AHUR 2023) and the Spirit Cave Mummy (AHUR 2064). Nev Hist Soc Q 40:57–61.

Edgar HJH. 2002. Biological distance and the African American dentition. Doctoral Dissertation, The Ohio State University, Columbus, OH.

Gallardo A, Pimienta M. 2008. The discovery of a premolar with distosagittal ridge from the Spanish Copper Age. Am J Phys Anthropol 135:101–102.

Goebel T, Waters MR, O'Rourke DH. 2008. The Late Pleistocene dispersal of modern humans in the Americas. Science 319:1497–1502.

Green TJ, Cochran B, Fenton TW, Woods JC, Titmus GL, Tieszen L, Davis MA, Miller SJ. 1998. The Buhl burial: a Paleoindian woman from southern Idaho. Am Antiq 63:437–456.

Greenberg JH, Turner CG II, Zegura SL. 1986. The settlement of the Americas: a comparison of the linguistic, dental, and genetic evidence. Curr Anthropol 27:477–497.

Haeussler AMF. 1996. Dental anthropology of Russia, Ukraine, Georgia, Central Asia: evaluation of five hypotheses for Paleo-Indian origins. Doctoral Dissertation. Arizona State University, Tempe, AZ.

Haley BD, Wilcoxon LR. 2005. How Spaniards became Chumash and other tales of ethnogenesis. Am Anthropol 107:432–445.

Hawkey DE. 1998. Out of Asia: dental evidence for affinities and microevolution of early populations from India/Sri Lanka. Doctoral Dissertation. Arizona State University, Tempe, AZ.

Haydenblit R. 1996. Dental variation among four prehispanic Mexican populations. Am J Phys Anthropol 100:225–246.

Hrdlička A. 1921. Further studies on tooth morphology. Am J Phys Anthropol 4:141–176.

Hubbe M, Neves WA, Harvati K. 2010. Testing evolutionary and dispersion scenarios for the settlement of the New World. PLoS One 5(6):e11105.

Jahn OL, Bullen RP. 1978. The Tick Island site. St. Johns River, Florida. Fla Anthropol 31(Part 2):1–25.

Jantz RL, Owsley DW. 1997. Pathology, taphonomy, and cranial morphometrics of the Spirit Cave Mummy. Nev Hist Soc Q 40:62–82.

Jefferies RW. 1982. The Black Earth site. In: Jeffries RW, Butler BM, editors. The Carrier Mills archaeological project: human adaptation in the Saline Valley, Illinois. Carbondale: Center for Archaeological Investigations, Southern Illinois University. p 75–451.

Jenks AE. 1937. Minnesota's Browns Valley Man and associated burial artifacts. Memoirs of the American Anthropological Association, No. 49. Menasha, WI: American Anthropological Association.

Johnson J, Stafford T, Aije H, Morris D. 2002. Arlington Springs revisited. In: Browne D, Mitchell L, Chaney H, editors. Proceedings of the Fifth California Islands Symposium. Santa Barbara: Santa Barbara Museum of Natural History. p 541–545.

Johnston CA, Sciulli PW. 1996. Uto-Aztecan premolars in Ohio Valley populations. Am J Phys Anthropol 100:293–294.

Keil A. 1966. Grundzüge der odontologie: allgemeine und vergleichende zahnkunde als organwissenschaft. Berlin: Gebrüder Borntraeger.

Kobori LS, Miller RJ, Stevens C, Galliher M, Brooks ST, Morris DH. 1980. Great Basin occurrence of a southwestern dental trait: the Uto-Aztecan premolar. Nev Hist Soc Quart 22:236–245.

Kroeber AL. 1962. The Rancho La Brea skull. Am Antiq 27:416–417.

LeBlanc SA, Turner CG II, Morgan ME. 2008. Genetic relationships based on discrete dental traits: Basketmaker II and Mimbres. Int J Osteoarchaeol 18:109–130.

Lee C. 1999. Origins and interactions of the Caddo: a study in dental and cranial nonmetric traits. M.A. Thesis, Arizona State University, Tempe, AZ.

