CURRENT RESEARCH IN THE PLEISTOCENE

Volume 28 2011

A Peopling of the Americas Publication

CURRENT RESEARCH IN THE PLEISTOCENE

Volume 28 2011

A Peopling of the Americas Publication

Center for the Study of the First Americans
Department of Anthropology, Texas A&M University ▪ 4352 TAMU
College Station, Texas

CURRENT RESEARCH IN THE PLEISTOCENE

Volume 28 **2011**

Current Research in the Pleistocene is published annually by the Center for the Study of the First Americans. ISSN 8755-898X.

Typesetting and camera-ready preparation by C&C Wordsmiths, Lenoir, North Carolina

Printed by Tops Printing, Bryan, Texas

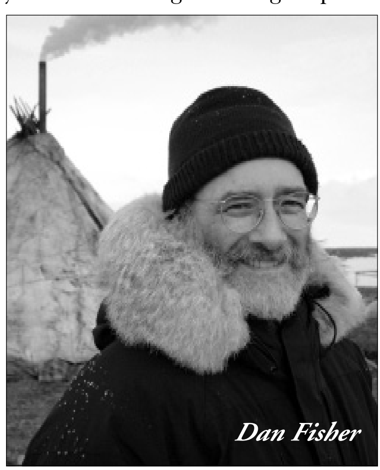
Contents

From the Editor

After 28 years, we are saying "good bye" to *Current Research in the Pleistocene.* In your hands you hold its last volume. Costs of production have risen far above the revenue brought from sales, making it uneconomical for us to continue publication in its present form.

Many people have contributed to the editing of *CRP* over the years, and here we want to acknowledge their efforts. Jim Mead started the journal and served as editor from 1984 through 1992; in this role he was succeeded by Brad Lepper from 1993 through 2002, and Mike Waters in 2003. Their hard work and dedication all of those years ago made possible the last eight volumes, which I had the pleasure to assemble. During my time as editor I've collaborated with hundreds of authors and reviewers, as well as an editorial board that was always quick to respond to requests for reviews and a variety of problems and queries. David Meltzer was the first to join the editorial board back in 1989, and over the years the board grew to a group size of nearly 20. Past and present board members include Mel Aikens, Dan Amick, David Anderson, Chris Bell, Luis Borrero, Loren Davis, Dan Fisher, Ruth Gruhn, Gary Haynes, Bryan Hockett, Masami Izuho, John Johnson, Jason LaBelle, Terri LaCourse, Brad Lepper, Heidi Luchsinger, Carole Mandryk, Francisco Mena, Akira Ono, Stephen Ousley, Ulyses Pardiñas, Bonnie Pitblado, Tad Schurr, Paul Sciulli, Frédéric Sellet, Linda Shane, Sergei Slobodin, Gentry Steele, Tom Stafford, and David Yesner. These scientists selflessly provided expert critiques and editorial assistance to me and past editors of the journal. Dan Fisher and Brad Lepper need to be expressly acknowledged: they have stuck with *CRP* for 18 years, Dan as editorial board member

Jim Mead



Dan Fisher

and Brad as editor and editorial board member. Thanks, Dan and Brad!

CRP never would have succeeded during the time that I've served as editor without three very important people: Laurie Lind and Jim and Charlene Chandler. Laurie unfailingly maintained order among hundreds of documents, images, and e-mail notes we received from authors annually, and she always did so with a cheery demeanor we all appreciated. Jim and Char's superb page-editing skills repeatedly led to a smart-looking, professional journal, one appreciated by all its authors and readers. Both Laurie and the Chandlers deserve our collective congratulations and gratitude for a job well done all these years. I am especially indebted to them for their extreme patience with me, given that in eight years as editor, I did not meet a single deadline that we set for *CRP* production. Finally, thanks to Josh Lynch and Heather Smith, Ph.D. students at Texas A&M University, who this past year assisted us in production of this last volume.


Brad Lepper

CRP is ending, but the Center for the Study of the First Americans' publishing efforts are not. We continue to produce the quarterly news magazine, *The Mammoth Trumpet*, and we maintain an established peer-reviewed book series with our partner, Texas A&M University Press. In the near future, we hope to resurrect *CRP* in a new format and under a new title, as an electronic quarterly journal that will not only maintain the short-article format but also include longer reviews and research reports. Currently we are developing proposals to academic journal publishers, one of whom we hope will be interested in providing us with the infrastructure needed to again deliver a peer-reviewed journal for the interdisciplinary field of first Americans studies. Please check our website (www.centerfirstamericans.org) during the next year for any news about this project, and don't hesitate to send me an e-mail note at goebel@tamu.edu if you'd like an update.

So, for now, farewell.

Ted Goebel

Archaeology of Northeast Asia

Recent Excavations at the Shimaki Paleolithic Site, Hokkaido, Japan

Ian Buvit, Karisa Terry, Masami Izuho, and Koh Hamaguchi

➤ **Keywords:** Paleolithic, Hokkaido, wedge-shaped cores

In August 2010, archaeologists from Tokyo Metropolitan University and Central Washington University reopened excavations at the Shimaki site on the second terrace of the Otofuke River, southeastern Hokkaido (43° 14′ N, 143° 18′ E). Previous excavations revealed a Paleolithic artifact concentration including a wedge-shaped core (Figure 1) associated with a fission track age of 21,700 ± 1800 CALYBP (Kato and Yamada 1988). The specimen exhibits the morphology of other northeast Asian post-last-glacial-maximum microblade cores from Siberia and northern Japan, but the facets on the face of the Shimaki artifact clearly preclude formal microblade detachment.

Earlier work at Shimaki was conducted by Tsuji and Kato in 1967 and 1969, by the Kamishihoro Board of Education in 1984, and by the University of Tsukuba in 1986–1988 (Kato and Yamada 1988). Stratigraphically, the artifact-bearing layer is within loamy floodplain sediments of the Otofuke River bracketed by the Sipfa-1 Tephra above (a.k.a. Tangara Pumice, <19,000 CALYBP) and the Sipfa-2 Tephra below (a.k.a. Uguisu Pumice, ca. 43,000 CALYBP). The 1984 excavations were the most productive, uncovering 6,566 mostly obsidian chipped-stone artifacts from the Paleolithic level (Kato and Yamada 1988). Several numerical ages, including the fission track and five obsidian hydration dates (BS.A1-26 19,000 ± 800 CALYBP; A1-137 18,200 ± 500 CALYBP; B1-43 18,200 ± 700 CALYBP; B1-2896 17,200 ± 800 CALYBP; B3-80 17,500 ± 900 CALYBP), indicate an occupation at or just after the last glacial maximum. A single conventional radiocarbon date of 25,500 ± 1200 RCYBP (GaK-3262) from 40 cm below the cultural level provides a lower age limit (Kosaka and Nogawa 1972).

Ian Buvit and Karisa Terry Tokyo Metropolitan University, Faculty of Humanities and Social Sciences, Minami-Ohsawa 1-1, Hachioji-shi, Tokyo, Japan, 192-0397; Central Washington University, Department of Anthropology and Museum, 400 East University Way, Ellensburg, Washington, 98926; e-mails: ibuvit@gmail.com karisaterry@hotmail.com

Masami Izuho and Koh Hamaguchi, Tokyo Metropolitan University, Faculty of Humanities and Social Sciences, Minami-Ohsawa 1-1, Hachioji-shi, Tokyo, Japan, 192-0397; e-mails: izuhom@tmu.ac.jp koh_hama0225@yahoo.co.jp

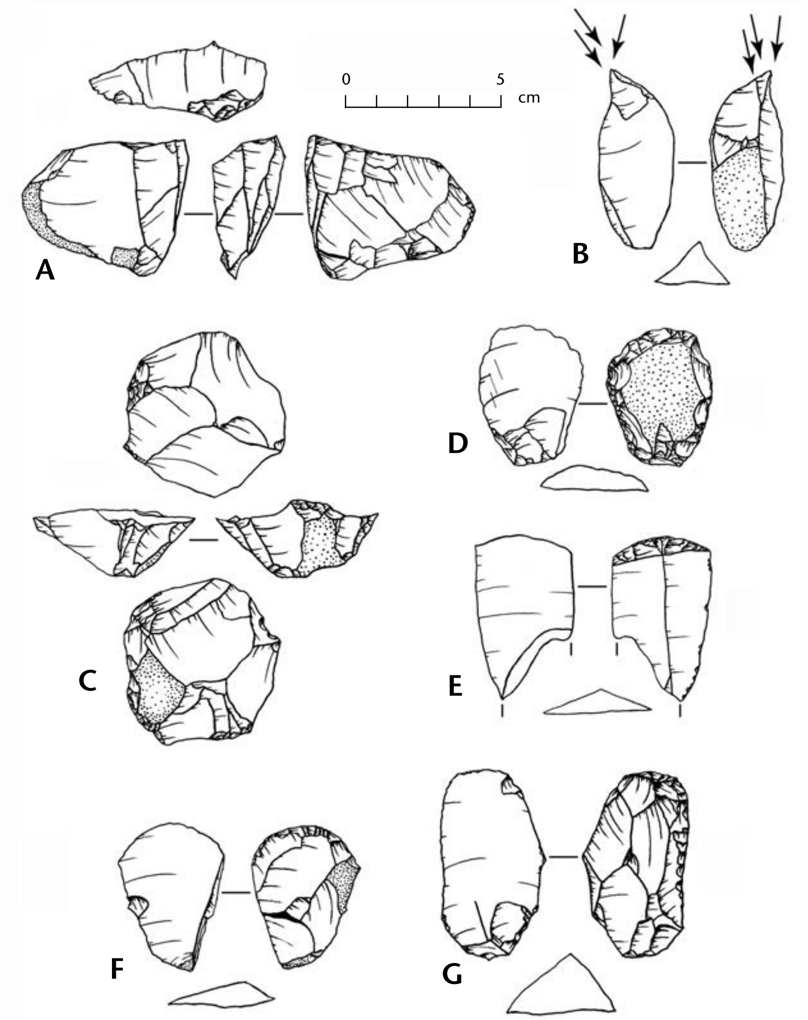


Figure 1. Paleolithic artifacts from the Shimaki site. **A,** wedge-shaped core; **B,** burin; **C,** flake core; **D–G,** scrapers.

Year 2010 excavations revealed Paleolithic artifacts associated with a hearth feature comprising an unlined ash and charcoal concentration (ca. 95 cm in diameter and 25 cm thick). Artifacts from all excavation units (N = 373) include 14 endscrapers, 5 sidescrapers, 12 flake cores, a burin, 4 retouched flakes, 210 flakes, 28 chips, 68 pebbles, and 32 pieces of ocher (see Figure 1 for examples). It is important to note that no microblades or other unequivocal microblade cores were discovered in 2010. Over 20 charcoal samples from the hearth feature and profiles are currently being processed at the University of Tokyo and should improve the geochronology of the site, especially the age of the archaeological material.

This and future work at Shimaki will help place Hokkaido within the framework of northeast Asian Paleolithic prehistory and to potentially facilitate our understanding of the development of microblade technology in the region.

References Cited

Kosaka, T., and K. Nogawa 1972 Hokkaido Tokachi Kamishihoro-cho niokeru Kyusekki Hoganso no ^{14}C Nendai (^{14}C Age of the Paleolithic Cultural Layer in Kamishihoro, Tokachi Region, Hokkaido). *Chikyu Kagaku* 26:137–38. (in Japanese)

Kato, S., and M. Yamada 1988 Hokkaido Katogun Kamishihorocho Shimaki iseki no Sekki Bunka (A Paleolithic Culture at Shimaki—The Oldest Paleolithic Components in Hokkaido). *History and Anthropology* 16:3–64. (in Japanese)

First Known Paleolithic Cache in Mongolia

Sergei Gladyshev, Alexander Popov, Andrei Tabarev, John W. Olsen, and B. Gunchinsuren

➤ **Keywords**: Mongolia, Paleolithic, cache, flakes

Paleolithic caches are a rare category of archaeological find, especially since relatively few are discovered and properly excavated by archaeologists. Most of the extant literature on Paleolithic caches focuses on the famous terminal-Pleistocene Paleoindian (Clovis, in particular) caches in North America and some earlier examples from western Europe, with additional sketchily reported finds from greater northeast Asia (e.g., the Russian Maritime Region, Chukotka, Yakutia, and Japan) (Kornfeld and Tabarev 2009). Some have speculated that caching behavior is more typical of North American cultures than those of northeast Asia (e.g., Bradley and Stanford 2004).

In 2009, the Joint Mongolian-Russian-American Archaeological Expedition continued excavating the stratified Tolbor-15 site in the Khangai Mountains of northern Mongolia (Gladyshev and Tabarev 2009), along with carrying out reconnaissance for similar localities in the Selenga River watershed nearby.

A number of interesting sites with blade, flake, and microblade industries were found on high fluvial terraces, arguably the most intriguing of which is situated on the southeastern face of a hill about 40 m above the Ikh-Tolboriin-

Sergei Gladyshev and Andrei Tabarev, Institute of Archaeology and Ethnography, 17 Lavrentieva Ave., Novosibirsk, 630090, Russia; e-mails: gladyshev@archaeology.nsc.ru tabarev@archaeology.nsc.ru

Alexander Popov, Museum of Archaeology, Far Eastern Federal University, 37 Okeansky Ave., Vladivostok, 690905, Russia; e-mail: poparchaeo@mail.ru

John W. Olsen, School of Anthropology , The University of Arizona, 1009 East South Campus Dr., Tucson, AZ 85721-0030; e-mail: jwo@arizona.edu

B. Gunchinsuren, Institute of Archaeology, Mongolian Academy of Sciences, 77 Jukovyn gudamj, Ulaanbaatar – 51, Mongolia; e-mail: bgunchinsuren@yahoo.com

Gol River (49° 14′ 07″ N, 102° 56′ 04″ E) (Figure 1A). Intensive erosion has exposed the upper part of a concentration of lithic artifacts from buried soil horizon approximately 10–15 cm below the surface. Excavation unit 50-by-50 cm revealed that these lithics occurred in a dense 30-by-30-cm concentration, as if they had been enclosed in a bag or some other container. The feature was

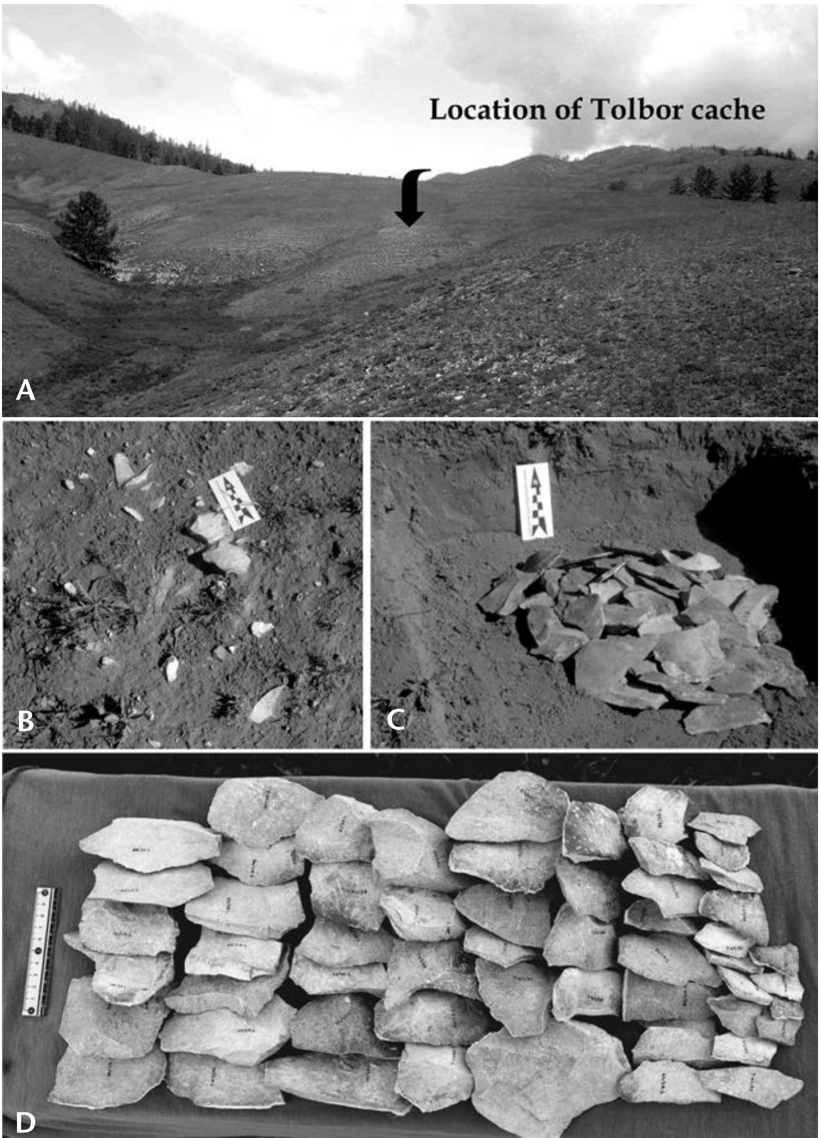


Figure 1. The Tolbor Paleolithic cache. **A,** location of the cache; **B,** before excavation; **C,** after excavation; **D,** contents of the cache.

not found in the context of an established occupation site or quarry, and no other artifacts were found in the sediment enclosing the cache or on the surface for a radius of hundreds of meters.

The cache assemblage includes 57 flat flakes made on local gray chert. All are discoidal with no traces of intentional retouch on their edges, and all are ideal blanks for tools. Fifty-three (93%) of the flakes may be described as large, with at least one minimum dimension exceeding 5 cm, while 16 (28%) are even larger, with at least one dimension exceeding 10 cm. No debitage or exhausted cores are associated with this set of blanks, and no formal tools from exotic raw materials or artifacts with hypertrophic proportions were found, so this feature cannot be easily interpreted as ritual or ceremonial in character; rather, the characteristics of its contents and location suggest it is a raw material cache—a hoard of special blanks—the first Paleolithic cache described from Mongolia.

Taking into consideration the long chronology of flake technologies associated with Pleistocene industries in northern Mongolia (Gladyshev et al. 2010) and the fact that datable materials were not found in direct association, the Tolbor cache may be preliminarily dated on typological and stratigraphic grounds to between 25,000–15,000 CALYBP, which corresponds with the predominance of flake industries in contrast with the blade (40,000–25,000 CALYBP) and microblade (15,000–11,000 CALYBP) industries.

This research was supported by grants # 09-06-00006a from the Russian Foundation for Basic Research and # 10-01-00548 a/g from the Russian Foundation for Humanities, as well as the Je Tsongkhapa Endowment for Central and Inner Asian Archaeology at the University of Arizona.

References Cited

Bradley, B., and D. Stanford 2004 The North Atlantic Ice-Edge Corridor: A Possible Paleolithic Route to the New World. *World Archaeology* 36(4):459–78.

Gladyshev, S., and A. Tabarev 2009 New Data on the Early Upper Paleolithic of Northern Mongolia. *Current Research in the Pleistocene* 26:17–18.

Gladyshev, S., J. Olsen, A. Tabarev, and Y. Kuzmin 2010 Chronology and Periodization of the Upper Paleolithic Sites of Mongolia. *Archaeology, Ethnography, and Anthropology of Eurasia* 3(43):35–42.

Kornfeld M., and A. Tabarev 2009 The French Connection? Or is It? *Current Research in the Pleistocene* 26:90–92.

An Early Lithic Assemblage from the Khaya IV Site, Western Beringia

Sergei B. Slobodin

➤ **Keywords:** Archaeology of Western Beringia, Kolyma region, Paleolithic Northeast Asia

The Khaya IV site is a long-term hunting camp located on the north slope of the Okhotsk-Kolyma Plateau, in the Upper Kolyma region, western Beringia. According to geological data, this region was free of ice during the Karga and Sartan (Anderson and Lozhkin 2002).

The site lies on a small tributary of the Maltan River named Bolshaya Khaya, and is situated on a rocky edge of an 11-m-high alluvial terrace (elevation 880 m). The cultural materials (stone artifacts) are enclosed in strongly cryoturbated, shallow (up to 30 cm thick) sandy loam deposits overlying the terrace base.

The artifact complex discovered from the site is homogeneous in typology, technology, and raw material. The latter is presented by siliceous platy cleavages from a nearby outcrop and chalcedony cobbles from the river bank. The artifacts include cores, blades, irregular microblades, burins, gravers, points, bifaces, scrapers, pendants, a chopper, and technical spalls (Figure 1).

The core types are presented by large and flat cores with a wide front for obtaining blade flakes; narrow cores, steeply beveled toward the frontal pressure-retouched platform; end cores on slabs; a flattened subprismatic core; flattened two-platform cores with retouched beveled pressure platforms; and a fragment of a core front with microblade removal negatives.

Bifaces have a flattened-lenticular cross section and are asymmetrically oval, semilunar, and asymmetrically triangular in shape. Points are bifacial leaf-shaped with rounded and pointed bases and sub-triangular with straight bases. Sidescrapers (including *déjeté*) are made on flakes, and endscrapers (including double-ended) on blades. Burins are dihedral, angle, and transverse, made on blade spalls. Ornaments are represented by a flat pendant with a hole, and beads.

The cultural association and age of these materials have not been precisely determined at the present, though it is clear that the Khaya IV tool complex is characteristic of Paleolithic complexes of northeast Asia, but differs from the Dyuktai (Mochanov 1977) and Ushki (layer 7) cultures (Vorobey 2009). This is corroborated by artifacts that reflect a transition from the subprismatic technique of obtaining blade blanks from broad core surfaces to end cores. Such a transition is recorded in early stages of the late Paleolithic of the Altai at the Kara-Bom site (Derevyanko et al. 2002) and in the middle of the late Paleolithic (25,000 to 18,000 RCYBP) in the Transbaikal region (Konstantinov 1994).

Sergei B. Slobodin, Northeastern Interdisciplinary Science Research Institute, Far East Branch of the Russian Academy of Science, Portovaya St. 16, Magadan 685000, Russia; e-mail: sslobodin@mail.ru

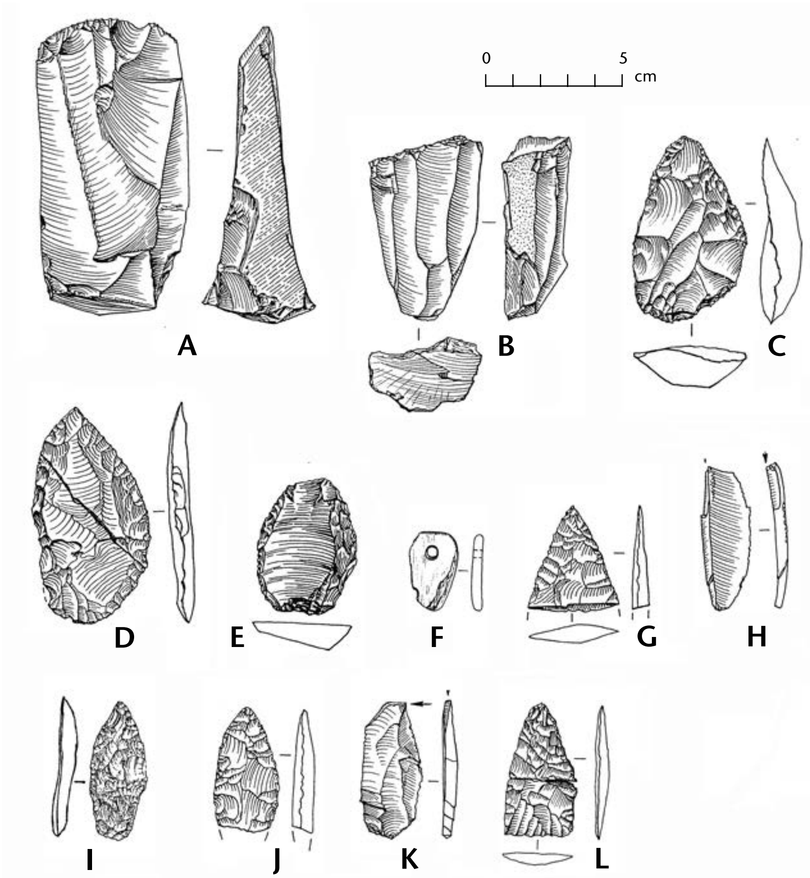


Figure 1. Stone tools from Khaya IV site: **A, B,** cores; **C, E,** scrapers; **D, G,** bifaces; **F,** pendant; **H, K,** burins; **I, J, L,** points.

The primary flaking technique of the Bol'shaya Khaya IV site shows parallels with materials of the early Abakan site complex on the Amur (21,000–25,000 RCYBP) (Derevyanko et al. 1998), and with the lower layer of the Ustinovka I site in Primor'e dated to 22,000–14,000 RCYBP (Vasil'evskii and Gladyshev 1989), or even to 30,000 RCYBP (Kononenko 2001).

The Khaya IV complex expands the variety of western Beringia Paleolithic traditions. Since the complex of Khaya IV site includes virtually all categories of the stone toolkit and arts items, there is no reason to believe that this complex presents functional or ecologically rooted variation of any of the known cultures of Beringia. Absence of microcore and microblade at Khaya IV site is reason to group it with non-microblade complexes of Beringia, such as Ushki (layer 7), Nenana and Yana, although it differs from them (see Slobodin 2011). Another aspect common to them all is the presence of bifaces (at the Yana site they are not numerous, but presented). Discovering and identifying a holistic complex of Khaya IV enhances the techno-typological analysis of mixed complexes or complexes with unclear context, both those existing and those not yet found in Beringia.

References Cited

Anderson, P. M., and A. V. Lozhkin, Ed. 2002 Late Quaternary Vegetation and Climate of Siberia and Russian Far East (Palynological and Radiocarbon Database). Magadan, NEISRI FEB RAS.

Derevyanko, A. P., P. V. Volkov, and Li Khonjon 1998 *Selemdzhinskaia Pozdnepaleoliticheskaia Kul'tura* [The Selemdzhinskaia Late Paleolithic Culture]. Novosibirsk.

Derevyanko, A. P., P. V. Volkov, and V. T. Petrin 2002 *Zarozhdenie Mikroplastinchatoi Tekhniki Rasshchepleniia Kamnia* [The Origin of the Microblade Technique of Flaking Stone]. Novosibirsk.

Kononenko, N. A. 2001 Ecology and Dynamics of Archaeological Cultures in the Valley of the Zerkal'naia River at the End of the Pleistocene—Beginning of the Holocene. *Archaeology, Ethnography, and Physical Anthropology of Eurasia* 1:40–59.

Konstantinov, M. V. 1994 *Kamennyi Vek Vostochnogo Regiona Baikal'skoi Azii* [*The Stone Age of the Eastern Baikal Region of Asia*]. Ulan Ude, Chita.

Mochanov Yu, A. 1977 *Drevneishie Etapy Zaseleniia Chelovekom Severo-Vostochnoi Azii* [The Earliest Stages of Human Settlement of Northeast Asia]. Nauka, Novosibirsk.

Slobodin S. B. 2011 Late Pleistocene and Early Holocene Cultures of Beringia: the General and the Specific *// From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/ Early Holocene Beringia,* edited by T. Goebel and I. Buvit, pp. 145–64. A Peopling of the Americas Publication, Center for the Study of First Americans, Department of Anthropology, Texas A&M University, College Station.

Vasil'evskii, R. S., and S. A. Gladyshev 1989 *Verkhnii Paleolit Yuzhnogo Primor'ia* [*The Upper Paleolithic of Southern Primor'e*]. Nauka, Novosibirsk.

Vorobey I. E. 2009 Some Comments on the Configuration Scheme for North Far East Pleistocene Archaeology. Proceedings of the Conference dedicated to the Memory of Academician K. L. Simakov, edited by I. A. Chereshnev, pp. 273–74. NESC FEB RAS, Magadan.

The Western Transbaikal, Siberia: New Materials of the Middle Phase of the Upper Paleolithic

Irina I. Razgildeeva and Aleksander V. Konstantinov

➤ **Keywords:** Upper Paleolithic technology, lithic workshop, Siberia

Long-term archaeological research in the western Transbaikal region (Russia, Siberia) has focused on a series of the multilayered late Upper Paleolithic settlements spanning the final stage of the Sartan glaciation (Konstantinov 1994, 2001). The expressive remains of domestic complexes dating from 20,000 RCYBP have revealed a strong connection between the organization of inhabited space, distributions of artifacts, and specialized toolkits. Collections

---

Irina I. Razgildeeva and Aleksander V. Konstantinov, Transbaikal State Humanitarian Pedagogical University, 129 Babushkina Street, Chita, 672007, Russia; email: labpaleo@yandex.ru

of stone artifacts have been found that contain wedge-shaped cores, microscrapers, knives, and microblades in combination with large cobble tools used as scrapers, choppers, etc. The repeated positioning of sites along floodplain terraces, short duration of occupations of dwellings, and specificity of tool assemblages point to specialized seasonal hunting habitations. Sites with full spectra of stone-tool manufacturing (i.e., workshops) are quite rare. The origins of this late Upper Paleolithic complex is unknown; our recent research therefore has focused on characterizing the middle phase of the Transbaikal Upper Paleolithic, ca. 25,000–20,000 RCYBP.

In 2007–2010 we researched a new Paleolithic site situated in the second alluvial terrace of the Menza River (85 m from the edge of the terrace, 7.35 m above the modern river level), called Ust'-Menza-14 (or Lagernaia) (Figure 1). Paleolithic cultural layers occurred at a depth of 3 m. Lithic artifacts recovered include scrapers on massive split cobbles, large cortical spalls, and numerous flakes. The occurrence of large boulders suggests the possible presence of dwelling features.

As of 2010, an area reaching 33 m^2 had been excavated. The exposed stratigraphic profile reached 5.6 m. From the top downward, stratigraphic layers are as follows: layers I-II, talus dating to the Holocene; layer III, talus dating to the Noril'sk stade (10,300–10,800 RCYBP); layer IV, pedocomplex dating to late Sartan interstadials (i.e., Kokorevo and Taimyr, 10,800–12,700 RCYBP); layer V, periglacial floodplain alluvium, dating to full Sartan glaciation (ca. 13,000–20,000 RCYBP); layer VI, normal floodplain alluvium dating to late Karga interglaciation (ca. 20,000–25,000 RCYBP); layer VII, river bed facies, also presumed to date to late Karga times. The cultural layer is connected with the lithological layer V, at the base of periglacial alluvium of the second floodplain terrace, at a depth of 2.9–3.4 m. The cultural layer is poorly preserved. Its surface is undulating, and ice-wedge features cut through the surface of the layer. Artifacts appear redeposited into ancient gully features, tracked by a band of fine white sand. The assemblage appears to have been water-sorted, with small pieces having been washed away. Artifacts are discolored by iron oxides, suggesting a marshy, wet substrate in antiquity. Surfaces of all artifacts are strongly eroded, but technological patterns permit us to consider them as a single, uniform complex.

The stone assemblage is characterized by large products—mostly cobble scrapers and rejected scraper preforms, as well as numerous cortical spalls and core-reduction flakes. The excavated area also contained rounded boulders and cobbles that appear to have been used as hammers and anvils. The site appears to have functioned as a workshop, and stone raw materials are chiefly of local metamorphosed sandstones and slates, microquartzites, quartzites, microslates, and poor-quality jasper). Bipolar reduction was the chief form of core splitting. Worked edges of tools were prepared by hard-hammer percussion. In addition, the assemblage has a series of scrapers and flakes on orthoclase rhyolites, which are not represented in the local alluvium. A small number of micro-flakes (n = 39) made of multicolored jasper, chalcedony, and volcanic glass also occur. An unusual artifact includes an angular fragment from a dark brown siliceous pebble of skarn containing 75% magnetite,

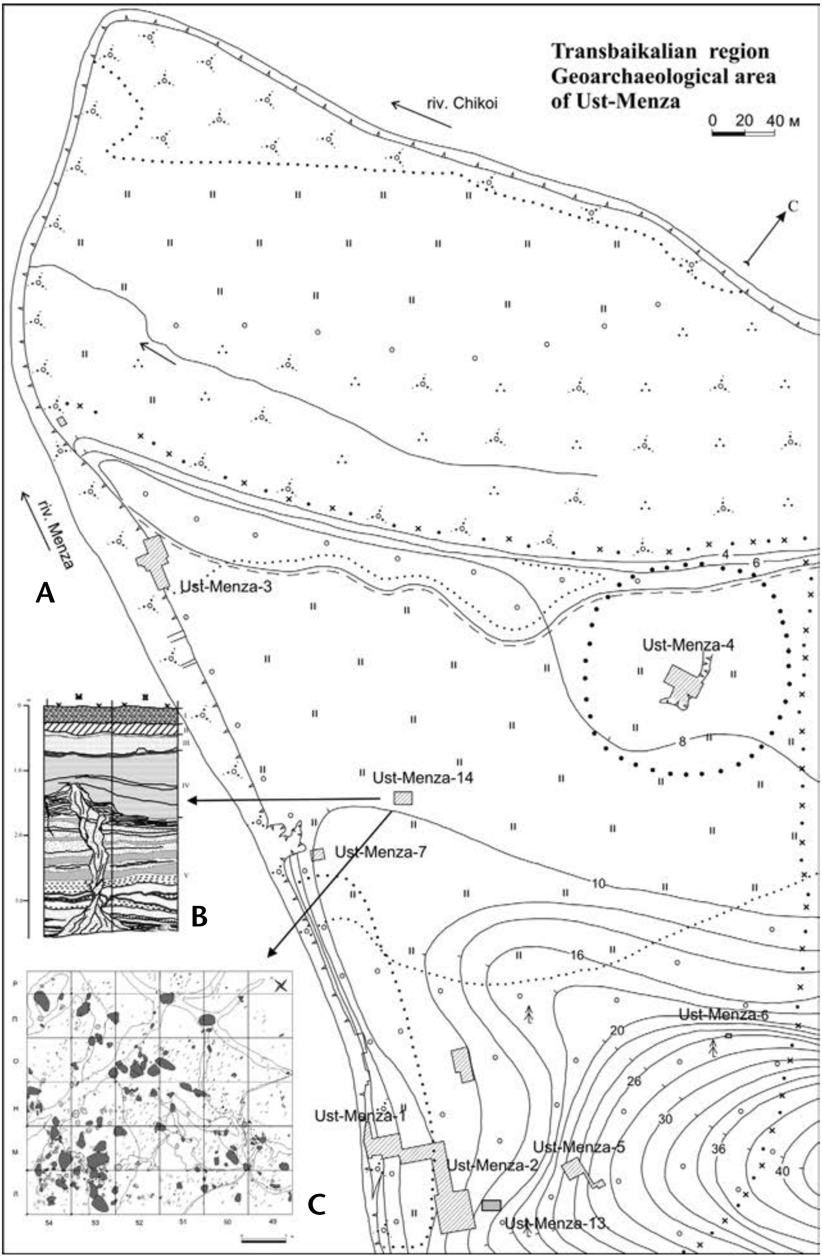


Figure 1. **A,** map of Ust'-Menza area; **B,** stratigraphic profile of Ust'-Menza-14; **C,** plan of excavation of Ust'-Menza-14.

4 cm long, 3 cm wide, and less than 1 cm thick. Skarns of this type occur further up the Menza River. The lithic assemblage totals 1,107 pieces, and among them are 24 scrapers on flakes, 10 scrapers on fragments, 9 possible knives, 4 combination scraper-knives, 2 chisel tools, and 2 retouched flakes. Forty hammerstones and numerous more fragments have been recovered, as well as 10 pebble-retouchers made on microsandstones and microslates. Faunal remains are poorly preserved.

Site mapping led to the distinction of an area roughly 4 m^2 in extent, in the area of the excavation corner closest to the Menza River, which contained a massive boulder-anvil (0.96 x 0.6 m in size) with a concavo-convex surface covered with barbs. From under it were recovered three hammerstones and a scraper, and around it were additional scrapers, hammerstones, chipped and split pebbles, cortical spalls, and flakes.

The analysis of Ust'-Menza-14 and its contents is not yet finished; however, already we have recorded differences between it and the other later Upper Paleolithic sites of the Ust'-Menza archaeological area. Ust'-Menza-14 contains, for the first time, a unique workshop site where the bipolar technique of splitting locally procured raw materials occurred. On the basis of the assemblage's stratigraphic position and character of its archaeological materials, we assign the horizon to the initial stage of a Sartan glaciation and the middle Upper Paleolithic archaeological period (i.e., Karasev 2002:61).

References Cited

Karasev V. V. 2002 *The Cenozoic of Transbaikal.* Chita [in Russian].

Konstantinov, A. V. 2001 *Ancient Dwellings of Transbaikalia: Paleolithic, Mesolithic.* Nauka, Novosibirsk [in Russian].

Konstantinov, M. V. 1994 Stone Age of the East Region of Baikal Asia. Publishing House BNDTS, Siberian Branch of the Russian Academy of Science, and CSPI of N. G. Chernyshevsky, Chita and Ulan Ude [in Russian].

The Definition of Raw-Material Centers during the Late Paleolithic, Neolithic, and Paleometal Ages of Sakhalin Island, Eastern Russia

A. A. Vasilevski and V. A. Grishchenko

➤ **Keywords**: Sakhalin island, jasper center, raw material

The raw-material (RM) basis of lithic industries during the Stone (20,000–3000 RCYBP) and Paleometal (until the 6th century A.D.) ages in Sakhalin

A. A. Vasilevski, Doctor of science, vice-rector of Sakhalin State University. Yzhno-Sakhalinck, Lenina str, 290, Sakhalin State University, Russia; e-mail: vasilevski@bk.ru

V. A. Grishchenko, Ph.D, Head of Educational archaeology museum of Sakhalin State University. Yzhno-Sakhalinck, Lenina str, 290, Sakhalin State University, Russia; e-mail: v.grishchenko@mail.ru

included local and exotic components. Local RM included various hornfels, tuff, siliceous argillite, andesite, basalt, gabbro, chalcedony, quartzite, etc. Generally, by local we understand the lithic RM that was collected by people locally within a distance of 50–100 km, or on a journey of 2–4 days on foot from residential sites during their hunting or fishing trips. Most tools, as a rule, were produced on such local RM. Nevertheless, major additions to late-Paleolithic industries, and to even a greater degree early-Neolithic industry, were exotic silicates used to make blades, especially microblades.

A significant phenomenon of the late-Pleistocene/early-Holocene archeology of the Japanese archipelago, Sakhalin, Kuril Islands. and Kamchatka was transporting obsidian from outcrops in Hokkaido and Kamchatka along the so-called "obsidian way," as much as 1000 km one way. Numerous publications (Kimura 1992, 1998; Vasilevski 1996; Phillips and Speakman 2009; Glascock et al., 2000; Kuzmin et al. 2002] are devoted to this. We note that the farther to the north a site is situated, the less obsidian is found in it. So it seems quite natural that we unearthed a few artifacts made of Hokkaido obsidian in sites in the north of Sakhalin.

Jasper characterized by sealing-wax color is widely distributed throughout the East Sakhalin Mountains and in the Tym and Nabil river valleys. In the region, several groups of Stone Age sites were discovered between 2001 and 2009 (Berseneva 2007; Mozhaev 2009, 2010; Vasilevski 2006) (Figure 1). The Paleolithic and Initial Neolithic lithic RM sites are situated at altitudes ranging from 250 to 400 m, close to river deposits and to numerous surface outcrops and rocks of jasper. These outcrops are the largest known resource of RM in the island. Massive spalls, sometimes weighing more than 30 kg, detached from natural stationary cores—lonely rocks—were frequently used as blanks, as well as big pebbles from river sides. Thus the makers reduced failures in production by avoiding cracks in the structures of cores. Much of the RM from the upper parts of original layers or rocks has been spoiled by forest fires, water, and frost, so jasper toolmakers preferred already realized blanks–pebbles and boulders (Figure 1B). Most artifacts from the sites include debitage, blanks, anvils and half-prepared and spoiled cores, fragments of blades, side spalls, platform-rejuvenation spalls, flakes, chips, and unsuccessful products. Used tools are rare, but their presence indicates the place was inhabited by people for some time, not just for procuring RM. Sites dating to the middle and late Neolithic and the Paleometal age (4th millennium B.C.–5th century A.D.) are dominated by tools and flakes made of jasper the color of sealing wax.

We distinguish four areas of local lithic RM distribution in the island region for the period 20,000–1500 RCYBP, as shown in Figure 1. The northern area (area 1), including most of northern and central Sakhalin, was the source of local flints and small amounts of jasper used about 20,000–7500 RCYBP. Area 2 corresponds to the Middle Sakhalin jasper area, which was the source of toolstone used throughout the period. These two areas became united after flake industries replaced microblade industries in the middle Neolithic, about 7500–7000 RCYBC. Area 3 is the area of southern Sakhalin, where although toolmakers used jasper from the north and obsidian from the south, local materials were the basis of the industry. This conclusion is based on the results of our excavations of such sites as Ogonky 5 and 8, Olympia 4–5 (late and final

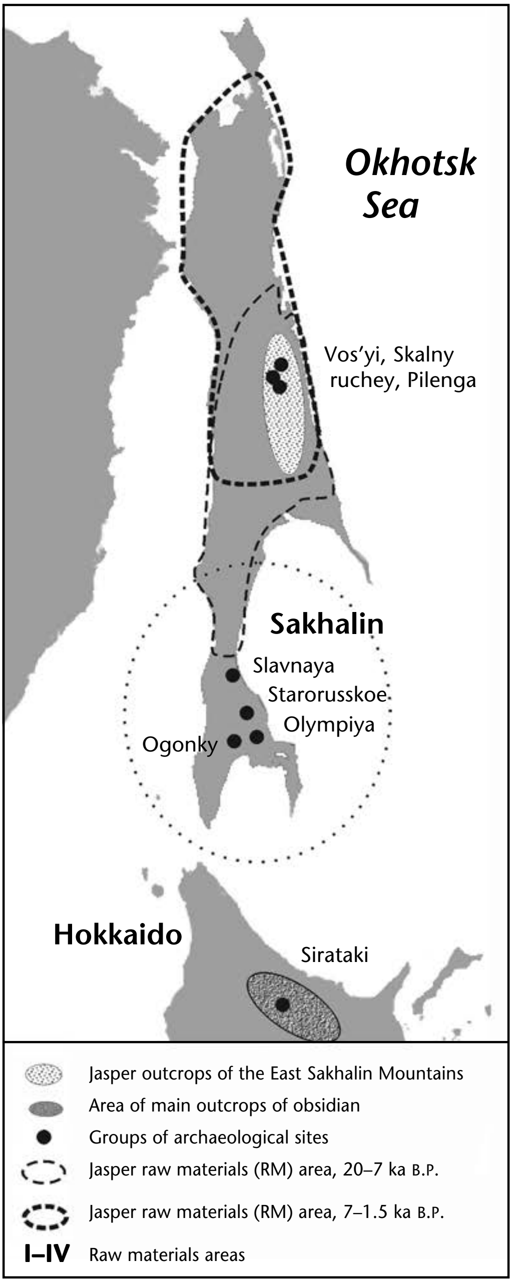


Figure 1. **A,** The raw-materials areas (I–IV) of Sakhalin and Eastern Hokkaido and the late-Paleolithic/early-Neolithic sites mentioned in the article; **B,** the jasper core from the late-Paleolithic site Vosyi 5; **C,** the bazalt core from late-Paleolithic site Ogonky 5; **D,** the obsidian core from late-Paleolithic site Starorusskoe 3.

Paleolithic), Slavnaya 4, and Starodubskoye 3 (Neolithic), etc. At the same time, some sites characterized by microblade assemblages and dating to 12,000–8000 RCYBP, such as Slavnaya 5, Ogonky 7, Sokol 1, and Starorusskoye 3 and 5 (Figure 1), all late Paleolithic and initial Neolithic, are characterized by a prevalence of obsidian tools. The latter facts confirm the significance of obsidian exchange and possible migrations of obsidian toolmakers from Hokkaido during some periods in the final Pleistocene and early Holocene. Area 4, situated in northern and eastern Hokkaido, is characterized by industries founded on local RM, primarily obsidian. As for the Kurils, obsidians from both Kamchatka and Hokkaido were used (Phillips and Speakman 2009), as was local basalt and jasper.

Despite the significance of obsidian for microblade production, local RM remained a basic necessity even during peaks of obsidian exchange during the period 12,000–8,000 RCYBP. During some periods the jasper outcrops of middle Sakhalin were even more significant than Hokkaido obsidian resources. This has to be assessed to develop a comprehensive understanding of the Stone Age industries of Sakhalin Island.

References Cited

Berseneva, E. V. 2007 Razvedki v verhovyah reki Vosi v Tymovskom rayone Sakhalinskoy oblasti. In *Archaeologicheskie otkrytiya 2005 goda,* edited by Lopatin N.V. pp. 421-422. Institute of archaeology, Russia academy of science, Moscow, (in Russian).

Glascock, M. D., M. S. Shackley, Y. V. Kuzmin, V. K. Popov, S. V. Gorbunov, A. A. Vasilevski, O. A. Shubina, V. I. Zaicev, and H. Sato 2000 Chapter 5: Geohimiya obsidiana is archaeologicheskih pamyatnikov Sakhalina I ego istochniki. In *Vulkanicheskie stekla Dalnego Vostoka Rossii: geologicheskie i archeologicheskie aspekty,* edited by Y. V. Kuzmin and V. K. Popov, pp.88–106. Russian Academy of Sciences, Far Eastern Branch, Far Eastern Geological Institute, Vladivostok, (in Russian, with English abstract).

Kimura H. 1992 *Reexamination of the Yubetsu Technique and Study of Horokazawa Toma Lithic Culture.* Sapporo University, Sapporo (English and Japanese).

——— 1998 Obsidian Humans Technology. In *Paleoecologya Pleistocena i kultury kamennogo veka Severnoy Asii i sopredelnyh territoryi,* edited by A.P. Derevyanko, pp. 302–14. Institute of archaeology and ethnography Siberian branch of Russia academy of science, Novosibirsk.

Kuzmin, Y. V., M. D. Glascock, and H. Sato 2002 Sources of Archaeological Obsidian on Sakhalin Island (Russian Far East). *Journal of Archaeological Science* 29(7):741–50.

Mozhaev, A. V. 2009 Stoyanka – masterskaya Skalnyi ruchei. In *Sakhalinskaya molodez i nauka,* edited by L.N. Konyhova, pp. 279–80. Sakhalin State University Press, Yzhno-Sakhalinsk (in Russian).

——— 2010 Stoyanki kamennogo veka mestorozdeni yashmy Vostochno-Sakhalinskih gor. Paper presented at the International Symposium "The initial human habitation of the continental and the insular parts of the Northeast Asia", Yzhno-Sakhalinsk (in Russian).

Phillips, S. C., and R. J. Speakman 2009 Initial Source Evaluation of Archaeological Obsidian from the Kuril Islands of the Russian Far East Using Portable XRF. *Journal of Archaeological Science* 36(6):1256–63.

Vasilevski, A. A. 1996 Zametki o Do i proto istorii ostrova Sakhalin. *Kraevedcheski bulletin* 1:54–79 (in Russian).

——— 2006 Dobycha, pervichnaya obrabotka i dvizhenie sirya v pozdnem paleolite I rannem neolite Sakhalina i Hokkaido (20-7 tys. l.n.). In *Problemy archaeologii ethnographii i anthropologii Siberi and sopredelnyh territoriy,* edited by A.P. Derevyanko, pp. 31–35. Institute of archaeology and ethnography Siberian branch of Russia academy of science Press, Novosibirsk (in Russian).

New Data on the Upper Paleolithic of the Upper Yenisei Area (Siberia)

Valery S. Zubkov, Sergey A. Vasil'ev, Galina Y. Yamskikh, Elena V. Syromyatnikova, Anna V. Kozachek, and Svetlana A. Gavrilkina

➤ **Keywords**: Yenisei, Upper Paleolithic, lithic workshops

The paper briefly summarizes the preliminary results of the first phase of a research project carried out in the upper Abakan valley (upper Yenisei basin, southern Siberia) in 2010. The main theme of the research is outlined as follows. Up to now our knowledge about the development of Paleolithic cultures in the vast area of the Yenisei River basin is mostly based on data from sites located within the narrow limits of the Yenisei valley itself, owing to the fact that the main research efforts have been associated with large-scale salvage archaeology campaigns in areas to be flooded by the river's reservoirs. Archaeologically, the large areas lying beyond the main valley floor are essentially blank. Moreover, searching for sites in the area not heavily affected by reservoirs and construction works seems to be promising from the viewpoint of detecting well-preserved buried sites.

The valley of the main left tributary of the upper Yenisei, the Abakan River, was chosen as an area to be investigated because of good preservation of Quaternary terraces and minimal recent human activities. Owing to the efforts of the senior author, several stratified Stone Age sites have been discovered since 2001 in the previously unexplored area (Zubkov 2008). The sites associated with the upper strata of the first terrace 5–7 m high (i.e., above the modern river level) are Sigurtup I, Matros I, Semenovsky Ruchey I, and Kuibyshevo I; for the second terrace 8–12 m high, Bolshie Arbaty I; for the third terrace (15–20 m high), Kuibyshevo III); for periglacial sediments forming elevations 27–29 m high, Mozharov Uval. Upper components of most of the sites produced remains of the Iron and Bronze Age as well as Neolithic cultures, while lower components could be assigned to the final Pleistocene or

Valery S. Zubkov, Department of Archaeology, Ethnography and Local History, Katanov Khakasiya State University, 5 Karl Marx St., 655000, Abakan, Russia; e-mail: zubkoffval@mail.ru

Sergey A. Vasil'ev, Paleolithic Department, Institute for the Material Culture History, 18 Dvortsovaya emb., 191186, St.Petersburg, Russia; e-mail: sergevas@av2791.spb.edu

Galina Y. Yamskikh, Faculty of Geography, Siberian Federal University, 79 Svobodny Ave., 660041, Krasnoyarsk, Russia; e-mail:yamskikh@mail.ru

Elena V. Syromyatnikova, Department of Theriology, Zoological Institute, 1 Universitetskaya emb., 199034, St. Petersburg, Russia; e-mail: aravir@mail.ru

Anna V. Kozachek, Faculty of Geography, St.PetersburgStateUniversity, 33 10 Liniya V.O., 199178, St.Petersburg, Russia; e-mail: anna_kozachek@mail.ru

Svetlana A. Gavrilkina, Faculty of Geography, St.PetersburgStateUniversity, 33 10 Liniya V.O., 199178, St.Petersburg, Russia; e-mail:svetilnic@mail.ru

early Holocene. The sites yielded bones of wild sheep, red deer, roe deer, moose, auroch or bison, and fish. More specifically, the lowermost component of Matros I produced reindeer bones; layer 2 at Bolshie Arbaty I produced sheep and fish; and layer 3 yielded moose and sheep.