Lewis TMN, Kneberg Lewis M. 1961. Eva: an Archaic site. Knoxville: University of Tennessee.

Moore JH. 1994. Ethnogenetic theory. Natl Geogr Res and Explor 10:10–23.

Moore JH. 2001. Ethnogenetic patterns in Native North America. In: Terrell JE, editor. Archaeology, language, and history. Westport, CT: Bergin and Garvey. p 31–56.

Morris DH. 1967. Maxillary premolar variation among the Papago Indians. J Dent Res 46:736–738.

Morris DH, Hughes SG, Dahlberg AA. 1978. Uto-Aztecan premolar: the anthropology of a dental trait. In: Butler PM, Joysey KA, editors. Development, function and evolution of teeth. London: Academic Press. p 69–79.

Myster SMT, O'Connell B. 1997. Bioarchaeology of Iowa, Wisconsin, and Minnesota. In: Owsley DW, Rose JC, editors. Bioarchaeology of the North Central United States. Fayetteville, AR: Arkansas Archeological Survey Research Series. p 147–239.

O'Rourke DH, Raff JA. 2010. The human genetic history of the Americas: the final frontier. Curr Biol 20:R202–R207.

Orr PC. 1962. The Arlington Spring site. Santa Rosa Island, California. Am Antiq 27:417–419.

Owsley DW, Hunt DR. 2001. Clovis and Early Archaic crania from the Anzick site (24PA506). Park County, Montana. Plains Anthropol 46:115–124.

Owsley DW, Jodry MA, Stafford TW, Haynes CV, Stanford DJ. 2010. Arch Lake Woman: physical anthropology and geoarchaeology. College Station, TX: Texas A&M University Press.

Powell JF. 1995. Dental variation and biological affinity among Middle Holocene human populations in North America. Doctoral Dissertation. Texas A&M University, College Station, TX.

Powell JF. 2002. Global perspective for cultural history: contextual analysis of human remains at the BZT-1 locality. In: D'Aigle RP. Cultural resource investigation: intensive survey and site testing at BZT-1, San Bernard National Wildlife Refuge, Brazoria County, Texas, Vol. 1. Spring, TX: CRC, International Archaeology & Ecology, LLC. p 98–100.

Powell JF. 2005. The first Americans: race, evolution, and the origin of Native Americans. Cambridge: Cambridge University Press.

Powell JF, Rose JC. 1999. Report on the osteological assessment of the 'Kennewick Man' skeleton. US Department of the Interior Report. General Technical Report No. CENWW. 97.Kennewick.

Potter BA, Irish JD, Reuther JD, Gelvin-Reymiller C, Holliday VT. 2011. A terminal Pleistocene child cremation and residential structure from eastern Beringia. Science 331:1058–1062.

Quinn RL, Tucker BD, Krigbaum J. 2008. Diet and mobility in Middle Archaic Florida: stable isotopic and faunal evidence from the Harris Creek archaeological site (8Vo24). Tick Island. J Archaeol Sci 35:2346–2356.

Reyes G, Padilla A, Palacios M, Bonomie J, Jordana X, García C. 2008. Posible presencia del rasgo dental premolar "Uto-Azteca" en un cráneo de época prehispánica (siglos II a.C., siglo IV d.C.), cementerio de "Las Locas". Quíbor (Estado Lara, Venezuela). Boletín Antropológico 72:53–85.

Ricklis RA. 2007. The Buckeye Knoll archaeological site in Victoria County, Texas: new evidence for understanding ancient lifeways on the Texas coastal plain. Corpus Christi, TX: Coastal Environments, Inc.

Sattler RA. 1996. Remnants, renegades, and runaways: Seminole ethnogenesis reconsidered. In: Hill JD, editor. History, power, and identity. Iowa City: University of Iowa. p 36–69.

Schulze C. 1987. Anomalien und mißbildungen der menschlichen zähne. Berlin: Quintessenz Verlags-GmbH.