The main focus of fieldwork has been at Kuibyshevo II, located in a small intermountain depression along the right bank of the Dzhebash River, a tributary of the Abakan (Figure 1). In a series of trial trenches on the flat surface of the erosional terrace 70 to 75 m above the river, the remains of a cultural layer associated with upper loams have been exposed. The depth of sediments is about 1.15 m. Under the modern soil is a brown loam, underlain by a brownish yellow loam with artifacts at a depth of 0.35–0.55 m. Redeposited artifacts also have been found in slope sediments at levels 55–60 and 90 m above the river, the last suggesting that another locality may have existed that is now destroyed. Near the site in the base of the terraces outcrops of quartzite blocks have been discovered.

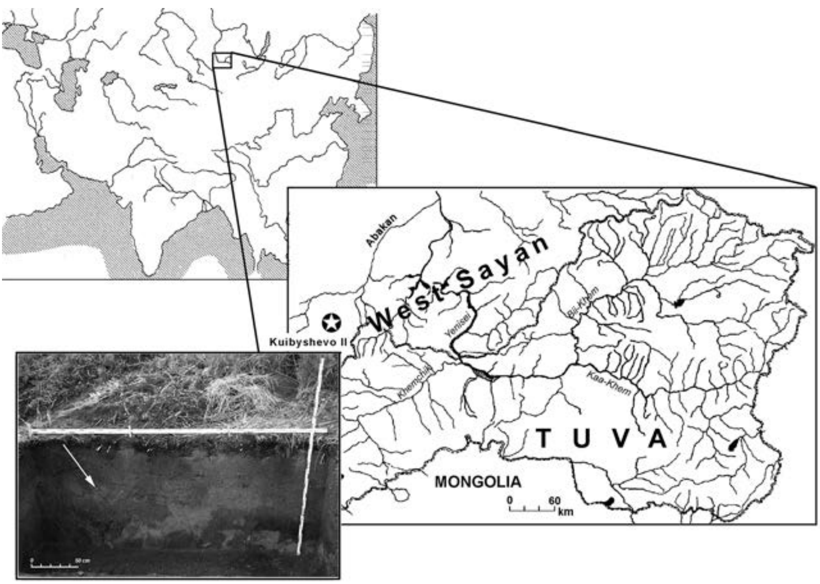


Figure 1. Kuibyshevo II site location and stratigraphy.

The importance of the site is threefold. First, it differs in the stratigraphic position from all known sites in the Yenisei basin and even beyond it. The culture-bearing layer represented by the dispersed lithics is embedded in thin covering loams above eluvium. This stratigraphy is more similar to that of Upper Paleolithic sites in the Russian Far East (Pacific areas) than in Siberia *sensu stricto*. Second, the functional peculiarity of the site is worth mentioning. Despite the long history of archaeological research and several hundred Upper Paleolithic sites now known from the Yenisei region, Kuibyshevo II is the first lithic workshop located near sources of raw material commonly used by prehistoric humans of the region. Third, the composition of the site's lithic assemblage is unique. Kuibyshevo II yielded three toolkits previously reported from different site clusters and traditionally considered incompatible. The core of the industry represents the Afontova-type lithic industry prevalent in the region during the final Pleistocene (Vasil'ev 1996), with heavy single- and double-platform cores, microblade wedge-shaped microcores, and numerous sidescrapers and endscrapers made on flakes. At the same time the site yielded a series of endscrapers on retouched blades and elongated burins, morphologically identical to "classic" specimens of the Kokorevo-type industry found in sites located several hundred kilometers north of Kuibyshevo II (Kokorevo I, Novoselovo VI and VII; for detailed discussion see Vasil'ev 1992). Moreover, the assemblage includes a series of foliate bifaces reported only from the sites of the Derbina cluster located further north of Kokorevo (Akimova et al. 2004). Thus the assemblage could be considered as a starting point for reexamining the complicated problem of the nature of lithic assemblage variability in the late Upper Paleolithic of Yenisei.

Future work should be oriented toward dating Kuibyshevo II. The dearth of organic matter prevented our using customary radiocarbon dating; therefore only RTL- and OSL-dating methods could help us establish the chronological position of the site. We plan to continue exploring this cursorily investigated area in our search for other Paleolithic occupations.

This research has been supported by the Russian Foundation for Basic Research, The RFBR-Khakasiya Program, Grant #10-06 98011. We thank the editorial board of *CRP* for correcting the English version of the paper.

References Cited

Akimova, E. V., S. A. Laukhin, Yu. M. Makhlaeva, A. F. Sanko, I. V. Stasiuk, and E.A. Tomilova 2004 The Archaeological Region of Derbina Bay in the Northeastern Part of East Sayan. In *Acts of the XIVth UISPP Congress, University of Liege, Belgium, 2–8 September 2001. General Sessions and Posters. Section 6. The Upper Palaeolithic. British Archaeological Reports International Series 1240*, edited by M. Dewez, P. Noiret and E. Teheux, pp. 215–23. British Archaeological Reports, Oxford.

Vasil'ev, S. A. 1992 The Late Paleolithic of the Yenisei: A New Outline. *Journal of World Prehistory* 6:337–83.

——— 1996 *Pozdnii Paleolit Verkhnego Eniseia [The Late Paleolithic of the Upper Yenisei*]. Peterburgskoe Vostokovedenie, St.Petersburg.

Zubkov, V. S. 2008 Arkheologicheskie Issledovaniya v Tashtypskom Rayone Respubliki Khakasiya (Predvaritelnye itogi) [Archaeological Investigations in the Tashtyp Region of the Republic of Khakasiya: Some Preliminary Results]. In *Martyanosvskie Kraevedcheskie Chteniya, vol. V,* edited by L. N. Ermolaeva, pp. 30–35. Krasnoyarsky Kraevoi Muzei, Krasnoyarsk.

Archaeology of North America

Paleoindian Occupation at the Paul Site, a Valley Locale in Yellowhouse Draw on the Southern High Plains, Texas

Paul N. Backhouse and Eileen Johnson

➤ **Keywords:** Hunter-gatherers, Paleoindian, Southern High Plains

The Paul site (41LU136) is a multicomponent, hunter-gatherer location with occupations that span the late Quaternary. It is a large valley site (4.37 acres) within Yellowhouse Draw just above the confluence with Blackwater Draw that then forms Yellowhouse Canyon and the North Fork of the Double Mountain Fork of the Brazos River. The site is well stratified, mirroring the regional valley fill stratigraphy (Holliday 1995) and, in particular, that of the Yellowhouse system sequence defined upstream at Lubbock Lake (Holliday 1985; Holliday and Allen 1987). A comprehensive program of subsurface investigations (Backhouse et al. 2010; Johnson 2010) has identified at least 16 occupational episodes within the 5 major units and yielded 26 radiocarbon dates. Deeply buried Paleoindian-age material is well represented, encompassing at least six occupation zones, and the in situ recovery context is significant regionally.

The Paleoindian strata (1 and 2 in the regional system; Holliday 1995) were below the water table, and access was through systematic trenching using a trackhoe, safety trench boxes, and pumps. Trackhoe scoops were in ca. 10-cm levels within an identified stratum, and the sediments from each provenienced scoop were water processed for recovery of cultural and biological materials. Fourteen of the 26 radiocarbon dates came from stratum 2.

Occupation zones were based on spatial distribution and topography (upper and lower valley margins, axis). Stratum 1, the deepest unit and representing terminal-Pleistocene deposits (Holliday 1985; Johnson 1987), contained at least two occupation zones in different Clovis-age substrata. Flaked lithic

Paul N. Backhouse, Florida Gulf Coast University, 10501 FGCU Blvd, South Fort Myers, FL 33965-6565; e-mail: pbackhouse@fgcu.edu

Eileen Johnson, Museum of Texas Tech University, Box 43191, Lubbock, TX 79409-3191; e-mail: eileen.johnson@ttu.edu

debitage (Ogallala Formation chert and quartzite) composed the lower zone, while the upper zone contained a flaked lithic biface, debitage (Edwards Formation, Tecovas, Alibates cherts, Ogallala Formation cherts, and quartzites), and caliche hearthstones. The biface (Edwards Formation chert) was snapped laterally (not a fresh break) and appears to be a basal segment that may have been hafted. This breakage pattern was consistent with projectile weapon breakage patterns derived from experimental research (Odell and Cowan 1988). The biface segment, however, lacked any evidence of fluting on either side and was much smaller than what is typical for Clovis blade technologies (Collins 1999). The extremely small size and angularity data indicated that the hearthstones were bits coming from the fracturing and fragmentation occurring on larger hearthstones. The dark gray coloration was characteristic of thermal alteration as a result of intense heating (Lintz 1989; Backhouse et al. 2005). While in stratigraphic context, the small size suggested post-depositional site formation processes most likely are responsible for the current location. The translocation (within-site displacement) of hearthstones over short distances can occur as a function of a number of site-formation processes (Backhouse et al. 2005; Petraglia 2002; Stevenson 1991), in this case, probable erosion and downslope displacement of hearth feature(s) originally located on the valley margins.

Stratum 2, representing early-Holocene deposits (Holliday 1985; Johnson 1987) contained at least four occupation zones within three substrata. The two zones in the lowermost deposits (substratum 2A; diatomite) were both composed of flaked lithic debitage primarily from Edwards Formation chert and Ogallala Formation quartzites. Lower 2A was undated, but dates above upper 2A indicated that the zones would date older than ~10,700 RCYBP, indicating Folsom age and in line with dates associated with 2A at Lubbock Lake and in the region (Holliday 1995; Johnson 1987). One occupation zone occurred in the substratum above 2A deposits (2p; peat), composed of flaked lithic debitage (Alibates chert and Ogallala Formation quartzite). It dated to ~10,700 RCYBP and indicated a third Folsom-age occupation. The uppermost deposits (2B; paludal muds) had one occupation zone composed of flake lithic debitage (Edwards Formation chert and Ogallala Formation cherts and quartzites) and hearthstone bits. Their medium light gray coloration is characteristic of thermal alteration through intense heating. Their occurrence indicated the presence of at least one hearth in the site area during 2B times. Associated dates ranged from ~9700 to ~9000 RCYBP, indicating a late-Paleoindian (Firstview) age for the zone.

Overall, the empirical technological characteristics recorded for the strata 1 and 2 flaked lithic assemblages are similar to each other. Tool sharpening and rejuvenation are the primarily activities. These tertiary reduction activities primarily are occurring with tools made from Edwards Formation chert and Ogallala Formation cherts and quartzites. The inferred presence of hearths is significant in that thermal technology is poorly understood at this time with few Paleoindian hearths known for the Southern High Plains (Backhouse 2010). Nevertheless, the hearthstone bits suggest that hot-rock technology is a component of Paleoindian indigenous fire technologies. Taken together, these activities indicate repeated occupation with a series of Paleoindian campsites within the Paul site.

Research at the Paul site was funded by the Museum of Texas Tech University and the City of Lubbock, conducted under Texas Historical Commission Antiquities permit #2625. The Paul Site Collection is a state-associated collection housed at the Museum of Texas Tech University, held-in-trust for the people and State of Texas. This manuscript represents part of the ongoing Lubbock Lake Landmark regional research into grasslands hunter-gatherers and adaptation to ecological change on the Southern Plains.

References Cited

Backhouse, P. N. 2010 Campfires in Context: Hunter-Gatherer Fire Technology and the Archaeological Record of the Southern High Plains, USA. *British Archaeological Reports International Series* 2114:1–189.

Backhouse, P. N., E. Johnson, and V. T. Holliday 2010 Prospecting for Deeply Buried Paleoindian Sites in the Yellowhouse System, Southern High Plains. *Current Research in the Pleistocene* 27:68–70.

Backhouse, P. N., E. Johnson, A. Brackenreed-Johnston, and B. Buchanan 2005 Experimental Hearths and the Thermal Alteration of Caliche on the Southern High Plains. *Geoarchaeology* 20(7):695–716.

Collins, M. B. 1999 *Clovis Blade Technology: A Comparative Study of the Keven Davis Cache, Texas.* University of Texas Press, Austin.

Holliday, V. T. 1985 Archaeological Geology of the Lubbock Lake Site, Southern High Plains of Texas. *Geological Society of America Bulletin* 96:1483–92.

——— 1995 Stratigraphy and Paleoenvironments of Late Quaternary Valley Fills on the Southern High Plains. *Geological Society of America Memoir* 186:1-136.

Holliday, Vance T., and B.L. Allen 1987 Geology and Soils. In *Lubbock Lake. Late Quaternary Studies on the Southern High Plains,* edited by E. Johnson, pp. 14-21. Texas A&M University Press, College Station

Johnson, Eileen 1987 *Lubbock Lake. Late Quaternary Studies on the Southern High Plains.* Texas A&M University Press, College Station.

_____ 2010 The Paul Site (41LU136), Late Quaternary Hunter-Gatherer Occupations in the Yellowhouse System on the Southern High Plains. Museum of Texas Tech University, *Lubbock Lake Landmark Quaternary Research Center Series* 18:1-397.

Lintz, Christopher 1989 Experimental Thermal Discoloration and Heat Conductivity Studies of Caliche from Eastern New Mexico. *Geoarchaeology* 4(4):319-346.

Odell, G. H., and F. Cowan 1988 Experiments with Spears and Arrows on Animal Targets. *Journal of Field Archaeology* 13:194–212.

Petraglia, M. D. 2002 The Heated and the Broken: Thermally Altered Stone, Human Behavior, and Archaeological Site Formation. *North American Archaeologist* 23(3):241–70.

Stevenson, M. G. 1991 Beyond the Formation of Hearth-Associated Artifact Assemblages. In *The Interpretation of Archaeological Spatial Patterning,* edited by E. M. Kroll and T. D. Price, pp. 269–99. Plenum Press, London.

Bison Hunting at Jake Bluff: New Directions in Clovis Hunting Technology

Leland C. Bement and Brian J. Carter

➤ **Keywords**: Southern Plains, Clovis, early Paleoindian

Excavation at the Jake Bluff site in northwest Oklahoma, USA, suggests Clovis mammoth hunters developed new techniques to procure bison as mammoths and other large game were extirpated from the North American plains.

The Clovis adaptation in North America is often portrayed as including the hunting and scavenging of mammoths and other large mammals (Haynes 2002) although a more generalist subsistence practice of broad spectrum foraging and hunting of smaller game is also included (Cannon and Meltzer 2004). This adaptation, including the production of the distinctive Clovis projectile point, stops within a century of the start of the Younger Dryas (YD) climatic episode ca. 12,900 CALYBP (Waters and Stafford 2007) and with the extirpation of mammoths and other large mammals. The largest remaining animal is the bison, and cultural adaptation on the North American Plains during the YD includes the development of new hunting tactics targeting bison. Although the development of large-scale bison hunting tactics is often attributed to members of the post-Clovis Folsom culture (Frison 2004), new evidence shows that Clovis hunters developed a bison hunting technique that would dominate the Southern Plains archaeological record for 8000 years—the arroyo trap (Frison 1978, 2004).

The recent analysis of materials excavated from the Jake Bluff site, an arroyo along the North Canadian River in northwestern Oklahoma, reveals that Clovis hunters maneuvered at least 22 bison of a predominantly cow/calf herd into a natural dead-end trap (Bement and Carter 2010). Sheer sandstone sidewalls and a steep knick point or erosional head prevented the animals from escaping (Figure 1). Four Clovis-style projectile points were recovered from the arroyo floor amidst the bones of the butchered animals. Secondary butchering locations dominated by fore and hind legs were found on the sidewall benches, indicating select parts were removed from the carcasses and handed to persons outside the arroyo for continued processing.

Jake Bluff has been radiocarbon dated to the end of the Clovis period (Waters and Stafford 2007). Two additional bone dates bring the total number of assays to five (Bement and Carter 2010:918). Four of the five assays are statistically the same at 95% confidence level (T = 6.866136, $\chi i^2(.05) = 7.81$, $\delta f = 3$; Reimer et al. 2004). Because the fifth date was outside the 95% confidence level, it was omitted from the average. An average of these four dates provides an age range of 12,825–12,850 CALYBP with a midpoint at 12,838 CALYBP. Jake Bluff postdates all Southern Plains mammoth kills and suggests

Leland C. Bement, University of Oklahoma, Norman, OK 73019; e-mail: lbement@ou.edu
Brian J. Carter, Oklahoma State University, Stillwater, OK 74078; e-mail: bjc@okstate.edu

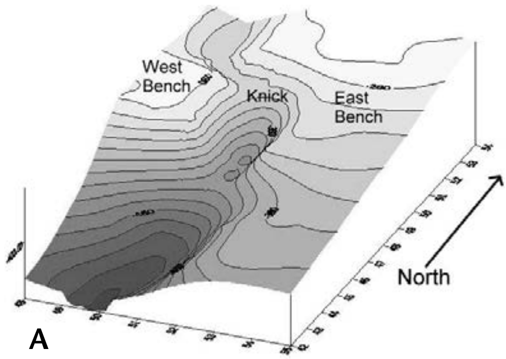


Figure 1. The excavated paleo-arroyo at Jake Bluff: **A,** a 3-dimensional rendering of the paleo-arroyo as derived from bedrock contours; **B,** a photograph taken from a position above the paleo-arroyo knick point, looking south down slope.

that Clovis hunters were developing new bison hunting techniques as mammoth numbers diminished in the area early in the Younger Dryas.

Other known Clovis bison kills include Blackwater Locality No. 1 in New Mexico, Aubrey in Texas, and at Murray Springs in Arizona (Ferring 2001; Haynes and Huckell 2007; Hester 1972). The reconstructed bison kills at these sites follow tactics similar to those employed at mammoth kills. The animals were ambushed at water holes (Huckell and Haynes 2007).

The hunters at Jake Bluff employed a different kind of landform, the gully. The development of the arroyo trap may have been facilitated by the opening of short gullies and arroyos at the onset of the YD (Holliday 1995). Coring along the North Canadian River floodplain margin identified numerous arroyos, including the one containing Jake Bluff and one with the oldest age of 13,000 CALYBP. A third arroyo contained the three Folsom-age bison kills at the Cooper site (Bement 1999). The extent that bison hunting permeated Folsom culture may be suggested by the presence of a painted bison skull below the bones of the second use of the arroyo. Such evidence of intensification and the importance of bison in all aspects of the culture are similarly manifest in other bison hunting cultures through time (Frison 2004).

Jake Bluff indicates Clovis people survived perturbations in faunal and floral resources at the start of the YD. Whether the changes were caused by acute factors (as suggested by proponents of the comet hypothesis [Firestone et al. 2007]) or by a progression of postglacial warming events, Clovis people adapted to the changing conditions around them. Among the adaptations was the development of the arroyo bison trap technique, a technique practiced by plains hunters for millennia.

References Cited

Bement, L. C. 1999 *Bison Hunting at Cooper site: Where Lightning Bolts Drew Thundering Herds.* University of Oklahoma Press, Norman.

Bement, L. C., and B. J. Carter 2010 Jake Bluff: Clovis Bison Hunting on the Southern Plains of North America. *American Antiquity* 75(4):907–33.

Cannon, M. D., and D. J. Meltzer 2004 Early Paleoindian Foraging: Examining the Faunal Evidence for Large Mammal Specialization and Regional Variability in Prey Choice. *Quaternary Science Reviews* 23:1955–87.

Ferring, C. R. 2001 *The Archaeology and Paleoecology of the Aubrey Clovis Site (41DN479) Denton County, Texas.* Center for Environmental Archaeology, Department of Geography, University of North Texas, Denton.

Firestone, R. B., A. West, J. P. Kennett, L. Becker, T. E. Bunch, Z. S. Revay, P. H. Schultz, T. Belgya, D. J. Kennett, J. M. Erlandson, O. J. Dickenson, A. C. Goodyear, R. S. Harris, G. A. Howard, J. B. Kloosterman, P. Lechler, P. A. Mayewski, J. Montgomery, R. Poreda, T. Darrah, S. S. Que Hee, A. R. Smith, A. Stich, W. Topping, J. H. Wittke, and W. S. Wolbach 2007 Evidence for an Extraterrestrial Impact 12,900 Years Ago that Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling. *Proceedings of the National Academy of Sciences* 104(41):16016–21.

Frison, G. C. 1978 *Prehistoric Hunters of the High Plains.* Academic Press, New York.

——— 2004 *Survival by Hunting: Prehistoric Human Predators and Animal Prey.* University of California Press, Berkeley.

Haynes, C. V., Jr., and B. B. Huckell 2007 *Murray Springs: A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona.* The University of Arizona Press, Tucson.

Haynes, G. 2002 *The Early Settlement of North America: The Clovis Era.* Cambridge University Press, Cambridge.

Hester, J. J. 1972 *Blackwater Locality No. 1: A Stratified, Early Man Site in Eastern New Mexico.* Publication of the Fort Burgwin Research Center, No. 8. Portales.

Holliday, V. T. 1995 *Stratigraphy and Paleoenvironments of Late Quaternary Valley Fills of the Southern High Plains.* Geological Society of America, Memoir 186. Boulder, Colorado.

Huckell, B. B., and C. V. Haynes 2007 Clovis Paleoecology as Viewed from Murray Springs, Arizona. In *Murray Springs, A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona*, edited by C. V. Haynes, Jr., and B. B. Huckell, pp. 214–25. The University of Arizona Press, Tucson.

Reimer, P. J, M. G. L. Baillie, E. Bard, A. Bayliss, W. J. Beck, C. J. H. Bertrand, P. G. Blackwell, C. E. Buck, G. S. Burr, K. B. Cutler, P. E. Damon, R. L. Edwards, R. G. Fairbanks, M. Friedrich, T. P. Guilderson, A. G. Hogg, K. A. Hughen, B. Kromer, G. McCormac, S. Manning, C. B. Ramsey, R. W. Reimer, S. Remmele, J. R. Southon, M. Stuiver, S. Talamo, F. W. Taylor, J. van der Plicht, and C. E. Weyhenmeyer 2004 IntCal04 Terrestrial Radiocarbon Age Calibration, 0-26 Cal kyr BP. *Radiocarbon* 46(3):1029–58.

Waters, M. R., and T. W. Stafford, Jr. 2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315:1122–26.

An Early-Holocene Site in the Upper Susitna Basin, Central Alaska

John C. Blong

➤ **Keywords:** Central Alaska Range, uplands, early Holocene

Central Alaska has a diverse late-Pleistocene and Holocene archaeological record. Lithic assemblages vary spatially and temporally, highlighted by the decision to use bifacial versus inset-microblade projectile technology (Goebel and Buvit 2011; West 1996b). Current explanations for this variability propose that technological choices were conditioned by seasonal variation in subsistence activities and technological organization on different landscapes (Potter 2008; Wygal 2009). The uplands of the central Alaska Range play an important role in assessing these hypotheses, as few prehistoric sites have been fully documented in this region (but see West 1996a; Wygal 2009).

Our research is focused on identifying hunter-gatherer adaptations to upland landscapes from the earliest colonization throughout the Holocene. In summer 2010 we conducted archaeological reconnaissance survey in the upper Susitna basin. We located four unrecorded surface lithic scatters and conducted test excavations at two of them; the most intriguing of these sites is Susitna Dune 1 (HEA-454).

Susitna Dune 1 is located in the upper Susitna basin at 63° 112′ 15.87423″ latitude, 147° 322′ 57.58083″ longitude, at 797 m above sea level. The site is located on a sand dune capped by aeolian sedimentary deposits (Figure 1), overlooking the upper Susitna basin to the north and east, approximately 1.2 km northeast of the Denali Highway. We excavated one 1-m^2 test unit and identified 3 cultural components. Components 2 and 3, located in the uppermost 25 cm of the profile, are undated (Figure 1). Component 1, buried 90 cm below the ground surface (Figure 1), contained four gray chert flakes and the articulated, but highly degraded, upper maxilla and teeth of a large Cervidae, probably wapiti (*Cervus canadensis*) or caribou (*Rangifer tarandus*). The small component-1 lithic assemblage indicates that secondary reduction and tool maintenance occurred at the site. We obtained an AMS ^{14}C date of 9620 ± 50 RCYBP (BETA-284748) from dispersed charcoal in component I.

Susitna Dune 1 plays an important role in understanding the colonization of south-central Alaska and early-Holocene upland adaptations. Along with Jay Creek Ridge (9500 RCYBP) (Dixon 1993:86), Susitna Dune 1 provides the earliest evidence of prehistoric upland use in the Susitna basin, indicating that the uplands played an important role in hunter-gatherer adaptations early in the occupation of central Alaska. In summer 2011 we will conduct further testing at Susitna Dune 1 to gain a more representative lithic and faunal assemblage and to obtain ^{14}C dates on all three cultural components.

John C. Blong, Center for the Study of the First Americans, Texas A&M University, College Station, Texas 77843; email: johnblong@tamu.edu

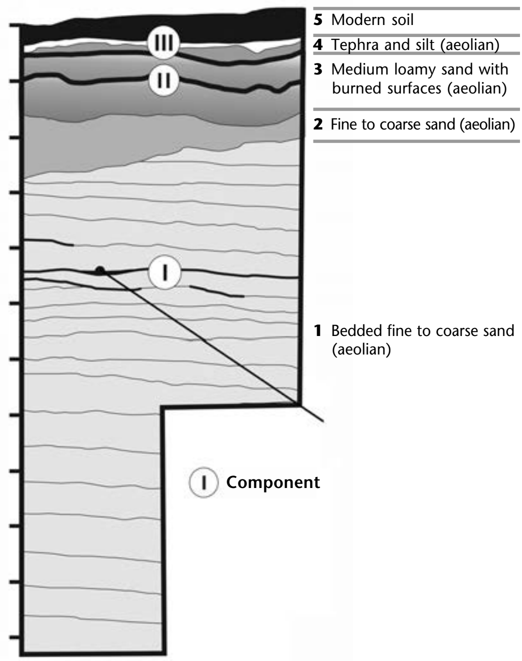


Figure 1. HEA-454 test unit 1 south wall profile.

References Cited

Dixon, E. J. 1993 *Quest for the Origins of the First Americans.* University of New Mexico Press, Albuquerque.

Goebel, T., and I. Buvit, editors 2011 Introducing the Archaeological Record of Beringia. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia,* pp. 1–32. Texas A&M University Press, College Station, Texas.

Potter, B. 2008 A First Approximation of Holocene Inter-assemblage Variability in Central Alaska. *Arctic Anthropology* 45(2).

West, F. H. 1996a South Central Alaska Range: Tangle Lakes Region. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 375–80. University of Chicago Press, Chicago.

——— 1996b Beringia and New World Origins. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 537–59. University of Chicago Press, Chicago.

Wygal, B. T. 2009 Prehistoric Colonization of Southcentral Alaska: Human Adaptations in a Post Glacial World. Ph.D. dissertation, Department of Anthropology, University of Nevada, Reno.

Ravenscroft: A Paleo-Arroyo and Late-Paleoindian Bison Kill in an Unusual Hillslope-Shoulder Position, Oklahoma Panhandle

Brian J. Carter, Leland C. Bement, and Kent J. Buehler

➤ **Keywords:** Paleo-arroyo, bison kill, soil-landscape

The ravages of soil erosion and deposition occurring over thousands of years create unique challenges for prospecting, finding, and revealing archaeological sites in Oklahoma. Many sites are deeply buried by alluvium, loess, or other unconsolidated debris and require significant excavation, sometimes removing up to several meters of soil and sediments (Bement and Buehler 1994; Bement and Carter 2010; Bement et al. 2007; Carter 1990; Carter and Bement 2003; Holmes 1973; Hurst et al. 2010; Retalick 1966). Deeply buried sites often occur in low-lying areas such as floodplains, stream terraces, footslopes, and toeslopes. Conversely, upland site preservation along summit, shoulder, or even backslope hillslope positions is poor. Upland sites are represented by scant surface scatters, extensive scatters on deflated surfaces, or small remnants of debris with dubious depositional environment and site context classifications.

The Ravenscroft arroyo bison kill site (Bement et al. 2008), however, occupies a hillslope-shoulder position similar to that documented at the Olsen-Chubbuck site in eastern Colorado (Wheat 1972). The gully deposits explored so far are over 1 m thick and extend laterally from 7 to 8 m. The Ravenscroft site is located in the High Plains Breaks along the left flank of a first-order tributary of Bull Creek in western Beaver County, Oklahoma (Figure 1). Two field seasons excavated a total area of 21 m². Sediments were excavated from the soil surface

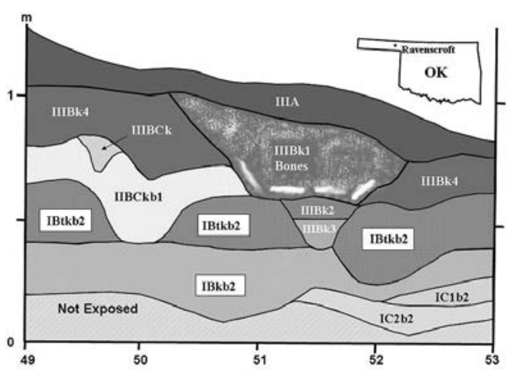


Figure 1. Soil-sediment profile (North 54, East 49 to 53 grid plane coordinates) through the middle of the Ravenscroft site, identifying three arroyo fill units (I, II, and III) and soil horizon designation for each unit (A, Bk, BCkb1, Btkb2, Bkb2, or Cb2).

Brian J. Carter, 160 Ag Hall, Dept. of Plant and Soil Sciences, Oklahoma State University. Stillwater, OK 74059-6028; e-mail: brian.j.carter@okstate.edu

Leland C. Bement and Kent J. Buehler, 111 E. Chesapeake Room 102, Oklahoma Archeological Survey, University of Oklahoma, Norman, OK 73019; e-mails: lbement@ou.edu kbuehler@ou.edu

through the paleo-arroyo sediments. Three separate arroyo fills (Units I, II, and II) are identified from a soil profile (Figure 1) located between the two grid excavated areas. The partially butchered remains of an estimated ten bison occur on the paleo-arroyo floor of the upper most arroyo fill (Unit IIIBk1; Figure 1). Along with the bison remains, artifacts from fabricating and sharpening knives were found in this ancient gully, but so far no projectile points. A radiocarbon assay on a bison petrous places the kill event at 9090 ± 30 RCYBP (UCIAMS 78134). Portions of the upper paleo-arroyo deposits are gone, having been truncated by hillslope erosion. A native warm-season short- and mid-grass prairie now stabilizes the ground surface and protects the paleo-arroyo deposits from rapid erosion. During this recent stabilization period, soil that contains a mollic A horizon and calcic Bk horizon has formed into the upper part of the surface-exposed paleo-arroyo sediments (IIIA; Figure 1).

The particle-size content of the fill material ranges from a coarse sandy loam to a sandy clay loam. The arroyo-fill modal particle size is a sandy loam and fines upward for each unit. A prominent buried soil, the Btkb2 horizon, is formed into the top of Unit I (IBtkb2) and identifies a stable period during arroyo development and prior to the bison kill. The modal yellowish red (5YR4/6) and strong brown (7.5YR5/6) colors of the lower fills (Units I and II, respectively) indicate that these fill materials are eroded from adjacent Permian and Quaternary sediments. These lower "colorful" units strongly contrast with the dark brown color of the Unit III fill. Material source for this upper arroyo fill originated from the erosion of the surface soil A horizon marking the final stages in this paleo-arroyo development. The paleo-arroyo development at Ravenscroft site must have progressed from an initial incision into the hillslope of predominately Permian and Quaternary sediments, and ended with a series of headcuts tapping surface soil A horizons and calcium carbonate-rich sediments. This eroded A horizon material now makes up the bulk of Unit I and provides a foundation for the dark brown coloration. Subsequent to paleo-arroyo development several meters of stream incision have left the Ravenscroft site "high and dry." Current base level for modern gullies occurs 4 to 6 m below the estimated base level that once existed for the paleo-arroyo that is the Ravenscroft site. Initial continuous push-tube cores to 1 to 2 m depth are credited with revealing the extent and geoachaeological relevance of the site. Undisturbed continuous shallow cores are recommended for the initial exploration of upland archaeological sites.

The hill-slope shoulder position of the Ravenscroft arroyo and the bison kill it contains illustrates the difficulty predicting the location of paleo-arroyos on the High Plains. The inverted topography where once low arroyos are now buried within shallow upland hillslope deposits high in the drainage also reminds us of the extent of landscape change over the last 9,000 years.

References Cited

Bement, L. C., and K. J. Buehler 1994 Preliminary Results from the Certain Site: A Late Archaic Bison Kill in Western Oklahoma. *Plains Anthropologist* 39(148):173–83.

Bement, L. C., K. J. Buehler, and B. J. Carter 2008 Ravenscroft: An Early Archaic Bison Kill in the Oklahoma Panhandle. Paper presented at the 66th Plains Conference, Laramie, Wyoming.

Bement, L. C., and B. J. Carter 2010 Jake Bluff: Clovis Hunting on the Southern Plains of North America. *American Antiquity* 75(4):907–33.

Bement, L. C., B. J. Carter, R. A. Varney, L. S. Cummings, and J. B. Sudbury 2007 Paleoenvironmental reconstruction and bio-stratigraphy, Oklahoma Panhandle, USA. *Quaternary International* 169/170:39–50.

Carter, B. J. 1990 Soils within the Deer Creek Floodplain. In *A Survey of Archeological Resources and an Evaluation of Buried Site Potential in Northwestern Oklahoma County, Oklahoma*, edited by J. L. Hofman and R. R. Drass, pp. 31–43. Archeological Resource Survey Report No. 36, Oklahoma Archeological Survey, Norman, OK.

Carter B. J., and L. C. Bement 2003 Geoarchaeology of the Cooper Site: Evidence for Multiple Folsom Bison Kills in Northwestern Oklahoma. *Geoarchaeology* 18:115–27.

Holmes, M. 1973 *The Packard Site.* Prehistoric People of Oklahoma No. 1, Oklahoma Archeological Survey, Norman, OK.

Hurst, S., B. J. Carter, and N. B. Athfield 2010 Investigation of a 10,214 Year-Old Late Paleoindian Bison Kill at the Howard Gully Site in Southwestern Oklahoma. *Plains Anthropologist* 55(213):25–37.

Retallick, H. J. 1966 Geomorphology of the Domebo Site. In *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains*, edited by F. C. Leonhardy, pp.3–9. Contributions of the Museum of the Great Plains Number 1, Great Plains Historical Association, Lawton, OK.

Wheat, J. B. 1972 The Olsen-Chubbuck Site, a Paleo-Indian Bison Kill. *American Antiquity* Memoir 26.

Recent Excavations at Teklanika West: A Late-Pleistocene Multicomponent Site in Denali National Park and Preserve, Central Alaska

Sam Coffman and Ben A. Potter

➤ **Keywords:** Younger Dryas, bison, uplands

Recent excavations at Teklanika West have yielded new data on site chronology and human occupation history. The site is located on a loess-mantled granitic bedrock bluff overlooking the glacial-fed Teklanika River, and lies within the Denali National Park and Preserve. Early investigations were largely surface collections (Morgan 1965; Treganza 1964; West 1965); these data were integral in defining the influential Denali Complex (West 1967, 1975, 1996). West interpreted the site to contain an undated single large Denali occupation, characterized by a microblade-rich assemblage with no associated fauna. A brief reinvestigation by Goebel (1992, 1996) yielded artifacts within a profile and stratigraphically associated radiocarbon dates indicating multiple occupa-

Sam Coffman, University of Alaska, Museum of the North, 907 Yukon Dr., Fairbanks, AK 99775; email: sccoffman@alaska.edu

Ben A. Potter, Department of Anthropology, University of Alaska Fairbanks. 310 Eielson Bldg., Fairbanks, AK 99775; email: bapotter@alaska.edu

tions from early to late Holocene. Our 2009 investigation of the site (12.25 m^2) focused on exploring basic questions of site chronology, component delineation, technological organization, and economy.

Stratigraphy of the site consists of ~50–120 cm of aeolian silt and sand; sediments, soils and dates are illustrated in Figure 1. Taphonomic disturbance in the form of cryoturbation is evident, particularly in the upper sediments (OAB horizons), though a tephra (of an unknown source, but not Jarvis Creek Ash) is relatively continuous across the site at ~40 cm below the modern surface. Radiocarbon dating illustrates a secure chronology for the site, including the Oshetna tephra (6502–7156 CALYBP) (Addison and Beget 2010) above the paleosol.

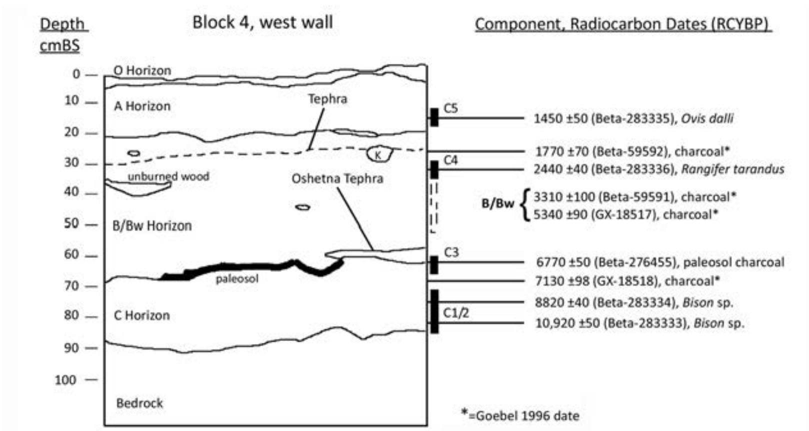


Figure 1. Stratigraphy and dating at Teklanika West.

Tentative component delineations are based on bone-collagen dating of taxa associated with lithics, stratigraphic association, vertical profile backplots, and material type distributions. The lowest two components (C1 and C2) appear spatially separated, below the paleosol. Component 1 is associated with a *Bison* sp. date of 10,920 ± 50 RCYBP and contains two broken bifacial preforms and a sidescraper. This component thus dates to the initial Younger Dryas period (Mangerud et al.1974; Meltzer and Holliday 2010), a period with very few components in eastern Beringia, perhaps during the transition between Nenana and Denali complexes.

Component 2 is associated with a *Bison* sp. date of 8820 ± 40 RCYBP and contains three strongly convex lanceolate projectile point bases, two end scrapers, two broken bifacial performs, and a few microblades. Component 3 is associated with the paleosol, dating to 6770 ± 50 RCYBP, and contains two bipointed lanceolate projectile points, microblades, three boulder spall scrapers, and highly fragmented faunal remains. Two other later-Holocene components contain caribou and dall sheep remains.

These data demonstrate the presence of multiple components, including one dating to the late Pleistocene. The relative lack of a microblade industry at the site might relate to the small sample size at present, but the presence of microblades in small samples in components 2, 3, and 4 are consistent with regional continuity of this technology (Potter 2008). No Nenana Complex diagnostic materials were found in any of the components (Goebel et al. 1991). Bison were brought to the site during and after the Younger Dryas, and coupled with the bison found at the intermediate Dry Creek Component 2 (~10,000 RCYBP) (Powers et al. 1983), this suggests that bison were a reliable resource in the northern foothills of the Alaska Range during and after the Younger Dryas. This exploitation strategy differs significantly from the later Holocene components, associated with modern upland ungulates (sheep and caribou).

Current interpretations of two distinct cultural traditions (Nenana and Denali complexes) separated by the Younger Dryas are more difficult to sustain given older microblade technology at Swan Point (Holmes 2001) and younger Chindadn points in Cultural Zone 3 at Swan Point (Holmes 2008). It is unclear at present how Teklanika West data fit into the broader cultural chronology of the region, but early interpretations of a single microblade-rich Denali Complex occupation at the site are shown to be incorrect. Analyses are ongoing at Teklanika West, but the initial data help elucidate lifeways of early populations in upland regions of central Alaska.

Funding for this project came from Denali National Park and Preserve and University of Alaska Fairbanks. Additional financial support was provided by the Otto Geist Fund of the University of Alaska Museum of the North and by the Murie Science and Learning Center Discover Denali Fellowship program. We thank Jeremy Karchut (Chugach National Forest) and Amy Craver and Lucy Tyrrell (Denali National Park) for their support and assistance of this project, and especially the volunteers who helped excavate the site.

References Cited

Addison, J., and J. Beget 2010 Tephra Analysis Report Summary: Teklanika West Archaeological Site. Report submitted to the authors 2010.

Goebel, T. 1992 *Geoarchaeological Research at Teklanika West, Denali National Park, Alaska.* Preliminary report submitted to the National Park Service, Alaska Support Office, Anchorage, AK.

——— 1996 Recent Research at Teklanika West: Site Stratigraphy and Dating. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 341–43. University of Chicago Press, Chicago.

Goebel, T., W. R. Powers, and N. Bigelow 1991 The Nenana Complex of Alaska and Clovis Origins. *Clovis: Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp.49–79. Center for the Study of the First Americans, Oregon State University, Corvallis.

Holmes, C. E. 2001 Tanana River Valley Archaeology Circa 14,000 to 9000 B.P. *Arctic Anthropology* 38(2):154–70.

——— 2008 The Taiga Period: Holocene Archaeology of the Northern Boreal Forest, Alaska. *Alaska Journal of Anthropology* 6(1-2).

Mangerud, J., S. T. Andersen, B. J. Berglund, and J. J. Donner 1974 Quarternary Stratigraphy of Norden, a Proposal for Terminology and Classification. *Boreas* 3:109–28.

Meltzer, D. J., and V. T. Holliday 2010 Would North American Paleoindians Have Noticed Younger Dryas Age Climate Changes? *Journal of World* Prehistory 23:1–41.

Morgan, H. M. 1965 *An Archaeological Survey of Mount McKinley National Park.* U.S. Department of Interior, National Park Service Contract 14-10-0434-951.

Potter, B. A. 2008 Radiocarbon Chronology of Central Alaska: Technological Continuity and Economic Change. *Radiocarbon* 50(2):181–204.

Powers, W. R., R. D. Guthrie, and J. F. Hoffecker 1983 Dry Creek: Archaeology and Paleoecology of a Late Pleistocene Alaskan Hunting Camp. Report submitted to the National Park Service, Contract No. CX-9000-7-0047.

Treganza, A. E. 1964 An Archaeological Survey of Mount McKinley National Park. University of Alaska and U.S. Department of the Interior, National Park Service, Contact No. 14-10-0434-1547.

West, F. H. 1965 *Excavations at Two Sites on the Teklanika River, Mount McKinley National Park, Alaska.* Report to the National Park Service, University of Alaska, College.

——— 1967 The Donnelly Ridge Site and the Definition of an Early Core and Blade Complex in Central Alaska. *American Antiquity* 32(3):360–79.

——— 1975 Dating the Denali Complex. *Arctic Anthropology* **12**(1):76–81.

——— 1996 Teklanika West. In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 332–41. University of Chicago Press, Chicago.

Evidence for Changing Toolstone Source Use and Range Mobility during the Paleoindian Occupation of the Great Lakes/Northeast

Christopher Ellis

➤ **Keywords:** Mobility, colonization, toolstones

Information on 80 Northeast–Great Lakes Paleoindian sites with concave-based points was compiled to more rigorously test the oft-suggested idea that range mobility declined through time (Burke 2006:84; Ellis and Deller 1997:12). This decline could be due to range reduction after an initial colonizing movement as the landscape filled up with people. The main raw material source employed was used as the measure of range mobility, assuming that material had to be directly procured (see Meltzer 1988). The sample was subdivided into two temporal groupings. One consisted of larger, more parallel-sided "Clovis-like" points. These all date to ≥ 10,500 RCYBP based on the dates from sites like Debert (MacDonald 1968) and Shawnee-Minisink (Waters and Stafford 2007) and represent the earliest evidence of *significant* human occupation. Other forms are assigned to later occupations. They include fluted-point types such as Barnes, Crowfield, and Michaud-Neponset (Deller and Ellis 1988; Spiess et al. 1998). They also include clearly related early unfluted forms such as Holcombe or Nicholas points. These later styles seem to date from about 10,500–10,000 RCYBP (Spiess et al. 1998).

The distances from source to site more often exceed 200 km earlier in time (χ^2 = 12.643; $\delta f = 1$; $p = .000$; Figure 1). Earlier sites also occur significantly farther on average from sources than do later ones (179 versus 128 km; t [for unequal variances] = 2.114; $\delta f = 75.727$; $p = .038$). The directions from site to

Christopher Ellis, Department of Anthropology, University of Western Ontario, London, Ontario, Canada N6A 5C2; email: cjellis @uwo.ca

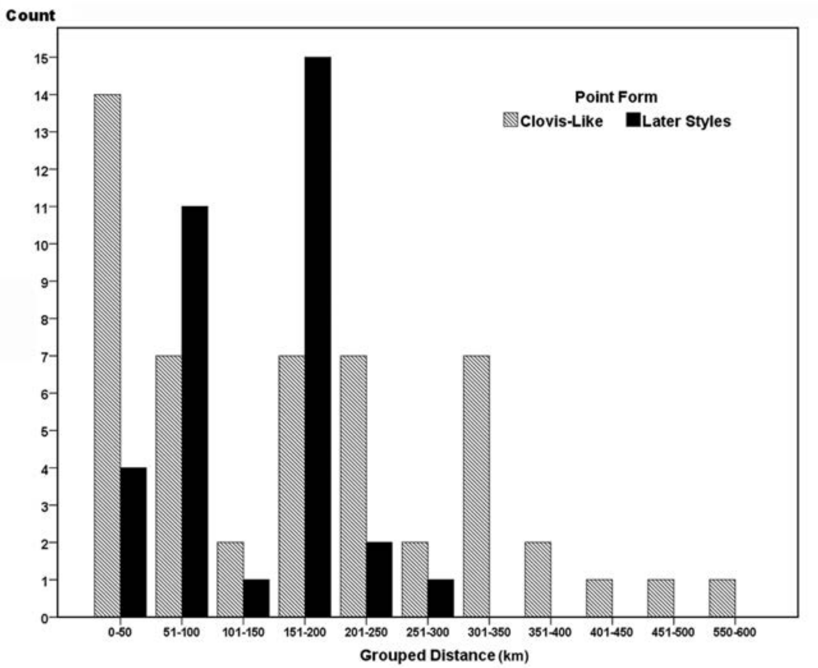


Figure 1. Comparison of Distance to Main Toolstone Source Between Sites with Clovis-like and later styles. The major material in the samples used here consists of at least 25% of an assemblage, and in all but four cases it includes at least 40% of the assemblage with many exceeding 80%. Since diagnostics at some sites indicate they were used in both periods, observations exceed $n = 80$ in some analyses. Note the stronger association of Clovis-like sites with stone source areas. The seemingly greater association of sites 150–200 km with later styles is not significant, but it is a product of sampling error and actually overemphasizes the average distance from toolstone source for those later styles (Ellis 2008).

source are predominantly north-south ($\chi^2 = 4.629$, $\delta f = 1$, $p = .031$) indicating the distances involved represent range mobility and probably seasonal movements rather than long-distance trips to procure raw materials that we would expect to be directionally variable. The contrast between samples from the Clovis-like sites and those from later-style sites suggests distinctly different ways of life. Given that the two are distributed widely over the same geographic areas, this information is consistent with the idea they are temporally different (Loebel 2005).

There are also suggestions of other temporal contrasts, such as how sites cluster by distance. There are significantly more earlier sites in the 0- to 50-km distance group associated with or close to stone sources ($\chi^2 = 5.556$, $\delta f = 1$, $p = .018$), reinforcing suggestions that these locations played a special role amongst those occupations (Anderson 1990:185-196). Often these sites are “quarry-related base camps” (Gardner 1977:258), that are right at the sources (e.g., Welling [Prufer and Wright 1970]; West Athens Hill [Funk 2004]). *Amongst concave based-styles* I do not know of later sites with *substantial* evidence of occupation sites at outcrops. However, the causes of such an association remain obscure.

References Cited

Anderson, D. G. 1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. In *Early Paleoindian Economies of Eastern North America*, edited by K. B. Tankersley and B. L. Isacc., pp. 163–216. Research in Economic Anthropology, Supplement 5. JAI Press, Greenwich, Connecticut.

Burke, A. 2006 Paleoindian Ranges in Northeastern North America Based on Lithic Material Sourcing. In *Notions de Territoire et de Mobilité: Exemples de L'Europe et des Premières Nations en Amérique du Nord Avant le Contact Européen*, edited by C. Bressy, A. Burke, P. Chalard and H. Martin, pp.77–89. Études et Recherches Archéologiques de L'Université de Liège No. 116. Liège, Belgium.

Deller, D. B., and C. J. Ellis 1988 Early Palaeo-Indian Complexes in Southwestern Ontario. In *Late Pleistocene and Early Holocene Paleoecology and Archaeology of the Eastern Great Lakes Region*, edited by R. Laub, N. Miller and D. Steadman, pp. 251–63. Bulletin of the Buffalo Society of Natural Sciences 33.

Ellis, C. J. 2008 Measuring Paleoindian Mobility and Land-Use in the Great Lakes/Northeast. Revised version of paper presented at the conference on Early Paleoindian Colonization and Settlement of the Midcontinent, University of Illinois, Urbana.

Ellis, C. J., and D. B. Deller 1997 Variability in the Archaeological Record of Northeastern Early Paleo-Indians: A View from Southern Ontario. *Archaeology of Eastern North America* 25:1–30.

Funk, R. E. 2004 *An Ice Age Quarry-Workshop. The West Athens Hill Site Revisited.* New York State Museum Bulletin 504. Albany, New York.

Gardner, W. 1977 Flint Run Paleoindian Complex and Its Implications for Eastern North American Prehistory. In *Amerinds and their Paleoenvironments in Northeastern North America*, edited by W. S. Newman and B. Salwen, pp. 257–63. Annals of the New York Academy of Sciences, Volume 288.

Loebel, T. J. 2005 *The Organization of Early Paleoindian Economies in the Western Great Lakes*. Ph.D. dissertation, Department of Anthropology, University of Illinois at Chicago. University Microfilms International, Ann Arbor.

MacDonald, G. F. 1968 *Debert: A Palaeo-Indian Indian Site in Central Nova Scotia.* National Museums of Canada, Anthropology Papers No. 16. Ottawa, Ontario.

Meltzer, D. J. 1988 Late Pleistocene Human Adaptations in Eastern North America. *Journal of World Prehistory* 2:1–52.

Prufer, O., and N. Wright 1970 The Welling Site (33Co-2): A Fluted Point Workshop in Coshocton County, Ohio. *Ohio Archaeologist* 20:259–68.

Spiess, A. E., D. Wilson, and J. Bradley 1998 Paleoindian Occupation in the New England–Maritimes Region: Beyond Cultural Ecology. *Archaeology of Eastern North America* 26: 201–64.

Waters, M. R., and T. W. Stafford Jr. 2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315:1122–26.