Scott GR, Turner CG II. 1988. Dental anthropology. Ann Rev Anthropol 17:99–126.

Scott GR, Turner CG. 1997. The anthropology of modern human teeth. Cambridge: Cambridge University Press.

Scott GR, Turner CG. 2006. Dentition. In: Ubelaker D, editor. Handbook of North American Indians, Vol. 3. Environment, origins, and population. Washington, DC: Smithsonian Institution. p 645–660.

Smith BH. 1984. Patterns of molar wear in hunter-gatherers and agriculturalists. Am J Phys Anthropol 63:39–56.

Stafford TW, Hare PE, Currie L, Jull AJT, Donahue DJ. 1991. Accelerator radiocarbon dating at the molecular level. J Archaeol Sci 18:35–72.

Steele DG. 1998. Human biological remains. In: Collins MB, editor. Wilson-Leonard: an 11,000-year archaeological record of hunter-gatherers in central Texas, Vol.5. Austin: Texas Archaeological Research Laboratory, University of Texas. p 1441–1462.

Stojanowski CM, Doran GH. 1998. Osteology of the Late Archaic Bird Island site (8D152). Fla Anthropol 51:139–145.

Stojanowski CM, Johnson KM, Doran GH, Ricklis RA. 2011. Talon cusp from two Archaic period cemeteries in North America: implications for comparative evolutionary morphology. Am J Phys Anthropol 144:411–420.

Stojanowski CM, Schillaci MA. 2006. Phenotypic approaches for understanding patterns of intracemetery biological variation. Yearb Phys Anthropol 49:49–88.

Sutter RC. 1997. Dental variation and biocultural affinities among prehistoric populations from the coastal valleys of Moquegua, Peru, and Azapa, Chile. Doctoral Dissertation, University of Missouri, Columbia, MO.

Taylor MS. 2010. The Uto-Aztecan premolar in early hunter-gatherers and agriculturalists from south-central North America. Paper presented at the 2010 Annual Meeting of the Texas Association of Biological Anthropologists.

Turner CG II. 1984. Advances in the dental search for Native American origins. Acta Anthropogenet 8:23–78.

Turner CG II. 1985. The dental search for Native American origins. In: Kirk R, Szathmary E, editors. Out of Asia: peopling the Americas and the Pacific. Canberra: Journal of Pacific History. p 31–78.

Turner CG II. 1991. Subjective impression of Australmelanesian dentition. Dent Anthropol 6:4–5.

Turner CG II. 1992a. New World origins: new research from the Americas and the Soviet Union. In: Stanford DJ, Day JS, editors. Ice Age hunters of the Rockies. Boulder: University Press of Colorado. p 7–50.

Turner CG II, 1992b. The dental bridge between Australia and Asia: following Macintosh into the East Asian hearth of humanity. Perspect Hum Biol 2/Archaeol Oceania 27:143–152.

Turner CG II. 2002. Teeth, needles, dogs, and Siberia: bioarchaeological evidence for the colonization of the New World. In: Jablonski NG, editor. The first Americans: the Pleistocene colonization of the New World. San Francisco: Memoirs of the California Academy of Sciences No. 27. p 123–158.

Turner CG II, Nichol CR, Scott GR. 1991. Scoring procedures for key morphological traits of the permanent dentition: the Arizona State University Dental Anthropology System. In: Kelley M, Larsen C, editors. Advances in dental anthropology. New York: Wiley-Liss. p 13–31.

Turner CG II, Scott GR. 2007. The dentition of American Indians: evolutionary results and demographic implications following colonization from Siberia. In: Henke W, Tattersall I, editors. Handbook of paleoanthropology, Vol.3. Berlin: Springer-Verlag. p 1901–1941.

Waters MR. 1986. Sulphur Springs woman: an early human skeleton from southeastern Arizona. Am Antiq 51:361–365.

Young DE. 1988. The double burial at Horn Shelter: an osteological analysis. Central Texas Archeol 11:13–115.