CA-SRI-26: A Terminal-Pleistocene Site on Santa Rosa Island, California

Jon M. Erlandson, Torben C. Rick, and Nicholas P. Jew

➤ **Keywords** Channel Islands, Paleocoastal period, maritime adaptations

Located east of the mouth of Arlington Canyon, CA-SRI-26 was identified by Orr (1951:223, 1968) as potentially the oldest of several "Pleistocene" shell middens he described on the northwest coast of Santa Rosa Island. Erlandson (1994) relocated these sites in the early 1990s, collecting ^{14}C samples and showing that all contained early-Holocene components dated between ~9300 and 7800 CALYBP. The youngest of these was a patchy red abalone midden at CA-SRI-26 buried in a paleosol ~1–1.5 m below the surface (Erlandson 1994:191). In deeply incised gullies nearby, multiple paleosols were visible deeper in late-Pleistocene alluvium of the Upper Tecolote Formation, but no archaeological materials were found in these older soils at the time.

In July 2010, Erlandson carefully reexamined these gullies at CA-SRI-26 and found a low-density deposit of chipped-stone artifacts, animal bones, and occasional marine shells eroding from a ~40- to 50-cm-thick paleosol situated ~2–2.5 m below the surface and about 1 m below the early-Holocene red abalone midden. This Paleocoastal component has produced a small assemblage of artifacts and faunal remains from stratified contexts, including a California mussel (*Mytilus californianus*) shell fragment AMS dated to 10,545 ± 30 RCYBP (UCI-80937), with a calibrated age range of 11,340–11,220 CALYBP. The contents and stratigraphy of this component are very similar to a terminal-Pleistocene site (CA-SRI-512) located <1 km to the northeast (Erlandson et al. 2011), supporting the veracity of this ^{14}C date. So far, our investigation of the Paleocoastal component at CA-SRI-26 has been limited to a single small test pit, but the preliminary results are significant and are summarized here.

CA-SRI-26 is located on the high bluffs several hundred meters northeast of CA-SRI-173, where the deeply buried bones of the ~13,000-year-old Arlington Man were found in 1959 (Johnson et al. 2002; Orr 1962; Rick et al. 2005), and a rocky sill in the canyon bottom brings freshwater to the surface year-round. Today the coastline is located ~100 m north of CA-SRI-26, but 11,500 CALYBP sea levels along the southern California Coast were ~50 m below present (Masters and Aiello 2007) and the site may have been as much as 5–7 km from the outer coast. Rising postglacial seas may have formed an embayment at the mouth of Arlington Canyon, however, backed by a broad, marshy canyon bottom (Erlandson et al. 2011).

Jon M. Erlandson and Nicholas P. Jew, Museum of Natural and Cultural History, University of Oregon, Eugene, OR 97403-1224; Department of Anthropology, University of Oregon, Eugene, OR 97403-1218; e-mails: jerland@uoregon.edu njew@uoregon.edu

Torben C. Rick, Archaeobiology Program, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012;e-mail: RickT@si.edu

A small test pit excavated (with 4 10-cm levels of 20 liters each; total volume = 80 liters) in the intact site remnants produced >100 chipped-stone artifacts and almost 200 bone fragments from birds (n = 106), fish (n = 54), sea mammal (n = 6), rodent (n = 15), and undifferentiated vertebrates (n = 9). Most of the bones are heavily fragmented and not further identifiable, but at least one bird bone was identified as goose (c.f., *Branta* spp.). Also recovered were several fragments of California mussel shell.

The artifacts from CA-SRI-26 provide another window into maritime Paleoindian technologies on the Northern Channel Islands. Neither Arlington Springs (CA-SRI-173) nor a terminal Pleistocene component at Daisy Cave (CA-SMI-261) produced diagnostic artifacts, but recent work at Cardwell Bluffs (CA-SMI-678, 679) and CA-SRI-512 has shown that Paleocoastal island peoples were armed with stemmed points and chipped-stone crescents similar to those of the Western Pluvial Lakes Tradition (WPLT; Beck and Jones 2010; Erlandson et al. 2011). Although smaller, the CA-SRI-26 assemblage is similar to those from Cardwell Bluffs and CA-SRI-512. Several fragments or preforms of Channel Island Barbed (CIB) points (see Justice 2002) were found at the site, along with a complete stemmed and serrated Amol point found on an eroded surface. Also recovered were two chipped-stone crescent fragments—one in situ and another eroded from the gully wall.

Our preliminary investigations suggest that Paleocoastal peoples camped at CA-SRI-26 ~11,300 CALYBP. They chose a high bluff adjacent to the largest drainage on the island, a place where freshwater was readily available along with a commanding view of the coastal lowlands and near-shore waters along the northern shore of Santarosae. While occupying the site, they hunted birds and sea mammals, fished in coastal waters, and collected shellfish from rocky shore habitats. These early seafaring peoples were armed with finely made stemmed points and crescents similar to those found in WPLT sites scattered across America's Far West. Although CA-SRI-26 was located some distance from the coast, its Paleocoastal occupants clearly had a maritime economy and hunting technology. Future excavations should shed more light on the contents of the site and the lives of its occupants.

Our research was supported by a National Science Foundation grant (BCS 0917677) to Erlandson and Rick, Channel Islands National Park (CINP), and our home institutions. At CINP we are grateful to Mark Senning for logistical support. We also thank an anonymous reviewer, Ted Goebel, and the editorial staff for assistance in the review and publication of this paper.

References Cited

Beck, C., and G. T. Jones 2010 Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* 75:81–116.

Erlandson, J. M. 1994 *Early Hunter-Gatherers of the California Coast.* Plenum, New York.

Erlandson, J. M., T. C. Rick, T. J. Braje, M. Casperson, B. Culleton, B. Fulfrost, T. Garcia, D. A. Guthrie, N. Jew, D. J. Kennett, M. L. Moss, L. Reeder, C. Skinner, J. Watts, and L. Willis 2011 Paleoindian Seafaring, Maritime Technologies, and Coastal Foraging on California's Channel Islands. *Science* 331:1181–85.

Johnson, J. R., T. W. Stafford, Jr., H. O. Ajie, and D. P. Morris 2002 Arlington Springs Revisited. *Proceedings. of the 5th California Islands Symposium,* edited by D. R. Browne, K. L. Mitchell, and H. W. Chaney, pp. 541–45. Santa Barbara Museum of Natural History, Santa Barbara.

Justice, N. D. 2002 *Stone Age Spear and Arrow Points of California and the Great Basin*. Indiana University Press, Bloomington.

Masters, P. M., and I. W. Aiello 2007 Postglacial Evolution of Coastal Environments. In *California Prehistory: Colonization, Culture, and Complexity*, edited by T. L. Jones and K. A. Klar, pp. 35–51. Altamira, New York.

Orr, P. C. 1951 Ancient Populations Centers on Santa Rosa Island. *American Antiquity* 16:221–26.

——— 1962 The Arlington Springs Site, Santa Rosa Island, California. *American Antiquity* 27:417–19.

——— 1968 *Prehistory of Santa Rosa Island*. Santa Barbara Museum of Natural History, Santa Barbara.

Rick, T. C., J. M. Erlandson, R. L. Vellanoweth, and T. J. Braje 2005 From Pleistocene Mariners to Complex Hunter-gatherers: The Archaeology of the California Channel Islands. *Journal of World Prehistory* 19:169–228.

The Cochiti Clovis Point Base, Sandoval County, New Mexico

Gregory D. Everhart and Bruce B. Huckell

➤ **Keywords:** Clovis point, Cochiti Lake, New Mexico

On 15 January 2010, U.S. Army Corps of Engineers (Corps), Albuquerque District, archaeologists John D. Schelberg, Lance Lundquist, and Gregory D. Everhart were conducting a pedestrian survey at Cochiti Lake, Sandoval County, New Mexico (Figure 1). During the survey, Everhart discovered the base of a Clovis projectile point. The Corps' Cochiti Lake dam and reservoir is located on the Rio Grande west of Santa Fe in north-central New Mexico. Cochiti Lake is located within the Pueblo de Cochiti Reservation on lands leased by the Pueblo to the Corps. Bruce B. Huckell visited the site 27 January 2010 to examine its geological context.

The site is positioned on the east side of the Rio Grande channel atop a terrace developed on an alluvial deposit of middle-early Pleistocene age (Qta_1 of Dethier and Sawyer 2007) near the mouth of White Rock Canyon, and west of the 120-m-high La Bajada (basalt) escarpment. The site is 1,688 m in elevation; the nearby Rio Grande channel is 1,609 m a.s.l. The point fragment was found near the top of the sloping edge of a road borrow ditch that was excavated in the 1970s, which may have exposed the point. A small trench dug along the ditch revealed that this high terrace has a >50-cm-thick strongly developed soil profile consisting of an A/B horizon overlying two clay-rich Bt

Gregory D. Everhart, Environmental Resources Section, U.S. Army Corps of Engineers, Albuquerque District, 4101 Jefferson Plaza, NE, Albuquerque, NM 87109; e-mail: gregory.d.everhart@usace.army.mil

Bruce B. Huckell, Maxwell Museum of Anthropology and Department of Anthropology, University of New Mexico, Albuquerque, NM 87131; e-mail: bhuckell@unm.edu

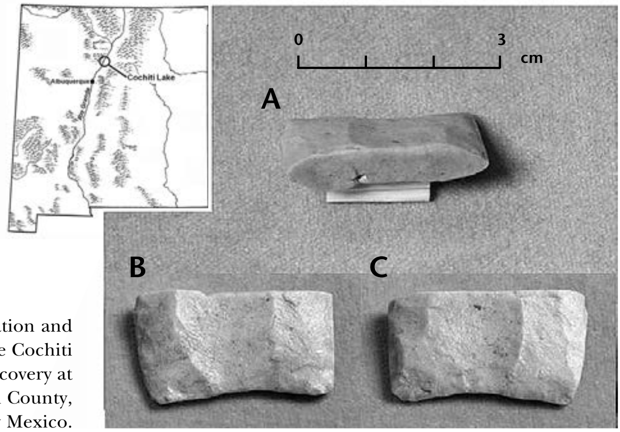


Figure 1. Location and photographs of the Cochiti Clovis point base discovery at Cochiti Lake, Sandoval County, New Mexico.

horizons. Below the lower Bt is a K horizon with Stage III calcium-carbonate morphology. The strength of soil profile development, consistent with at least a mid-Pleistocene age, suggests that this surface was stable long before Clovis occupation. Today this upland terrace is a Plains–Mesa Grassland with dispersed junipers (Dick-Peddie 1993:104–06).

The point is a relatively large basal fragment, broken by a transverse snap fracture that originated from a small cavity in the material (Figure 1A). It exhibits large single flutes on both faces that cut one or more previously detached basal thinning flake scars; the base is slightly concave, and both it and the lateral margins are well ground (Figure 1B and 1C). The point is made of a fine-grained, white orthoquartzite. While the specific source for this material is unknown, it may be derived from the Morrison formation (LeTourneau 2000:446–47). Occasional Clovis and Folsom artifacts from other central New Mexico sites are made from this same quartzite. Maximum length of the fragment is 19.0 mm, and the shorter side is 17.7 mm. Maximum width at the fracture is 31.6 mm; width at the base is 28.1 mm. Maximum thickness is 7.1 mm, and the basal concavity is 1.9 mm deep. The point fragment was reutilized subsequent to the break as evidenced by a well-rounded edge prominent on the transverse fracture nearest the side with the small cavity. The wear suggests that the vertically broken edge was used with a transverse (scraping or planing) motion. A point basal fragment from the Murray Springs, Arizona, Clovis site shows exactly the same pattern of reuse (Huckell 2007:199–200; Fig. 8.7c).

The point base was found at the northern margin of an extensive artifact scatter of primarily Archaic lithic tools and debitage, all of locally available fine-grained dacite. The Archaic scatter is densest approximately 150 m south of the Clovis point base. Artifacts on the surface within 50 m of the point base, however, include three red chert flakes and a chalcedony flake that suggest the possibility of a separate, possibly Clovis, component to the site. This will have to be assessed by future research. This is the first positively identified Clovis point found in Sandoval County (T. Fallis, pers.comm. Archaeological

Records Management Section, New Mexico Historic Preservation Division 2010; Huckell 2004:Figure 2).

Thanks to U.S. Army Corps of Engineers, Albuquerque District, archaeologists John Schelberg, Jonathan Van Hoose, and Ariane Pinson. Gary Smith, Department of Earth and Planetary Sciences, University of New Mexico, directed us to relevant geological literature.

References Cited

Dethier, D. P., and D. A. Sawyer 2007 Stratigraphy of Upper Cenozoic Fluvial Deposits of the La Bajada Constriction Area, New Mexico. In *The Cerrillos Uplift, the La Bajada Constriction, and Hydrogeologic Framework of the Santo Domingo Basin, Rio Grande Rift, New Mexico*, edited by S. A. Minor, pp. 27–40. Professional Paper 1720, Department of the Interior, Geological Survey.

Dick-Peddie, W. A. 1993 *New Mexico Vegetation: Past, Present and Future.* University of New Mexico Press, Albuquerque.

Huckell, B. B. 2004 Clovis in the Southwestern United States. In *New Perspectives on the First Americans*, edited by B. T. Lepper and R. Bonnichsen, pp.93–101. Center for the Study of the First Americans, Texas A&M University Press, College Station.

——— 2007 Clovis Lithic Technology: A View from the Upper San Pedro Valley. In *Murray Springs, A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona,* edited by C. V. Haynes, Jr., and B. B. Huckell, pp. 170–213. Anthropological Papers of the University of Arizona 71, University of Arizona Press, Tucson.

LeTourneau, P. D. 2000 Folsom Toolstone Procurement in the Southwest and Southern Plains. Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Comparing Great Basin Paleoindian Raw Material Procurement Strategies: X-ray Fluorescence Data from Obsidian Fluted and Stemmed Points from Mud Lake and Lake Tonopah, Nevada

Lindsay A. Fenner, Geoffrey M. Smith, Samuel Coffman, and Gary D. Noyes

➤ **Keywords:** Source Provenance Analysis, Paleoindians, Great Basin

The relationship between fluted and stemmed projectile points in the Great Basin remains poorly understood. For example, we do not know if fluted points

Lindsay A. Fenner, SWCA Environmental Consultants, Inc., 257 East 200 South, Suite 200, Salt Lake City, UT, 84111; email: lfenner@swca.com

Geoffrey M. Smith, Great Basin Paleoindian Research Unit, Department of Anthropology, University of Nevada, Reno. 1664 No. Virginia Street/MS0096, Reno, NV 89557; email: geoffreys@unr.edu

Samuel Coffman, University of Alaska, Museum of the North. 907 Yukon Dr., Fairbanks, AK, 99775; email: sccoffman@alaska.edu

Gary D. Noyes, P.O. Box 807, Tonopah, NV, 89049; email: gdnoyes@frontiernet.net

represent the basal cultural stratum (Willig and Aikens 1988), if stemmed points preceded fluted points (Beck and Jones 2010; Bryan 1991), or if the two point types overlapped in time and perhaps represented different components of the same toolkit (Beck and Jones 1997). Furthermore, if the two point styles do indeed represent different time periods, owing to a paucity of comparative studies our understanding of if and how fluted- and stemmed-point users' lifeways differed remains limited. Additional comparisons between fluted and stemmed point assemblages are needed to help resolve these issues.

Toward that goal, we compared existing (Coffman 2008; Haarklau et al. 2005) and previously unpublished results of X-ray fluorescence (XRF) analyses of 19 fluted points[1] and 86 stemmed points collected from sites around Mud Lake and Lake Tonopah, Nevada.[2] Following Eerkens et al. (2007), we compared obsidian source diversity using a statistical technique known as bootstrapping to avoid potential issues related to sample size. If source diversity differs significantly between the two samples, then it may provide evidence that fluted and stemmed points were used by different groups possessing different toolstone procurement strategies, perhaps at different times. Alternatively, if source diversity does not differ significantly, then it may indicate that the two point types simply represented different components of the same toolkit or that they were used by groups possessing similar toolstone procurement strategies.

Summarized in Table 1 are the unpublished and previously published XRF results. A wide variety of geochemical types from California and Nevada are represented in both samples with a possible difference in distribution evenness present (e.g., Crow Spring fluted frequency); however, when adjusted for sample size, source diversity does not differ significantly between them ($p = .267$, two-tailed).

Although our samples are admittedly small and comprise a single raw material type, these results suggest that the individuals that produced the distinctive fluted and stemmed point technologies used the same obsidian sources—a finding that is at odds with Fagan's (1996) results of a comparative study of fluted and stemmed points from the Dietz site in Oregon in which he found notable differences in obsidian use between the two point types.

We would like to thank the Great Basin Paleoindian Research Unit, University of Nevada, Reno and the Northwest Research Obsidian Studies Laboratory for supporting the XRF analysis of additional Paleoindian points from Mud Lake. Special thanks are due to Gary Noyes for bringing the rich cultural resources of Mud Lake to the attention of the archaeological community and sharing his extensive knowledge of the Tonopah area.

References Cited

Beck, C., and G. T. Jones 1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11:161–236.

[1] We used the criteria outlined by Warren and Phagan (1988) to distinguish fluted points from basally thinned, unfluted concave base points and only included the former in this study.

[2] Many of the points from Mud Lake and Lake Tonopah were collected by Gary Noyes under the auspices of the Nevada State Museum. Those artifacts have well-documented proveniences and were mapped prior to collection using the compass-and-distance method from a central site datum that was standard practice in archaeological fieldwork prior to the emergence of GPS technology.

Table 1. Summary of the geochemical types of obsidian represented in fluted and stemmed point samples from sites near Mud Lake and Lake Tonopah, Nevada.

	New data		Previous data■		Total	
Geochemical types	**Stemmed**	**Fluted**	**Stemmed**	**Fluted**	**Stemmed**	**Fluted**
Bodie Hills, CA	1		1		2	
Casa Diablo (Lookout Mountain), CA	1				1	
Casa Diablo (Sawmill Ridge), CA			1	1	1	1
Coso, (West Sugarloaf), CA				2		2
Coso (Sugarloaf Mountain), CA		1				1
Crow Spring, NV			2	7	2	7
Garfield Hills, NV			1		1	
Goldfield Hills, NV			1		1	
Mono Glass Mountain, CA	1		1		2	
Montezuma Range, NV	7		9	1	16	1
Mount Hicks, NV	4		3	1	7	1
Mount Majuba, NV			1		1	
Obsidian Butte, Variety 2, NV	2		2	1	4	1
Obsidian Butte, Variety 3, NV	3		6	1	9	1
Obsidian Butte, Variety 4, NV	1		1		2	
Obsidian Butte, Variety 5, NV	4		7		11	
Queen, CA	7		9	4	16	4
Saline Ridge, CA			4		4	
Silver Peak, NV	1				1	
Tempiute Mountain, NV	3		2		5	
Total	**35**	**1**	**51**	**18**	**86**	**19**
Geochemical type diversity					**9.5**	**8.02**

■Previously published results were compiled from Coffman (2008) and Haarklu et al. (2005).

——— 2010 Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* 75(1):81–116.

Bryan, A. L. 1991 The Fluted Point Tradition in the Americas—One of Several Adaptations to Late Pleistocene American Environments. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 15–33. Center for the Study of the First Americans. Oregon State University, Corvallis.

Coffman, S. 2008 *Paleoindian Occupations at Pluvial Lake Tonopah and Mud Lake, Southcentral Nevada.* Unpublished Undergraduate Thesis, Department of Anthropology, University of Nevada, Reno.

Eerkens, J. W., J. R. Ferguson, M. D. Glascock, C. E. Skinner, and S. A. Waechter 2007 Reduction Strategies and Geochemical Characterization of Lithic Assemblages: A Comparison of Three Case Studies from Western North America. *American Antiquity* 72(3):585–97.

Fagan, J. L. 1996 Obsidian Hydration Analysis of Clovis and Western Pluvial Lakes Artifacts from the Dietz Site. Paper presented at the 25th Biennial Great Basin Anthropological Conference, Kings Beach, CA, Oct. 10-12.

Haarklau, L., L. Johnson, and D. L. Wagner 2005 *Fingerprints in the Great Basin: The Nellis Air Force Base Regional Obsidian Sourcing Study*. Morgan Printing, Austin.

Warren, C. N., and C. Phagan 1988 Fluted Points in the Mojave Desert: Their Technology and Cultural Context. In *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, edited by J. A. Willig, C. M. Aikens, and J. L. Fagan, pp. 121–30. Nevada State Museum Anthropological Papers 21. Carson City.

Willig, J. A., and C. M. Aikens 1988 The Clovis-Archaic Interface in Far Western North America. In *Early Human Occupations in Far Western North America: The Clovis-Archaic Interface*, edited by J.

A. Willig, C. M. Aikens, and J. L. Fagan, pp. 1–40. Nevada State Museum Anthropology Papers 21, Carson City.

Pleistocene Archaeology of the Tanana Flats, Eastern Beringia

Edmund P. Gaines, Kate S. Yeske, Scott J. Shirar, William C. Johnson, and James F. Kunesh

➤ **Keywords:** Archaeology, Beringia, colonization

The Tanana Flats (Figure 1), central Alaska, marks a geographic crossroads and natural corridor between Pleistocene archaeological sites in the Nenana and Tanana valleys (Goebel and Bigelow 1996; Goebel et al. 1996; Hoffecker et al.1996; Holmes 1996, 2006; Pearson 1999; Powers and Hoffecker 1989; Potter 2009; Potter et al. 2008, 2010). Through a combination of AMS ^{14}C dating and inter-site stratigraphic correlations, 10 sites recently identified in the flats have been dated to the terminal Pleistocene (Gaines et al. 2010; 2011). Ongoing investigations underscore the importance of this region in understanding the early peopling of eastern Beringia and the New World.

Six sites are situated on an alluvial terrace (Péwé et al. 1966) that exhibits a general stratigraphic sequence of basal gravels, overlain by up to 4 m of Pleistocene aeolian sand, which is capped by 1–1.5 m of loess. Testing at FAI-02043 identified at least two components, the earliest of which occurs in the upper portion of the sands at 95–110 cm below the surface (bs). The recovered assemblage consists of lithics and fauna including hare (*Lepus* sp.), goose (Subfamily Anserinae) and bison (*Bison* sp.) associated with a charcoal age of 11,600 ± 50 RCYBP (Beta-283430). The later component consists of lithic debitage in the lowest portions of the loess at 80–90 cm bs and produced a charcoal date of 10,730 ± 50 RCYBP (Beta-281235). FAI-02019 yielded flakestone from the basal portion of the loess at 60–70 cm bs with a charcoal date of 11,050 ± 70 RCYBP (Beta-277776). FAI-02077 produced debitage, microblades, and a biface from the lower loess near the sand contact at 35 cm bs with a charcoal date of 10,130 ± 50 RCYBP (Beta-283435).

Edmund P. Gaines, Arktikos Archaeology, PMB 193, 3875 Geist Road, Suite E, Fairbanks, AK 99709; email: epg74@yahoo.com

Kate S. Yeske, Colorado State University, Center for Environmental Management of Military Lands (CEMML) 1060 Gaffney Road #4500, Fort Wainwright, AK 99703; email: kateyeske@gmail.com

Scott J. Shirar, Archaeology Department, University of Alaska Museum of the North, 907 Yukon Drive, Fairbanks, AK 99775; email: sjshirar@alaska.edu

William C. Johnson, Department of Geography, The University of Kansas, 1475 Jayhawk Boulevard, Lawrence, KS 66045-7613; email: wcj@ku.edu

James F. Kunesh, Department of Anthropology, St. Cloud State University, 720-4th Avenue South, St. Cloud, MN 56301-4498; email: woodtik82@hotmail.com

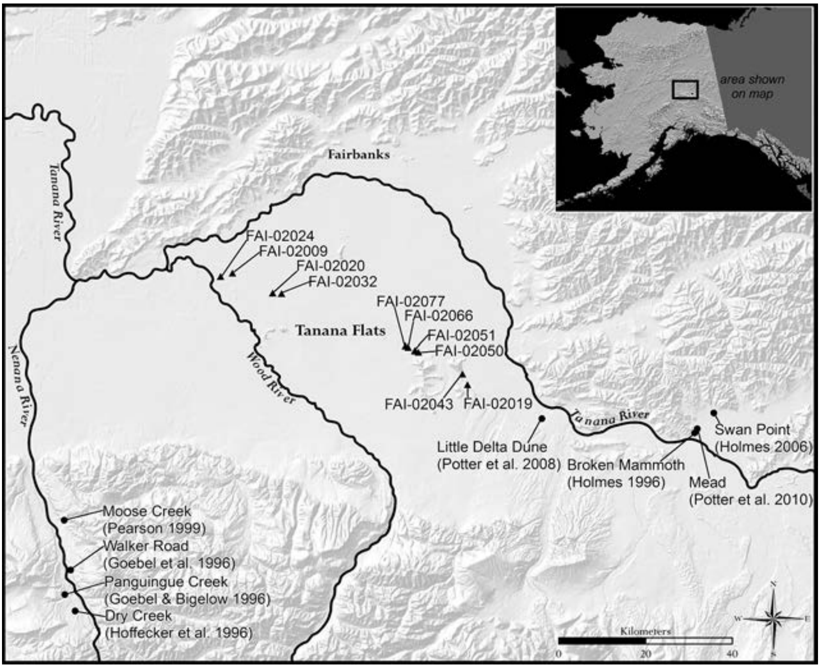


Figure 1. Pleistocene archaeological sites in the Tanana Flats, and Nenana and Tanana valleys.

Other sites on the landform—FAI-02050, FAI-02051, and FAI-02066—remain undated; however, artifacts deeply buried in the lower sands suggest terminal Pleistocene ages.

Four sites—FAI-02009, FAI-02020, FAI-02024, and FAI-02032—occur in a vegetated dune field east of the Wood River (Péwé et al. 1966). Dune stratigraphy consists of 7+ m of Pleistocene sand capped by 1–2 m of Holocene loess. These sites contain buried artifacts at or below the sand/loess contact at depths of 70–130 cm bs. Comparisons with nearby well-dated dune and aeolian sand sequences in the Tanana Valley (Potter et al. 2008; 2010) provide reasonable terminal-Pleistocene/early-Holocene age estimates. Pending luminescence (OSL & IRSL) age analyses are expected to support these approximations.

Early sites in the Nenana and Tanana valleys have been used as the basis for hypotheses concerning the early habitation of eastern Beringia and colonizing of the New World (Goebel et al. 1991; Hamilton and Goebel 1999; Potter 2009; Yesner 2001). Research presented herein is the result of reconnaissance survey and limited testing. Further investigations in the Tanana Flats will undoubtedly provide a crucial link between the two river valleys and produce important new information regarding the Pleistocene occupation of Beringia and the New World.

This research was made possible only by the determined efforts of the 2009 and 2010 field crew members, who braved difficult conditions and remained ever diligent in their search for elusive early archaeological remains. Funding was provided by Army Environmental Command (AECOM) as part of Section 106 compliance surveys.

References Cited

Gaines, E. P., K. S. Yeske, and S. J. McGowan 2010 Annual Report: Cultural Resources Survey and Evaluation, Fort Wainwright, Alaska 2009. Unpublished report prepared for the U.S. Army Garrison, Fort Wainwright. Colorado State University, CEMML.

Gaines, E. P., K. S. Yeske, W. E. McLaren, J. F. Kunesh and M. Shimel 2011 Annual Report: Cultural Resources Survey and Evaluation, Fort Wainwright, Alaska 2010. Unpublished report prepared for the U.S. Army Garrison, Fort Wainwright. Colorado State University, CEMML.

Goebel, T., and N. H. Bigelow 1996 Panguingue Creek. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West, pp. 363–66. University of Chicago Press, Chicago.

Goebel, T., W. R. Powers, and N. H. Bigelow 1991 The Nenana Complex of Alaska and Clovis Origins. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 49–79. Center for the Study of the First Americans, Oregon State University, Corvallis.

Goebel, T., W. R. Powers, N. H. Bigelow, and A. S. Higgs 1996 Walker Road. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West, pp. 356–62. University of Chicago Press, Chicago.

Hamilton, T. D., and T. Goebel 1999 Late Pleistocene Peopling of Alaska. In *Ice Age Peoples of America: Environments, Origins, and Adaptations of the First Americans*, edited by R. Bonnichsen and K. L. Turnmire. Center for the Study of the First Americans, Oregon State University, Corvallis.

Hoffecker, J. F., W. R. Powers, and N. H. Bigelow 1996 Dry Creek. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West, pp. 342–43. University of Chicago Press, Chicago.

Holmes, C.E. 1996 Broken Mammoth. In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West, pp. 312–18. University of Chicago Press, Chicago.

Holmes, C. E. 2006 *The Archaelogical Sequence at Swan Point, Central Alaska.* Poster Presented at the 14th Annual Arctic Conference, October 20-21, University of Oregon, Museum of Natural and Cultural History, Eugene.

Pearson, G. A. 1999 Early Occupation and Cultural Sequence at the Moose Creek: A Late Pleistocene Site in Central Alaska. *Arctic* 52(4):332–45.

Péwé, T. L., C. Wahrhaftig, and F. Weber 1966 Geologic Map of the Fairbanks Quadrangle, Alaska. *U.S. Geological Survey Map I-455.*

Potter, B. A. 2009 Tanana River Basin, East Central Alaska: Understanding the Colonization of the New World. In *Archaeology in America,* vol. 4, West Coast and Arctic/Subarctic, edited by F. P. McManamon, L. S. Cordell, K. Lightfoot, and G. R. Milner, pp 308–10. Greenwood Press, Connecticut.

Potter, B. A., P. J. Gilbert, C. E. Holmes, and B. A. Crass 2010 Recent Archaeological Research at the Mead Site, Central Alaska. Poster presented at the 75th Annual Meeting of the Society for American Archaeology, St. Louis.

Potter, B. A., J. D. Reuther, P. M. Bowers, and C. Gelvin-Reymiller 2008 Little Delta Dune Site: A Late Pleistocene Multicomponent Site in Central Alaska. *Current Research in the Pleistocene* 25:94–97.

Powers, W. R., and J. F. Hoffecker 1989 Late Pleistocene Settlement in the Nenana Valley, Central Alaska. *American Antiquity* 54(2):263–87.

Yesner, D. R. 2001 Human Dispersal into Interior Alaska: Antecedent Conditions, Mode of Colonization, and Adaptations. *Quaternary Science Reviews* 20:315–27.

Great Basin Stemmed Series Surface Assemblages at Pluvial Mud Lake, Nevada

Barbi Malinky Harmon

➤ **Keywords:** Paleoindian, Great Basin

In 2007, Kautz Environmental Consultants, Inc., conducted an archaeological inventory on the floor of Ralston Valley in central Nevada in support of a proposed solar development. During the inventory, five sites containing Great Basin Stemmed Series flaked stone tool assemblages were encountered and documented, representing occupations of Ralston Valley dating to the latest Pleistocene or early Holocene (Beck and Jones 1997). Each of these assemblages contains between one and five Stemmed Series point fragments in association with other implements such as bifaces, modified flakes, scrapers and small scatters of debitage. Toolstone in the assemblages is dominated by obsidian and basalt, and the Stemmed Series points are identified as unshouldered base fragments. Four of the five assemblages are single component, containing only Stemmed Series point fragments, while one site also contained a Middle Archaic Elko Series projectile point. In addition to the five assemblages identified, two isolated artifacts were also documented, including one Parman-like base fragment and one concave sidescraper nearly identical to those identified at the Sadmat Locality in western Nevada (Graf 2001:76, Fig. 4.22; Warren and Ranere 1968:10, Fig. 2).

The surveyed block straddles several ancient lake shorelines associated with extinct pluvial Mud Lake, and the assemblages were identified in direct association with these shorelines (Figure 1). These ancient lake features were identified by Nellis Air Force Base as part of a series of studies of Ralston Valley. While their elevations are documented, these beach strands have not yet been dated. Mud Lake had a maximum surface area of 427 km^2 and a maximum depth of 26 m (Mifflin and Wheat 1979). The lake was likely a semipermanent pluvial lake containing no fishes (Hubbs and Miller 1948:49), and is assigned an age equivalent to that of Lake Lahontan. The assemblage discussed here is merely the latest in a series of both stemmed and fluted point assemblages identified from Mud Lake, the most famous of which is the Noyes Collection (Coffman and Noyes 2008).

All the documented isolated artifacts and sites containing Stemmed Series points cluster within a tight range of elevations at the northernmost margin of the lake. All are situated between 1,604.5 m and 1,607.3 m, constituting a range in elevation of only 2.8 m. These locations fall directly between the identified highstand of Mud Lake at 1,609 m, and the next-lowest identified ancient beach strand at 1,603 m. Occupations at all these sites are undoubtedly directly related to the existence of pluvial Mud Lake. These sites may date

Barbi Malinky Harmon, Principal Investigator, Kautz Environmental Consultants, Inc., 1140 Financial Blvd, Suite 100, Reno, NV 89502; email: malinky@kecnv.com

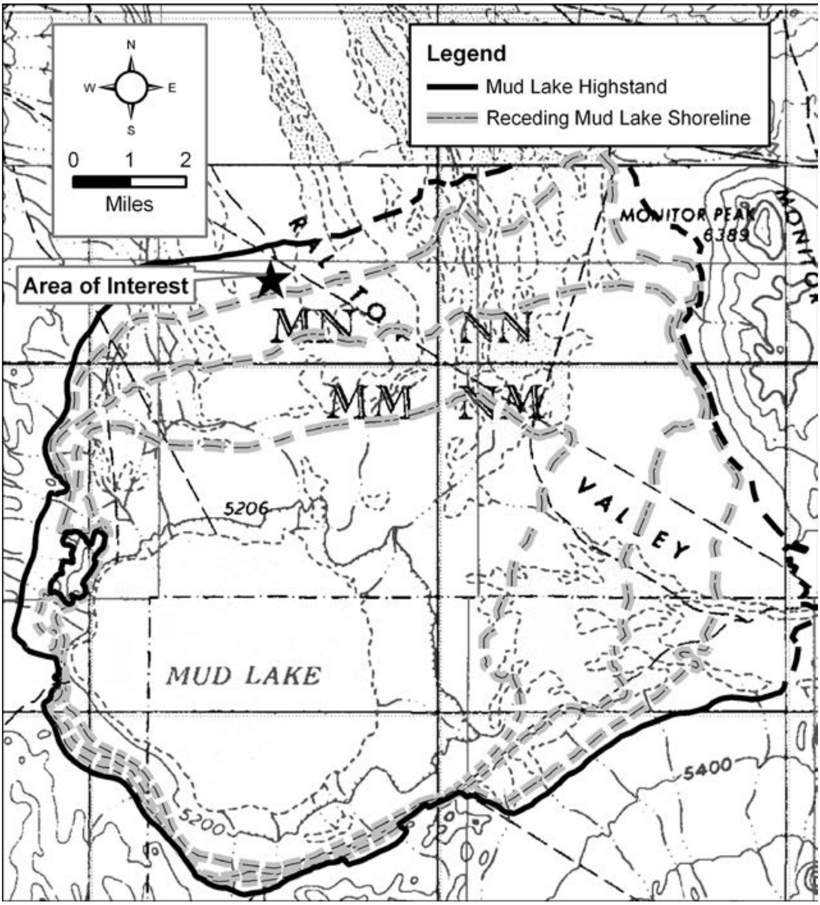


Figure 1. Highstand and shorelines of Mud Lake in relation to archaeological assemblages. (Dashed lines indicate approximate shoreline elevations; solid lines indicate mapped shoreline features.)

to the period immediately following the recession from the highstand of the lake, or may be associated with a later temporary refilling of the basin in Ralston Valley. Absolute dating of the identified shorelines is necessary to fully understand not only the history of Mud Lake, but also how it is related to the prehistory of Ralston Valley. Future investigations may also focus on obsidian source and hydration rim data to further aid in understanding the timing and nature of the prehistoric occupations around Mud Lake.

References Cited

Beck, C., and G. T. Jones 1997 The Terminal Pleistocene/Early Holocene Prehistory of the Great Basin. *Journal of World Prehistory* 11(2):161–236.

Coffman, S., and G. Noyes 2008 Morphometric Variation in Great Basin Fluted and Unfluted

Concave-Based Projectile Points from Pleistocene Lake Tonopah and Mud Lake, Nevada. *Current Research in the Pleistocene* 25:68–70.

Graf, K. E. 2001 Paleoindian Technological Provisioning in the Western Great Basin. Unpublished M.A. thesis, Department of Anthropology and Ethnic Studies, University of Nevada, Las Vegas.

Hubbs, C. L., and R. R. Miller 1948 The Zoological Evidence: Correlation Between Fish Distributions and Hydrographic History in the Desert Basin of Western United States. In *The Great Basin: With Emphasis on Glacial and Postglacial Times*, edited by C. L. Hubbs, R. R. Miller, and E. A. E. Blackwelder, pp.17–166. University of Utah, Salt Lake City.

Mifflin, M. D., and M. M. Wheat 1979 *Pluvial Lakes and Estimated Pluvial Climates of Nevada.* Nevada Bureau of Mines and Geology Bulletin 94. Mackay School of Mines, University of Nevada, Reno.

Warren, C. E., and A. J. Ranere 1968 Outside Danger Cave: A View of Early Man in the Great Basin. In *Early Man in Western North America*, Eastern New Mexico University Contributions in Anthropology, edited by C. Irwin-Williams, pp. 6–18. Eastern New Mexico University Paleo-Indian Institute, Portales.

Clovis Activity in the Central Plains Uplands

Jack L. Hofman and Brendon P. Asher

➤ **Keywords:** Clovis settlement, site documentation, upland Plains

Many Clovis artifacts from Kansas and Nebraska have been recovered from active stream deposits (Hofman and Hesse 2002; Holen 2001), but two Clovis sites in northern Kansas provide important exceptions. Diskau (Schmits 1987) is located between the Big Blue and Republican rivers, and Eckles (Holen 2001, 2010) is 130 km northwest of Diskau on a high terrace of White Rock Creek, tributary to the Republican River. Four additional Clovis sites are here documented in upland settings between the Big Blue and Republican rivers, providing further evidence of Clovis activity in the Central Plains uplands.

The Larson site (14RP11) yielded a Clovis point found with two broken bifaces during terracing of a central Republic County field. The site is on the southeast slope of a prominent divide and a short distance from a marsh or spring. The bifaces were subsequently lost, but the Clovis point (Hofman and Hesse 2002: Figure 1e) is nearly complete with probable impact damage on the tip and one blade edge. The material is translucent chalcedony, probably a White River Group silicate (WRGS), though not necessarily from the northeast Colorado Flattop Butte source. Much of the Clovis assemblage from Eckles (Hoard et al. 1992, 1993; Holen 2001, 2010) is WRGS and this material is also present in the Diskau Clovis assemblage (Schmits 1987).

The Bredthauer site (14RP327) is a multicomponent upland site in central Republic County a few kilometers south of Larson and in a similar terrace

Jack L. Hofman and Brendon P. Asher, Department of Anthropology, 622 Fraser Hall, 1415 Jayhawk Blvd, Lawrence, KS 66045; e-mails: hofman@ku.edu Brendon5@hotmail.com

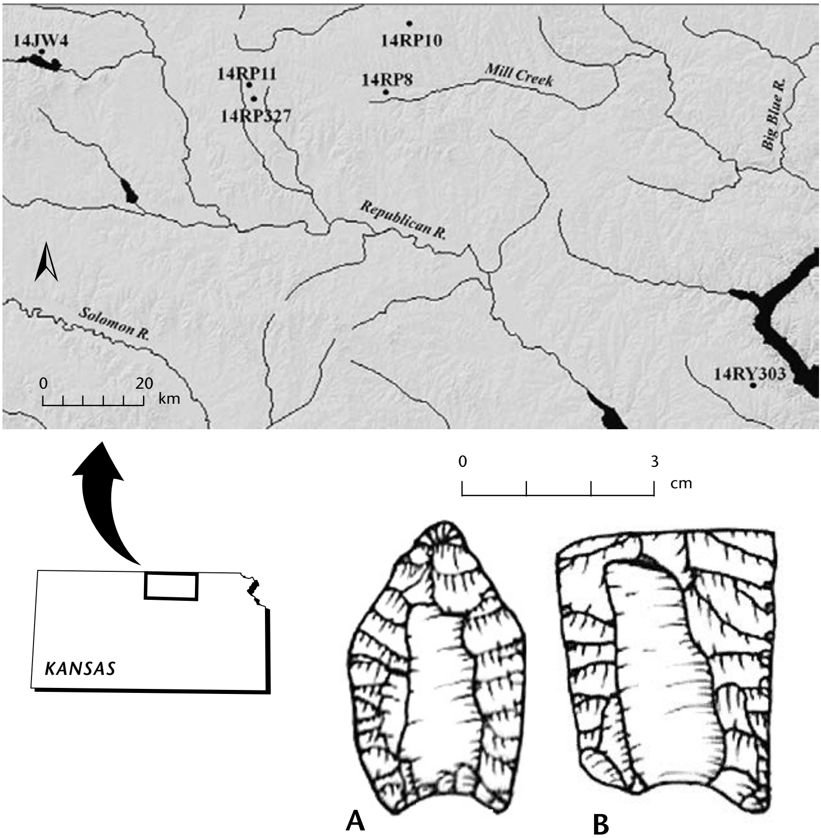


Figure 1. Clovis sites and selected points from Republic County, Kansas and vicinity including Eckles (14JW4) and Diskau (14RY303). **A, B,** Clovis points from the Bredthauer site (14RP327).

setting near a spring. Key artifacts from this location include three Clovis points, one complete with a reworked tip and blade and two large basal fragments. Also from this site are blades and unifacial tools of probable Paleoindian origin. The points are manufactured from Smoky Hill Jasper (SHJ), which is well represented in the Diskau collection (Schmit 1987). A large unifacially retouched flake, two blades, and endscraper all of SHJ may reflect Clovis activity at this site.

The Graham site (14RP10), located in northeastern Republic County, is on a north sloping ridge toe near a spring on a tributary of the Little Blue and has evidence for multiple Paleoindian occupations. A Folsom point base made from SHJ and a reworked Clovis point of gray Permian chert are recorded from this site. This Clovis point has a reworked tip and is heavily patinated. The Fisher-Filipi site (14RP8) is on Mill Creek where an impact-damaged Clovis point of SHJ was found eroding from a basal clay stratum.

Collectively, these finds provide supportive evidence for fairly intensive use of upland settings by Clovis people in this portion of the Central Plains. The abundance of seeps, springs, and marshes along upland tributaries in the area probably attracted animals and Clovis people to this region.

For their help in various ways we thank Robert Hoard, Virginia Wulfkuhle, Steve Holen, Al Johnson, Mike Fosha, Richard Gould, Mary Adair, Edward Larson, William Graham, Annette Bredthauer, Todd Filipi, Frank Fisher, Larry and Pat Walter, and Deb Aaron.

References Cited

Hoard, R. J., J. R. Bozell, S. R. Holen, M. D. Glascock, H. Neff, and J. M. Elam 1993 Source Determination of White River Group Silicates from Two Archaeological Sites in the Great Plains. *American Antiquity* 58:698–710.

Hoard, R. J., S. R. Holen, M. D. Glascock, H. Neff, and J. M. Elam 1992 Neutron Activation of Stone from the Chadron Formation and a Clovis Site on the Great Plains. *Journal of Archaeological Science* 19:655–65.

Hofman, J. L., and I. S. Hesse 2002 Clovis in Kansas. Institute for Tertiary-Quaternary Studies, *TER-QUA Symposium Series* 3:15–36.

Holen, S. R. 2001 Clovis Mobility and Lithic Procurement on the Central Great Plains of North America. Ph. D. Dissertation, Department of Anthropology, University of Kansas, Lawrence.

——— 2010 The Eckles Clovis Site, 14JW4: A Clovis Site in Northern Kansas. *Plains Anthropologist* 55(216):299–310.

Schmits, L. 1987 The Diskau Site: A Paleoindian Occupation in Northeast Kansas. *Current Research in the Pleistocene* 4:69–70.

Folsom Obsidian Procurement and Use at the Boca Negra Wash Site, New Mexico

Bruce B. Huckell, M. Steven Shackley, Matthew J. O'Brien, and Christopher W. Merriman

➤ **Keywords:** Folsom, obsidian sourcing, technological organization

Since its discovery in 1997, the Boca Negra Wash Folsom site has been the subject of four seasons of investigation. It is one of three excavated Folsom sites in the Middle Rio Grande Basin, and has produced a large assemblage of artifacts, a significant proportion of which is made of obsidian. The site consists of two loci, A and B, adjacent to a playa (Holliday et al. 2006: Figure 3; Huckell and Kilby 2000; Huckell et al. 2002, 2003); 95 1-m^2 units were

Bruce B. Huckell, Maxwell Museum of Anthropology and Department of Anthropology, University of New Mexico, Albuquerque, NM 87131; e-mail: bhuckell@unm.edu

M. Steven Shackley, Geoarchaeological XRF Laboratory, Department of Anthropology, University of California, Berkeley, CA 94720; e-mail: shackley@berkeley.edu

Matthew J. O'Brien and Christopher W. Merriman, Department of Anthropology, University of New Mexico, Albuquerque, NM 87131; e-mails: mjobrien@unm.edu merriman@unm.edu

excavated at Locus A and 104 at Locus B. Locus A produced 480 artifacts, 70 of which were obsidian, and Locus B yielded 1335 artifacts, 421 of them obsidian. This material composes 16.9% of the debitage at Locus A and 33% at Locus B. Obsidian accounts for 18.8% of tools at Locus A and 34.3% at Locus B. Folsom use of obsidian in the Middle Rio Grande Valley has been long appreciated (Amick 1994; Judge 1973; LeTourneau 2000; LeTourneau et al. 1996). LeTourneau and Baker 2002 (Table 3.3) reported that obsidian composed 15.9% of their sample of 822 Folsom points, preforms, and channel flakes from the Basin and Range Province of New Mexico. The obsidian was from two general source areas: the Jemez Mountains, which contain at least four geochemically distinct sources (Cerro Toledo, El Rechuelos, Valle Grande, and Bear Springs Peak), and two Mount Taylor volcanic field sources, Grants Ridge and Horace Mesa (also see Shackley 2005).

Sixteen artifacts from Boca Negra Wash have been characterized by X-ray fluorescence at the Berkeley Geoarchaeological XRF Laboratory (Table 1), the largest sample yet analyzed from a single Folsom site. All are from the Jemez Mountains, with 15 of the 16 (93.8%) assigned to the Valles Rhyolite (VGM, Valle Grande member) and one to the Cerro Toledo Rhyolite (CTR) (Shackley 2005: 64-74). LeTourneau (2000:96–100) reported XRF results on 33 Folsom artifacts from 19 Southwestern/Southern Plains sites showing that VGM obsidian was dominant (26 of 33, or 78.8%); CTR was a minor contributor (3 of 33, or 9.1%).

Table 1. Boca Negra Wash Folsom site obsidian artifacts characterized by XRF.

Artifact number	Artifact type	Locus	Source
6	Biface frag	A	Valles Rhyolite
28	Flake frag	A	Valles Rhyolite
32	Flake frag	A	Valles Rhyolite
56	Flake	A	Valles Rhyolite
130	Folsom preform base	B	Valles Rhyolite
316	Folsom point midsection	A	Valles Rhyolite
433	Folsom preform base	B	Valles Rhyolite
522	Channel flake	B	Valles Rhyolite
909	Flake tool frag	B	Valles Rhyolite
1490	Biface frag	B	Valles Rhyolite
1582	Channel flake	B	Valles Rhyolite
1753	Folsom point base	B	Valles Rhyolite
2000	Folsom point basal corner	B	Valles Rhyolite
2021	Folsom point tip	B	Valles Rhyolite
2059	Pseudo-fluted point frag	B	Valles Rhyolite
2284	Folsom point basal corner	B	Cerro Toledo

The predominance of VGM obsidian at Boca Negra Wash is significant because it is uniquely derived from Cerro del Medio, a resurgent dome complex within the Valles Caldera approximately 75 km north of the site. Obsidian from this source has not been transported fluvially outside the Jemez caldera to any significant extent or in pieces larger than approximately 40 mm (LeTourneau and Shackley 2009; Shackley 2005, 2010). Thus, to obtain pieces of suitable size for the manufacture of projectile points, bifaces, or other tools, knappers had to travel to the caldera, where pieces up to 30–40 cm in maximum dimension and of high knapping quality are available (LeTourneau and Steffen 2002; Shackley 2005). CTR obsidian was clearly also used; its primary outcrops are to the northeast and southeast of the Valle Grande itself, but it occurs in Rio Grande Valley alluvium in a secondary source context.

What can be said of how Folsom knappers at the Boca Negra Wash were transporting and using obsidian? The site lies approximately 75 km south of the caldera and some 1,340 m lower. In our estimation, the obsidian was probably directly procured by members of the Folsom group that occupied Boca Negra Wash, based on the relatively large percentage of the assemblage it composes and on its occurrence as finished tools, tools broken in manufacture, and debitage. Indirect procurement (exchange) cannot be completely ruled out (Meltzer 1989), but given that Pedernal chert is present in similar abundance (28% of the materials in Locus A, 16.5% in Locus B) and is available from primary outcrops 20–25 km north of the Valles Caldera, direct procurement seems the most logical explanation (Shackley 2005: 117–133). We infer that the obsidian was transported in already reduced form—potentially including finished projectile points—because only 3 of 504 obsidian artifacts (0.6%) exhibit cortex. Quarry products such as large flakes or small bifacial preforms are likely candidates for these partially reduced forms. Locus B yielded 92 pieces of debitage that retained striking platforms; 67 (72.8%) are faceted, another 21 (22.8%) are plain, and the remaining 4 (4.3%) are cortical. The much smaller sample from Locus A included 9 plain and 3 faceted striking platforms. The dominance of faceted platforms suggests that biface production was an important aspect of obsidian use here. Moreover, it appears that the pieces being transported were not large. Although the obsidian debitage from the site is fragmented, it consists of small pieces. At Locus B mean debitage piece size is 8.4 mm (± 3.9 mm) long, 6.4 mm (± 3.8 mm) wide, and 1.3 mm (± 0.09 mm) thick. It seems that obsidian was used primarily for weapons tips and informal flake tools. The 15 recovered obsidian tools include Folsom points and point preforms (7), bifaces (3), gravers (1), unifacially retouched (3) and utilized (1) flake tools.

The apparent predominance of VGM obsidian at Boca Negra Wash is of critical importance in reconstructing Folsom lithic material procurement and transport. Data from both debitage and tools from this single-component site also provide insights into the forms in which obsidian was transported and the role it played in technological organization.

References Cited

Amick, D. A. 1994 Folsom Diet Breadth and Land Use in the American Southwest. Unpublished Ph.D dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Holliday, V. T., B. B. Huckell, J. H. Mayer, S. L. Forman and L. D. McFadden 2006 Geoarchaeology of the Boca Negra Wash Area, Albuquerque Basin, New Mexico, USA. *Geoarchaeology* 21:765–802.

Huckell, B. B., and J. D. Kilby 2000 Boca Negra Wash, a New Folsom Site in the Middle Rio Grande Valley, New Mexico. *Current Research in the Pleistocene* 17:45–47.

Huckell, B. B., J. D. Kilby, and M.J. Hamilton 2003 2002 Investigations at the Boca Negra Wash Folsom Site, North-central New Mexico. *Current Research in the Pleistocene* 20:33–35.

Huckell, B. B., J. D. Kilby, B. Buchanan, M. J. Hamilton and S. Ruth 2002 2001 Excavations at the Boca Negra Wash Folsom Site, North-central New Mexico. *Current Research in the Pleistocene* 19:39–40.

Judge, W. J. 1973 *Paleoindian Occupation of the Central Rio Grande Valley in New Mexico.* University of New Mexico Press, Albuquerque.

LeTourneau, P. D. 2000 Folsom Toolstone Procurement in the Southwest and Southern Plains. Unpublished Ph.D dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

LeTourneau, P. D., and T. Baker 2002 The Role of Obsidian in Folsom Lithic Technology. In *Folsom Technology and Lifeways*, ed. by J. E. Clark and M. B. Collins. Special Publication No. 4, Lithic Technology, pp. 31-45. University of Tulsa, Tulsa.

LeTourneau, P. D., and M. S. Shackley 2009 Geochemistry of Paleoindian and Early-Archaic Obsidian Artifacts from New Mexico and Colorado. *Current Research in the Pleistocene* 26:81–84.

LeTourneau, P. D., M. S. Shackley, J. M. Warnica and J. Cummings 1996 Analysis of Folsom Obsidian Artifacts from New Mexico. *Current Research in the Pleistocene* 13:59–61.

LeTourneau, P. D., and A. Steffen 2002 Field Investigations at a Likely Source for New Mexico Obsidian Folsom Artifacts. *Current Research in the Pleistocene* 19:57–59.

Meltzer, D. J. 1989 Was Stone Exchanged among Eastern North American Paleoindians? In *Eastern Paleoindian Lithic Resource Use,* ed. by C. J. Ellis and J. C. Lothrop, pp.11–39. Westview Press, Boulder.

Shackley, M. S. 2005 *Obsidian, Geology and Archaeology in the North American Southwest.* University of Arizona Press, Tucson.

——— 2010 The Secondary Distribution of Archaeological Obsidian in the Rio Grande Quaternary Sediments, Jemez Mountains to San Antonito, New Mexico: Inferences for Prehistoric Procurement and the Age of Sediments. Poster presentation, 38th International Symposium on Archaeometry, Tampa, Florida.

Ultrathin Biface at the Adair-Steadman (41FS2) Folsom Campsite/Workshop on the Southern Plains

Stance Hurst and Eileen Johnson

➤ **Keywords:** Folsom, ultrathin bifaces, Southern Plains

Adair-Steadman (41FS2), located on the western Rolling Plains of Texas, was a persistently used place for hunter-gatherer groups to camp and manufacture stone tools from the nearby abundant outcrop of gravels that included large tabular nodules of Edwards Formation chert. Notably, Folsom-age hunter-gatherer groups used the chert outcrop for manufacturing an array of tools including bifaces for projectile points. The sequence of Folsom point manufacture was reconstructed from the large number of manufacturing failures at the site (Tunnell 1977; Tunnell and Johnson 2000).

Stance Hurst and Eileen Johnson, Museum of Texas Tech University, Box 43191, Lubbock TX 79409-3191; e-mails: stance.hurst@ttu.edu eileen.johnson@ttu.edu

An end segment of an ultrathin biface (TTU-A7-45272) was identified during analysis of the Adair-Steadman assemblage. The ultrathin biface, made from Edwards Formation chert, is 58.56 mm long and 73.8 mm wide, with a maximum thickness of 6.81 mm. The thickest part of the biface segment is near the tip; center thickness is 6.1 mm. The minimum width/thickness ratio for this ultrathin fragment ranges between 10.8 and 12.1; inasmuch as this segment is not the widest portion of the biface, the ratio for the unbroken ultrathin biface would have been significantly greater. Large expanding flakes terminating near midline were removed to thin the center and create a bi-plano cross section.

Other ultrathins on the Southern Plains have been documented at 41LU8 (Johnson 2010), Blackwater Draw Locality No. 1 (Boldurian and Cotter 1999:81–82), Gault (Dickens 2005:69), Pavo Real (Collins et al. 2003), Ryan (Hartwell 1995:172–74), Shifting Sands and nearby Wyche Ranch (Hofman et al. 1990; Rose 2011), and as an isolated find (Wyckoff 1996). All currently known documented ultrathins were manufactured from Edwards Formation chert. Their widespread distribution on the Southern Plains suggests they were part of the transportable toolkit. The Westfahl biface was found the farthest from the Edwards Formation, 420km away (Wyckoff 1996). On the Southern High Plains, the 41LU8, Blackwater Draw Locality No. 1, and Ryan ultrathins are located 150–200 km distant, and the Shifting Sands and Wyche Ranch ultrathins were located ca. 100km (Hofman et al. 1990) away. Like Adair-Steadman, the Pavo Real and Gault ultrathins were associated with a workshop located at an Edwards Formation chert outcrop.

The presence of ultrathins at Ryan and Gault suggests ultrathin bifaces also were part of Clovis and Plainview technologies. On the Northwestern Plains, Muniz (2005) documented ultrathins as part of Cody toolkits. Ultrathin technology may not be diagnostic of just the Folsom period and may have been an important specialized tool used throughout Paleoindian times.

The Southern Plains ultrathins complete enough for identification were ovate in shape and bi-plano to biconcave in cross section, with width/thickness ratios of 7.6–19.0. The lowest width/thickness ratio was measured on an ultrathin segment from Pavo Real that likely was an early-stage ultrathin biface (Collins et al. 2003:102). The largest width/thickness ratio was from the ultrathin at Blackwater Draw Locality No. 1 (Boldurian and Cotter 1999:82). The measurements and technological characteristics of ultrathins on the Southern Plains fall within the range of variation for ultrathins defined on the Northern Plains (Root et al. 1999).

Manufacturing ultrathin bifaces likely required a high level of skill similar to fluting Folsom points (Root et al. 1999:141). Workshops such as Adair-Steadman contain a high number of manufacturing failures resulting from start-up problems at the source location. The production of ultrathin bifaces may follow a pattern similar to that for Folsom point production. Folsom points often were manufactured at considerable distances from raw material sources. This pattern suggests a flexible technology in which bifacial cores or flake blanks were used to replenish the supply of Folsom points rather than transport a large number of finished Folsom points (Hofman 1992). Similarly, larger bifacial cores or earlier-stage ultrathin bifaces may have been reduced into ultrathin bifaces when the supply of ultrathins became depleted. At Shifting Sands, ultrathin biface segments may have been recycled into Folsom points and other tool types (Rose, personal communication, 2011) in a similar fashion as found on the Northern Plains (Root et al. 1999).

Folsom lithic technology appears to be centered upon carrying intermediary tool blanks that were themselves used as tools before being converted into projectile points and ultrathins (Hofman 1992). Ultrathin bifaces likely were an important part of the toolkit used for butchering bison (Jodry 1999:204–09) and served as cores if other tool types had become depleted (e.g., Surovell et al. 2003). The impromptu place of manufacture for ultrathin bifaces, similar to that for projectile points, suggests hunter-gatherers during the Folsom period used a highly flexible toolkit to provision themselves with stone tools as needed without being tethered to lithic source locations (Sellet 2004). Future investigations will need to explore the incidence of ultrathins in other Paleoindian toolkits and whether ultrathins are diagnostic of only the Folsom period.

Adair-Steadman research is funded by the Museum of Texas Tech University. Thanks are due to Richard Rose (Midland) for granting access to the Shifting Sands Collections, sharing information, and discussing ideas. This manuscript represents part of the ongoing Lubbock Lake Landmark regional research into grasslands hunter-gatherers and adaptation to ecological change on the Southern Plains.

References Cited

Boldurian, A. and J. Cotter 1999 *Clovis Revisited: New Perspectives on Paleoindian Adaptations from Blackwater Draw, New Mexico.* The University Museum, University of Pennsylvania, Philadelphia.

Collins, M. B., D. B. Hudler and S. L. Black 2003 Pavo Real (41BX52): *A Paleoindian and Archaic Camp and Workshop on the Balcones Escaprment, South-Central Texas.* Studies in Archaeology 41. Texas Archeological Research Laboratory, University of Texas at Austin and Archeological Studies Program. Report 50, Environmental Affairs Division, Texas Department of Transportation, Austin.

Dickens, W. A. 2005 Biface Reduction and Blade Manufacture at the Gault Site (41BL323): A Clovis Occupation in Bell County, Texas. Unpublished Ph.D. dissertation, Department of Anthropology, Texas A&M University, College Station.

Hartwell, W. T. 1995 The Ryan's Site cache: Comparisons to Plainview. *Plains Anthropologist* 40:165–84.

Hofman, J. L. 1992 Recognition and Interpretation of Folsom Technological Variability on the Southern Plains. In *Ice Age Hunters of the Rockies*, edited by D. J. Stanford, pp. 193–224. University of Colorado Press, Boulder.

Hofman, J. L., D. S. Amick and R. O. Rose 1990 Shifting Sands: A Folsom-Midland Assemblage from a Campsite in Western Texas. *Plains Anthropologist* 35:221–53.

Jodry, M. 1999 *Folsom Technological and Socioeconomic Strategies: Views from Stewart's Cattle Guard and the Upper Rio Grande Basin, Colorado.* Unpublished Ph.D. dissertation, College of Arts and Sciences, American University, Washington D.C.

Johnson, E. 2010 Background. In *Jones Station #1 (41LU129), A Multi-Component Rim Site Overlooking Yellowhouse Canyon on the Llano Estacado*, edited by E. Johnson, pp. 23–46, Lubbock Lake Quaternary Research Center Series 17, Lubbock.

Muniz, M. 2005 The Cody Complex Revisited: Landscape Use and Technological Organization on the Northwestern Plains. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Root, M. J., J. D. William, M. Kay and L. K. Shifrin 1999 Folsom Ultrathin Biface and Radial Break Tools in the Knife River Flint Quarry Area. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 144–68. International Monographs in Prehistory, Ann Arbor.

Rose, R. O. 2011 The Shifting Sands Site: A Southern Plains Folsom-Midland Assemblage. *Bulletin of the Texas Archeological Society* 82:299–324.

Sellet, F. 2004 Beyond the Point: Projectile Manufacture and Behavioral Inference. *Journal of Archaeological science* 31:1553–66.

Surovell, T. A., N. M. Waguespack and M. Kornfeld 2003 A Note on the Functions of Folsom Ultrathin Bifaces. *Current Research in the Pleistocene* 20:75–76.

Tunnell, C. 1977 Fluted Projectile Point Production as Revealed by Lithic Specimens from the Adair-Steadman Site in Northwest Texas. In *Paleoindian Lifeways*, edited by E. Johnson, pp. 140–68. Texas Tech University, Lubbock.

Tunnell, C. and L. Johnson 2000 Comparing Dimensions for Folsom Points and their By-Products From Adair-Steadman and Lindenmeier Sites and Other Localities. *Texas Historical Commission Archaeological Reports Series* no. 1.

Wyckoff, D. G. 1996 The Westfahl and Engle Bifaces: Isolated Finds of Large Bifaces on the Southern Plains. *Plains Anthropologist* 41:287–96.

New Late-Pleistocene Lithic Artifacts from the Hiscock Site, Western New York State

Richard S. Laub

➤ **Keywords:** Hiscock site, lithics, fluted biface

Hiscock is a late-Quaternary locality in northern Genesee County, New York (Laub et al. 1988). I describe here Pleistocene lithics excavated at this site subsequent to an earlier report on this topic (Laub 2006).

The proximal portion of a fluted biface (Buffalo Museum of Science catalogue no. C30363; Figure 1A–C) is from an unconformity between the precultural Cobble Layer and the overlying Holocene Woody Layer (Laub 2003; Figure 1D) near the margin of the basin. The fracture surface is flat, and perpendicular to the worked surfaces of the artifact. This surface (Figure 1C) bears two small conchoidal scars with several distinctly smaller ones at the center of one edge, and a narrow rim along the opposite edge. The two lateral and basal edges of the artifact have been ground, suggesting that it had been completely formed before breakage (Lepper 1988, 2002). The specimen, the seventh from this site (see Ellis et al. 2003 and Laub 2006 for the others), was in the same stratigraphic context as C24956, the first fluted biface found at Hiscock, and approximately 7 m distant.

The basal corner of a fluted biface (BMS C30364; Fig. 1 E, F) is from the

Richard S. Laub, Geology Division, Buffalo Museum of Science, Buffalo, NY 14211, and Department of Geology, State University of New York at Buffalo, Buffalo, NY 14260; e-mail: laub@buffalo.edu

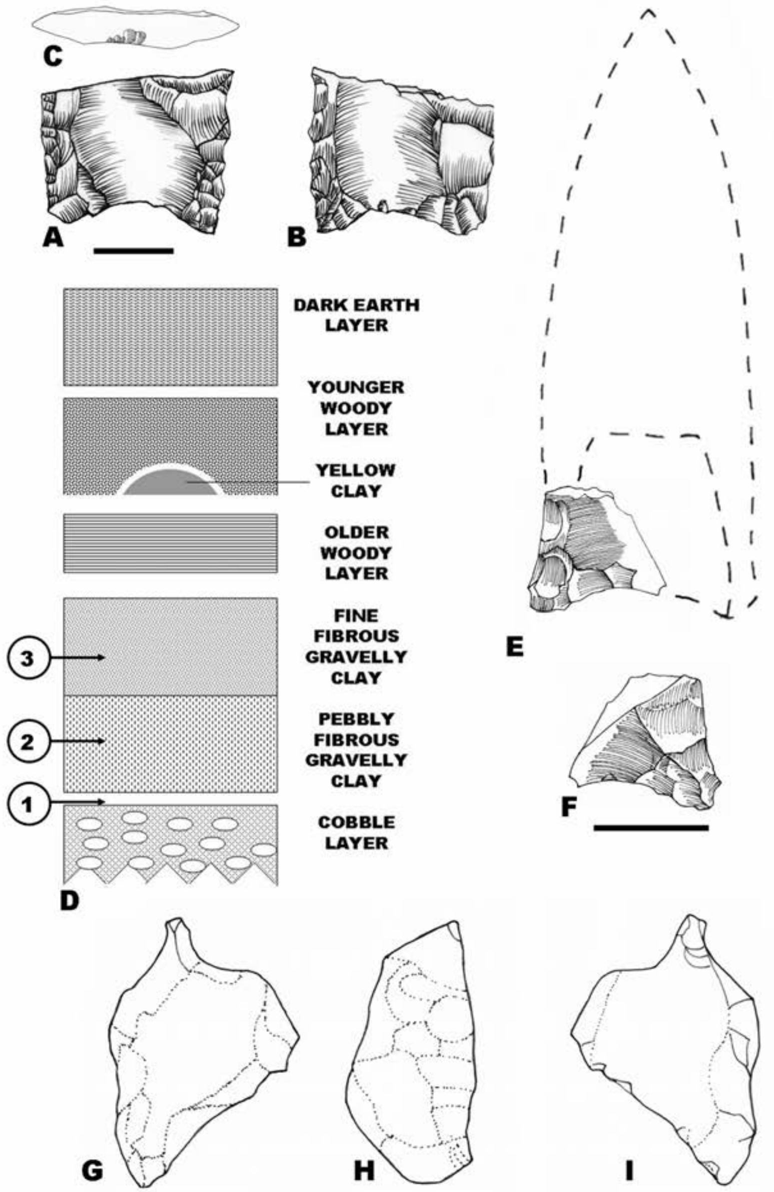


Figure 1. **A-C**, BMS C30363, base of a fluted biface, in lateral (A, B) and distal (C) views. **D**, Generalized stratigraphic column for the Hiscock site. 1, stratigraphic position of C30363; 2, stratigraphic position of C30364; 3, stratigraphic position of C30365. **E-F**, BMS C30364, basal corner of a fluted biface in obverse and reverse views. **G-I**, BMS C30365, a possible graver, in "dorsal," "lateral," and "ventral" views, respectively. Note the prominent narrow projection facing upward. Dotted lines indicate rounded rather than sharp boundaries. All scale bars = 1 cm. Artifact illustrations by William L. Parsons.

pebbly Fibrous Gravelly Clay (Laub 2003), and lay closer to the axis of the basin than the previous specimen. It includes part of the flute scar. Both the lateral and basal edges have been ground. It is not clear if this represents an eighth fluted biface, or if it separated from one of the others known from this site.

A third specimen (BMS C30365; Fig. 1G–I) is a blocky piece of chert from the fine Fibrous Gravelly Clay (Laub 2003) with a small patch of weathering rind. It lay 7 m from the previous specimen, and closer to the basin margin. This specimen bears a prominent narrow projection, suggestive of a graver point, which is based on the broadest surface of the piece and rises steeply to a flat surface that is parallel to the first. The projection is defined by two laterally bounding concavities, one of which is single while the other consists of several smaller concavities. These depressions lack the concentric ripples of typical conchoidal fractures. There is a distinct flat area just above the terminus of the projection. The absence of fine flaking around the prominence leaves a cultural origin questionable.

The fluted biface base and basal corner show no obvious evidence of reworking. They and the putative graver appear to be made of Onondaga chert, the principal lithic source in the vicinity.

The author thanks the following people for their assistance. Leonid I. Shmookler (Ecology and Environment, Lancaster, New York), James M. Adovasio and Allison Byrnes (Mercyhurst Archaeological Institute, Mercyhurst College, Erie, Pennsylvania), John D. Holland (Holland Lithic Laboratory, Buffalo Museum of Science, Buffalo, New York), John D. Holland Jr. (Buffalo, New York), and Bradley T. Lepper (Ohio Historical Society, Columbus) provided helpful and insightful comments. William L. Parsons and Michael R. Grenier (Buffalo Museum of Science) respectively created the artifact drawings and did the graphic layout of the figure. Excavation of the Hiscock site has been carried out by hundreds of volunteers, too numerous to mention, but fully deserving of deep gratitude. The project is supported by individual and corporate contributors through the Buffalo Museum of Science.

References Cited

Ellis, C. J., J. Tomenchuk, and J. D. Holland 2003 Typology, Use and Sourcing of the Late Pleistocene Lithic Artifacts from the Hiscock Site. In *The Hiscock Site: Late Pleistocene and Holocene Paleoecology and Archaeology of Western New York State*, edited by R. S. Laub, pp. 221–37. Bulletin of the Buffalo Society of Natural Sciences 37.

Laub, R. S. 2003 The Hiscock Site: Structure, Stratigraphy and Chronology. In *The Hiscock Site: Late Pleistocene and Holocene Paleoecology and Archaeology of Western New York State*, edited by R. S. Laub, pp. 18–38. Bulletin of the Buffalo Society of Natural Sciences 37.

——— 2006 New Developments Concerning the Pleistocene Component of the Hiscock Site (Western New York State). *Current Research in the Pleistocene* 23:119–21.

Laub, R. S., M. F. DeRemer, C. A. Dufort, and W. L. Parsons 1988 The Hiscock Site: A Rich Late Quaternary Locality in Western New York State. In *Late Pleistocene and Early Holocene Paleoecology and Archeology of the Eastern Great Lakes Region*, edited by R. S. Laub, N. G. Miller, and D. W. Steadman, pp. 67–81. Bulletin of the Buffalo Society of Natural Sciences 33.

Lepper, B. T. 1988 Early Paleo-Indian Foragers of Midcontinental North America. *North American Archaeologist* 9(1):31–51.

——— 2002 Reading Between the Lines: Drawing the Boundaries of Paleoindian Culture Areas in Midcontinental North America. In *The Paleoindian Period in Pennsylvania*, edited by K. Carr and J. Adovasio, pp. 79–89. Pennsylvania Historical and Museum Commission, Harrisburg.

Late-Paleoindian versus Early-Archaic Occupation of Yellowstone Lake, Wyoming

Douglas H. MacDonald, Richard E. Hughes, and Jannifer W. Gish

➤ **Keywords:** Altithermal, lithic technology, Yellowstone

Archaeological data from sites in the Greater Yellowstone Ecosystem (GYE) of Wyoming and Montana indicate that some portions of the region were attractive to early- and middle-Holocene hunter-gatherers. In this paper, we provide new data on a high-elevation early Plains Archaic site, Fishing Bridge Point (48YE381), that suggest land-use patterns contrasting with those of the late-Paleoindian period.

Fishing Bridge Point is located along the northwest shore of Yellowstone Lake, Wyoming, at an elevation of 7,785 ft. amsl, on the S2 lake shoreline dated to the early Holocene (Pierce et al. 2007). This site contained an early-Archaic burn feature within a buried soil on the incipient beach of the lake shore (MacDonald and Livers 2010). Wood charcoal from the feature returned an AMS ^{14}C date of 5910 ± 50 RCYBP (Beta-265310), with a 2-σ calibration of 6860–6640 CALYBP. It is the first early-Archaic feature ever to be excavated in Yellowstone National Park.

Comparing lithic raw-material data from Fishing Bridge Point with earlier late-Paleoindian occupations at the Osprey Beach site (Johnson et al. 2004; Shortt 2003) at Yellowstone Lake suggests dynamic shifts in settlement patterns during the early Holocene. Located only 20 km south of Fishing Bridge Point, Osprey Beach contained significant amounts of chert (46%) from at least six sources and volcanics from another 11 sources (54% of total). In stark contrast, early-Archaic Fishing Bridge Point occupations yielded nearly exclusively obsidian (90%), with 95% of that sourced to Obsidian Cliff. Cashman dacite from southwest Montana was the only other non–Obsidian Cliff source, while 4–6 sources of chert and other materials account for less than 10 percent of the material at the site. Total lithic assemblages analyzed from the two sites are not significantly different (n = 127 from Osprey Beach; n = 90 from Fishing Bridge).

These data suggest that hunter-gatherers at Yellowstone Lake switched from a wide-ranging settlement and/or trade pattern in the late-Paleoindian period (represented by 17 lithic sources) to a constricted, tethered settlement/trade pattern in the early Archaic (using only 6–8 lithic sources, including mostly

Douglas H. MacDonald, Department of Anthropology, the University of Montana, Missoula, MT 59812; e-mail: douglas.macdonald@mso.umt.edu

Richard E. Hughes, Geochemical Research Laboratory, 20 Portola Green Circle, Portola Valley, CA, 94028-7833; e-mail: rehughes@silcon.com

Jannifer W. Gish, JG Research, 5146 Longmeadow Cove, Memphis, TN 38134; e-mail: jgresearch@yahoo.com

Obsidian Cliff). Cannon and Hughes (1995, 1997) made similar observations based on obsidian source-use contrasts at sites also within Yellowstone National Park.

Fossil pollen collected from the early-Archaic levels at Fishing Bridge Point (Gish 2010) indicates the presence of a shrub-grassland at Yellowstone Lake at the time of occupation (elevation 7,750 ft. amsl). Our pollen data corroborate soils data from nearby Dead Indian Pass in the Absaroka Mountains, which indicate substantial grasslands in the pass (elevation 7,900 ft. amsl) approximately 6000 RCYBP (Reider et al. 1988). Apparently, some portions of the high-elevation GYE drew grass-hungry ungulates and human predators during the early-Archaic period.

Lithic and pollen data from the Fishing Bridge Point site at Yellowstone Lake support those from other regional sites, confirming that the Altithermal was a significant climatic event for early- and middle-Holocene hunter-gatherers. After 9000 RCYBP, hunter-gatherers living in the northern Plains and Rocky Mountains moved into areas with reliable and permanent water sources, including river watersheds and lakes, especially those at higher (cooler) elevations such as Yellowstone Lake, Wyoming.

References Cited

Cannon, K. P., and R. E. Hughes 1995 It's Not Just Obsidian Cliff: Diversity of Obsidian Source Use in Yellowstone National Park. Paper presented at the Second Biennial Rocky Mountain Anthropological Conference, Steamboat Springs, Colorado.

——— 1997 Provenance Analysis of Obsidian Paleoindian Projectile Points from Yellowstone National Park, Wyoming. *Current Research in the Pleistocene* 17:101–04.

Gish, J. W. 2010 Pollen Residue from Five Sites in Yellowstone National Park. Paper presented at the 68th Plains Anthropological Society Meeting, Bismarck, North Dakota.

Johnson, A., B. O. K. Reeves, and M. W. Shortt 2004 Osprey Beach: A Cody Complex Camp on Yellowstone Beach Lifeways of Canada, Calgary, Alberta, Canada. Report submitted to Yellowstone National Park, Wyoming.

MacDonald, D. H., and M. C. Livers 2010 Montana Yellowstone Archaeological Project, Survey and Evaluation of Sites along Yellowstone Lake's Northern Shore, Interim Report of the 2009 University of Montana Field Season. Report submitted by The University of Montana to Yellowstone National Park, Mammoth, Wyoming.

Pierce, K. L, K. P.Cannon, G. A. Meyer, M. J. Trebesch, and R. Watts 2007 Post-Glacial Inflation-Deflation Cycles, Tilting, and Faulting in the Yellowstone Caldera Based on Yellowstone Lake Shorelines. In *Recent Contributions to the Geology of Yellowstone*, edited by L. A. Morgan, pp. 131–64. U.S. Geological Survey Professional Paper 1717.

Reider, R. G., G. A. Huckleberry, and G. C. Frison 1988 Soil Evidence for Postglacial Forest-Grassland Fluctuations in the Absaroka Mountains of Northwestern Wyoming, U.S.A. *Arctic and Alpine Research* 20(2):188–98.

Shortt, M. W. 2003 Record of Early People on Yellowstone Lake: Cody Complex Occupation at Osprey Beach. *Yellowstone Science*: 2–9.

Reinvestigation of the Cape Site, an "Early Man" Locality in Western Nebraska

David W. May, Matthew G. Hill, and David J. Rapson

➤ **Keywords:** Geoarchaeology, Paleoindian, Great Plains

The discovery of artifacts associated with the remains of extinct animals at Folsom and Blackwater Draw, New Mexico, in the 1920s and 1930s put archaeologists and vertebrate paleontologists on high alert for similar sites elsewhere on the Great Plains. The Cape site, Morrill County, western Nebraska (Figure 1), was one of numerous suspected "Early Man" sites (Sellards 1952:5) investigated during this period (Barbour and Schultz 1936), several of which figured centrally in establishing the early culture history for the region

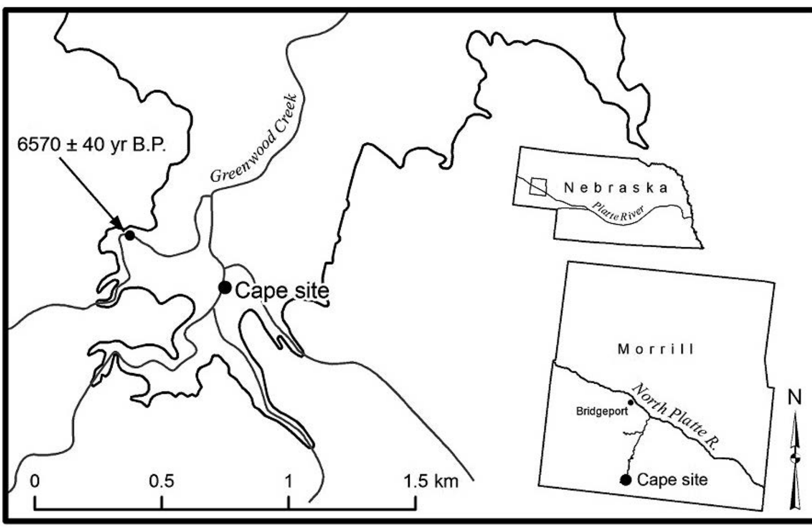


Figure 1. Map of the Cape site along Greenwood Creek, Morrill County, Nebraska.

(Barbour and Schultz 1932a, 1932b). Despite being relatively well published (Bell and Van Royen 1934a, 1934b, 1936), the Cape site was largely ignored in these discussions, presumably because the stratigraphy proved difficult to interpret and no diagnostic artifacts were recovered.

In May of 2010 we relocated the Cape site using the map and site description provided in Bell and Van Royen (1936). It is situated along the northeast bank

David W. May, Department of Geography, University of Northern Iowa, Cedar Falls, IA 50614-0406; email: dave.may@uni.edu

Matthew G. Hill and David J. Rapson, Department of Anthropology, Iowa State University, Ames, IA 50011-1050; emails: mghill@iastate.edu drapson@uwyo.edu

of the lower East Fork of Greenwood Creek, adjacent to a spring. In the original description, the site extends almost to the confluence with the West Fork. Today, the upper two stratigraphic units (B and C) identified by Bell and Van Royen (1936, Figure 2, p. 407) are exposed, as is their "old soil" located at the contact between these stratigraphic units. We found a scatter of bison bone fragments 5–20 cm below the surface of unit B (their "partially cemented sandy silt"), and in the "old soil." Although unit A (more than 3.6 m below the terrace) was not located in this section during the current study, it was identified in a natural cut-bank exposure on the northwest side of the West Fork just upstream of the confluence of the two forks. Here, we found a pocket of charcoal that looked like a burned branch in situ in stratified sand 4.5 m below the modern terrace surface. The charcoal was identified as willow (Tony Zalucha, personal communication, 2010). The AMS conventional radiocarbon age of the charcoal was 6570 ± 40 RCYBP (Beta-280092) or 7560–7420 CALYBP (at 2σ, using IntCal04). This date firmly establishes that the Cape site is not an Early Man site, but represents instead a deposit of probable Archaic age.

We thank Pete Lapaseotos, land owner, for granting us permission to work on his ranch, and Stewart Glass for providing information about springs in the valley. The Department of Geography, University of Northern Iowa, funded the AMS radiocarbon assay.

References Cited

Barbour, E. H., and C. B. Schultz 1932a The Mounted Skeleton of *Bison Occidentalis* and Associated Dart-Points. *Bulletin of the University of Nebraska State Museum* 32(1):354–70.

——— 1932b The Scottsbluff Bison Quarry and Its Artifacts. *Bulletin of the University of Nebraska State Museum* 34(1):283–86.

——— 1936 Palaeontologic and Geologic Consideration of Early Man in Nebraska: With Notice of a New Bone Bed in the Early Pleistocene of Morrill County, Nebraska. *Bulletin of the University of Nebraska State Museum* 45(1):431–49.

Bell, E. H., and W. Van Royen 1934a An Evaluation of Recent Nebraska Finds Sometimes Attributed to the Pleistocene. *The Wisconsin Archeologist* 13(3):49–70.

——— 1934b Studies Relating to the Antiquity of Man in America. *Carnegie Institution of Washington, Yearbook No.* 33:303–05.

——— 1936 Some Considerations Regarding the Possible Age of an Ancient Site in Western Nebraska. In *Chapters in Nebraska Archaeology*, edited by E. H. Bell, pp. 405–19. University of Nebraska Press, Lincoln.

Sellards, E. H. 1952 *Early Man in America: A Study in Prehistory.* University of Texas Press, Austin.

Fluted Points from Pine County, Minnesota: The Neubauer Collection

Stephen L. Mulholland and Susan C. Mulholland

➤ **Keywords:** Clovis, Folsom, Gainey, Holcombe

At present, Pine County has the highest number of reported fluted projectile points in Minnesota with 17 recorded and another one reported but unconfirmed. The majority (16) are in a private collection owned by Joseph Neubauer. Joe collected artifacts from the Snake River drainage in the general area of Pine City for over 80 years, with only a short break for World War II. Another reported point (Higginbottom 1996:46) has not been seen by the authors; a second was reportedly taken to New England as part of a private collection (Neubauer personal communication 2010).

Initial documentation of the Neubauer points included photographs, drawings, and descriptions, but not site locations (Shane n.d.). Recently Joe has allowed additional documentation, including locations of point recovery (Mulholland and Mulholland 2011). Site locations are along the Snake River valley and tributaries in southeastern Pine County. Recoveries are from plowed fields and other surface contexts on private lands. Other collectors also have artifacts from many of the localities. Only initial observations on the early-Paleoindian occupations are offered.

Material types largely indicate a regional origin. Four are Hixton silicified sandstone, whose source is about 275 km to the southeast (Carr and Boszhardt 2010). Three are Prairie du Chien (PDC) chert, found about 105 km to the south at the closest (Klawiter 2001). Two quartz points could be local or from Little Falls, about 135 km west (Mulholland and Mulholland 2010). One each of Knife Lake siltstone (KLS), Biwabik silica, and brecciated Kakabeka chert could be from local till sources deposited by northern glaciers (Mulholland and Klawiter 2009). Only four are as yet unidentified cherts, although two could be PDC and one could be Cochrane chert.

Although classification is difficult with isolated points, the 16 points are tentatively identified to four types: Clovis, Folsom, Gainey, and Holcombe. Clovis and Gainey are differentiated by flute width, depth of basal concavity, and depth of flaking scars as indications of direct and indirect percussion (Morrow and Morrow 2001). Folsom is much easier to identify, even in the Midwest (Morrow and Morrow 1999). Holcombe points are identified by the presence of narrow basal thinning flakes on one or both faces (Justice 1987:24).

Five projectile points are identified as Clovis (Figure 1A), including two of Hixton and one each of PDC chert, quartz, and KLS. Four have flutes on both faces while one is fluted on one side with a prepared nipple on the other. All five have shallow concave bases and relatively narrow flutes.

Stephen L. Mulholland and Susan C. Mulholland, Duluth Archaeology Center, 5910 Fremont St., Suite 1, Duluth, MN 55807; e-mails: archcenter@aol.com archcenter@aol.com

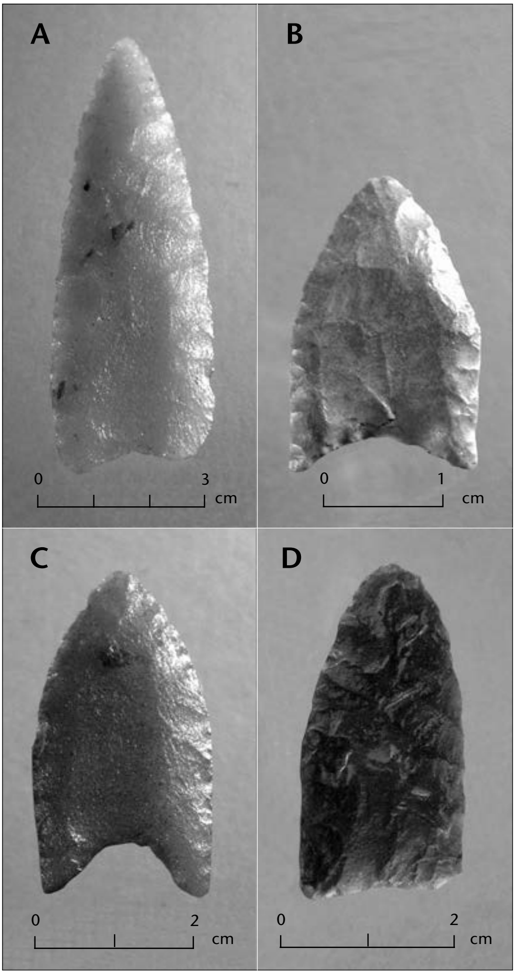


Figure 1. Examples of fluted points from the Neubauer Collection: **A,** Clovis; **B,** Folsom; **C,** Gainey; **D,** Holcombe.

Five projectile points are identified as Folsom (Figure 1B); materials include two of PDC chert, one of Hixton, one possible Cochrane chert, and one unidentified chert. All are fluted on both faces with a broad, distinctive flute. Small pressure flakes are present on the bases. Three of the points are broken.

Three projectile points are identified as Gainey (Figure 1C), including one of Hixton, one of an unidentified chert (possibly PDC), and one of quartz. The Hixton point is heavily resharpened but with a wide flute on both sides and a deeply concave base. The quartz point also has deeply concave base and flutes on both sides. The third artifact is an asymmetrical knife formed from a projectile point; at least one face has a very wide flute.

Three projectile points identified as Holcombe (Figure 1D) include Biwabik silica, brecciated Kakabeka chert, and an unidentified chert (possibly PDC). One point has a flute on one side and basal thinning flakes on the other; the other two have basal thinning flakes on each side. All are heavily resharpened; one lacks the tip.

The greatest concentration of recorded fluted projectile points in Minnesota has been the Neubauer collection in Pine County; the 10 (of 11) points recorded in the mid 1990s (Higginbottom 1996:36–45) are expanded in the present study to 16 (of 18). In addition, several (five) broken point bases with possible flutes or basal thinning flakes require further study to determine affiliation. The Snake River valley in the vicinity of Pine City is in the opening for an ice-free area early in the deglaciation of central Minnesota (Mulholland et al. 1997). This geographic situation may explain the concentration of early-Paleoindian projectile points and suggests that east-central Minnesota, as well as southwestern and southeastern areas, could be inhabited early in the late Pleistocene.

Grateful acknowledgment is given to Joseph Neubauer, Sr. for providing access to his collection. Special thanks to Anthony Romano for identification of the brecciated Kakabeka chert point and calling the prevalence of fluted points in the Pine City area to our attention. David Peterson and Larry Furo significantly assisted in the documentation project. Access to the unpublished Shane papers at the Science Museum of Minnesota was provided by Ed Fleming. Dan Wendt suggested the Cochrane chert identification.

References Cited

Carr, D. H., and R. F. Boszhardt 2010 Silver Mound, Wisconsin: Source of Hixton Silicified Sandstone. *Midcontinental Journal of Archaeology* 35(1):5–36.

Higginbottom, D. K. 1996 An Inventory of Fluted Projectile Points from Minnesota. Paper and draft report presented at the 54th Annual Plains Anthropological Conference, Iowa City.

Justice, N. D. 1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States.* Indiana University Press, Bloomington.

Klawiter, B. N. 2001 Geochemical-Geoarchaeological Provenance of Prairie du Chien Chert. *The Minnesota Archaeologist* 60:119–30.

Morrow, T. A., and J. E. Morrow 1999 On the Fringe: Folsom Points and Preforms in Iowa. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. A. Amick, pp. 65–81. International Monographs in Prehistory, Archaeological Series 12, Ann Arbor.

Morrow, J. E., and T. A. Morrow 2001 Exploring the Clovis-Gainey-Folsom Continuum: Technological and Morphological Variation in Midwestern Fluted Points. In *Folsom Technology and Lifeways*, edited by J. E. Clark and M. B. Collins, pp. 141–57. Special Publication No. 4 of Lithic Technology, University of Tulsa, Tulsa.

Mulholland, S. L., and B. N. Klawiter 2009 The Lithic Resources of Northeastern Minnesota. *The Minnesota Archaeologist* 68:51–70.

Mulholland, S. C., and S. L. Mulholland 2011 The Fluted Points of Pine City: Reexamination of the Neubauer Collection. Paper presented at the Council for Minnesota Archaeology symposium, Inver Grove Heights.

——— 2010 Two Quartz Fluted Points from Pine County, Minnesota. *Current Research in the Pleistocene* 27:140–42.

Mulholland, S. C., S. L. Mulholland, G. R. Peters, J. K. Huber, and H. D. Mooers 1997 Paleo-Indian Occupations in Northeastern Minnesota: How Early? *North American Archaeologist* 18:371–400.

Shane, O. C., III n.d. Unpublished descriptions of Minnesota fluted points, documents stored in the Science Museum of Minnesota, St. Paul.

The Third Lake Cache, St. Louis County, Minnesota

Susan C. Mulholland, Christopher L. Hill, and Stephen L. Mulholland

➤ **Keywords:** Jasper taconite, Kakabeka chert, Minnesota

In 1982, a lithic assemblage containing bifaces and debitage was discovered between Third Lake and the Cloquet River east of Independence in St. Louis County, Minnesota. This region contains Independence till (combined Rainy lobe and St. Croix phase, Superior lobe); outwash (Alborn phase, St. Louis sublobe) is in the Cloquet River valley, and Highland moraine deposits (Automba phase, Superior lobe) are immediately to the south (Hill 2007; Lehr and Hobbs 1992). The artifacts were exposed in a shallow subsurface context by loggers bulldozing a haul road for a logging operation. The loggers collected some artifacts and notified the Minnesota Power land owners; limited field investigations conducted by personnel from the University of Minnesota Duluth (UMD) Archaeometry Laboratory included one author (CLH). In 1998, the portion of the collection in the possession of David Johnson, Jr., was photographed by one author (SLM). The cache has not been reported in detail, although it is briefly cited as the Third "River" site (Harrison et al. 1995:15, 21; Mulholland and Klawiter 2009:61).

Reportedly, only the "most interesting" artifacts were originally collected; "numerous smaller pieces" were discarded into the nearby woods. At present, only the Johnson, Jr., collection (38 artifacts) has been photographed in detail; 14 artifacts from the later investigation, presently in UMD curation, were briefly reviewed. Efforts are underway to locate the materials still in the possession of the original collectors for a more detailed study; the present review indicates two findings.

The lithic assemblage consists of two types of raw material, jasper taconite and Kakabeka Falls chert. Both materials are commonly found in this region of northeastern Minnesota and adjacent Ontario near Lake Superior (Mulholland and Klawiter 2009). However, the quality represented in this assemblage is quite remarkable. Both types are especially high-grade materials, with extremely high silica content and no noticeable flaws or imperfections. Overall, the amount and quality of both lithic types greatly exceeds that seen by one author (SLM) in any other collection from northeastern Minnesota. In general, jasper taconite pieces often exhibit flaws, particularly those recovered from till sources.

The range of artifact sizes and stages of manufacture is also interesting. No

Susan C. Mulholland and Stephen L. Mulholland, Duluth Archaeology Center, 5910 Fremont St., Suite 1, Duluth, MN 55807; e-mails: archcenter@aol.com archcenter@aol.com

Christopher L. Hill, Director, Environmental Studies Program, 1910 University Drive, Boise State University, Boise, ID 83725-2950; e-mail: chill2@boisestate.edu

finished tools were observed in the Johnson collection, and no projectile points were mentioned from the assemblage as a whole. The larger artifacts range from rough bifacially flaked items to more finished blanks and preforms. The smaller artifacts discarded by the original collectors probably included a variety of debitage, although small tools such as scrapers may not have been recognized. A larger piece, possibly a core, was photographed at the time of discovery but was not seen in the 1998 study.

Large jasper taconite bifaces in northeastern Minnesota tend to be Paleoindian rather than Archaic or later. Large Kakabeka chert bifaces are anomalous, not being common in any tradition. In addition, Paleoindian assemblages are characterized by high (over 90%) amounts of single or closely related material types (Bakken and Mather 1999; Mulholland 2002:94). The number of large bifaces from two high-quality lithic types strongly suggests a Paleoindian affiliation for this assemblage.

The site can be considered in terms of caching behavior. Seven late-Paleoindian caches from the western Great Lakes were classified into two categories (Carr and Boszhardt 2003:232). Ceremonial caches have broken points (heat fractured) of lithic materials from sources a long distance from the cache. Functional caches have mostly intact bifaces and are in closer proximity to the source of the materials. The bifaces are also less finished and, although attributed to specific complexes, do not include definitive projectile points. The Third Lake assemblage is most similar to functional caches, although caches can also represent other activities (Chandler 2001).

The Third Lake assemblage requires additional analysis to determine if the technology warrants attribution to the Paleoindian period. Review of more artifacts would strengthen the study; the photographs and materials in hand include only 52 pieces. Reported discard of small artifacts created a bias in the sample toward larger bifaces. However, this cache is important; few have been reported in Minnesota (Largent 2007), and the extremely high quality of the lithic materials is unique in northeastern Minnesota. Additional research will add to the knowledge of Paleoindian caching behavior in this region.

Grateful acknowledgment is given to David Johnson, Jr. for providing access to his collection. Thomas Houghtaling and Matt Radzak from Minnesota Power provided information on the original timber sale and logging company. Special thanks are given to Dr. Mark Muniz for calling the Kriesel cache article to our attention.

References Cited

Bakken, K., and D. Mather 1999 The Archaic Tradition at the Southern Mille Lacs Locality. Paper presented at the Archaic Tradition symposium, Council for Minnesota Archaeology, St. Paul.

Carr, D. H., and R. F. Boszhardt 2003 The Kriesel Cache: A Late Paleoindian Biface Cache from Western Wisconsin. *Plains Anthropologist* 47(187):225–35.

Chandler, J. M. 2001 Lithic Caches: The Puzzling Legacy from Early Knappers. *Mammoth Trumpet* 17(1):4–9.

Harrison, C., E. Redepenning, C. L. Hill, G. Rapp, Jr., S. E. Aschenbrenner, J. K. Huber, and S. C. Mulholland 1995 *The Paleo-Indian of Southern St. Louis Co., Minnesota: The Reservoir Lakes Complex.* Kendall-Hunt Publishing Company, Dubuque.

Hill, C. L. 2007 Geoarchaeological and Late Glacial Landscapes in the Western Lake Superior region, Central North America. *Geoarchaeology* 22(1):15–47.

Largent, F. 2007 Snapshots in Time: New Insights from Clovis Lithic Caches. *Mammoth Trumpet* 22(2):13–15.

Lehr, J.D., and H. C. Hobbs 1992 Glacial Geology of the Laurentian Divide Area, St. Louis and Lake Counties, Minnesota. In *Field Trip Guidebook for the Glacial Geology of the Laurentian Divide Area, St. Louis and Lake Counties*, edited by J. D. Lehr and H. C. Hobbs, pp. 1–54. Guidebook Series No. 18, Minnesota Geological Survey, St. Paul.

Mulholland, S. L. 2002 Paleo-Indian Lithic Resource Utilization in Northeastern Minnesota. Unpublished M.S. thesis, University of Minnesota, Minneapolis.

Mulholland, S. L., and B. N. Klawiter 2009 The Lithic Resources of Northeastern Minnesota. *The Minnesota Archaeologist* 68:51–70.

The Burgess-Mabrey Site: 40JK267, Jackson County, Tennessee

Mark R. Norton, John B. Broster, Dennis Burgess, and Larry Mabrey

➤ **Keywords:** Clovis, Cumberland, Southeast

The Burgess-Mabrey site (40JK267) is located on the Cumberland River in Jackson County, Tennessee, in the eastern Central Basin physiographic province at the contact with the Eastern Highland Rim physiographic province. The site is situated on a terrace above the relic channel of the river and adjacent to a tributary. High-quality Fort Payne and Bigby-Cannon chert cobbles and nodules are associated with the Mississippian and Ordovician limestone formations located here.

Prior to the completion of the Cordell Hull dam in 1973, this terrace was in agricultural use. It was during the 1960s that Mr. Mabrey began finding stone tools here while cultivating the terrace. Since the completion of the dam this landform is seasonally inundated by Cordell Hull Lake and is now managed by the U. S. Army Corps of Engineers.

Avocational archaeologists Dennis Burgess and Larry Mabrey informed the Division of Archaeology of this site upon recognizing the significant numbers of Paleoindian projectile points and tools within this artifact assemblage. Paleoindian projectile points including Cumberland, Clovis, Beaver Lake, and Quad have been recorded (Figure 1). Other Paleoindian artifacts include fluted biface preforms, blade cores, blades, unifacial blade tools, and overshot flakes.

The relatively low number of formal unifacial blade tools here leads us to

Mark Norton, John Broster, Dennis Burgess, andLarry Mabrey, Tennessee Division of Archaeology, 1216 Foster Ave, Cole Building #3, Nashville, TN 37243; e-mail: Mark.Norton@tn.gov john.broster@tn.gov

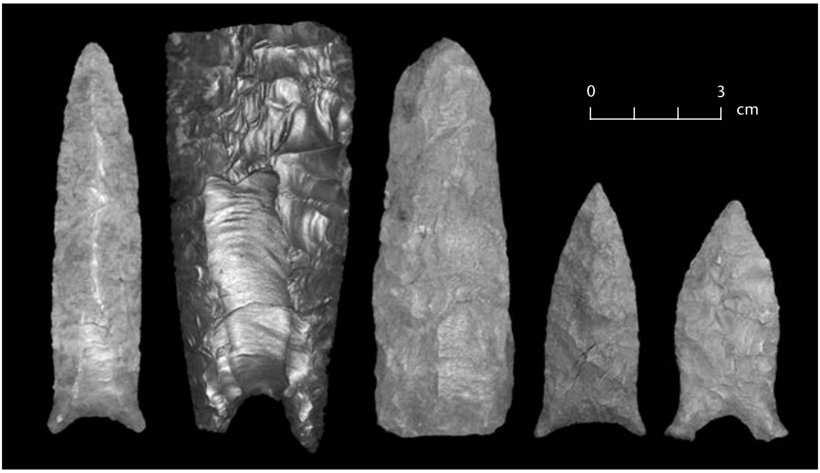


Figure 1. Projectile points from Burgess-Mabrey site: **A,** Cumberland; **B–C,** Clovis; **D,** Beaver Lake; **E,** Quad.

conclude this site may represent short-term Paleoamerican encampments associated with chert procurement. A similar artifact assemblage although larger in scale was recognized at the Sinclair site (40WY111), a Clovis quarry in Wayne County, Tennessee (Broster and Norton 2009). These short-term encampments differ from larger base camps, or staging areas (Anderson 1990:187–196) such as the Carson-Conn-Short site (40BN190), in Benton County, Tennessee, by having fewer numbers and varieties of unifacial blade tools (Broster and Norton 1993). We think the lower unifacial tool counts may indicate that fewer numbers of individuals were involved in trips to procure chert, which possibly were coupled with other tasks such as hunting forays. The primary focus of activity at these quarry locations is selecting raw material and reducing cobbles or nodules. The majority of the newly acquired bifaces and blades were packed and transported back to base camp for final tooling. Given the extent of the chert resources in the region, we think Burgess-Mabrey represents one of many short-term Paleoamerican camps associated with procuring chert. Test excavations are planned for the upper portion of this terrace, which is above the summer pool level of the lake, and within the site boundaries as described from the 1960s.

References Cited

Anderson, D. G. 1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. In *Early Paleoindian Economies of Eastern North America*, edited by K. Tankersley and B. Isaac, pp. 163–216. Research in Economic Anthropology Supplement 5.

Broster, J. B., and M. R. Norton 1993 The Carson-Conn-Short Site (40BN190): An Extensive Clovis Habitation in Benton County, Tennessee. *Current Research in the Pleistocene* 10:3–5.

——— 2009 The Sinclair Site (40WY111): A Clovis Quarry along the Buffalo River in Wayne County, Tennessee. *Current Research in the Pleistocene* 26:35–36.

New Fluted Artifact Finds at the Sheep Mountain Site (35HA3667), Harney County, Oregon

Patrick O'Grady, Michael F. Rondeau, and Scott P. Thomas

➤ **Keywords:** Fluting technology, obsidian studies, Oregon

The initial discovery of two fluted points at the Sheep Mountain site in the northern Great Basin of southeastern Oregon (O'Grady et al 2009; Rondeau 2007, 2008) prompted University of Oregon field school excavations there over the last three years. The majority of formed tools are stemmed points, but the fluted artifact inventory increases as field work continues. Most are surface recoveries. The four artifacts here reported include a fluted-point fragment, two fluted bifaces, and a biface that has been shaped in a manner consistent with fluted-point lithic reduction techniques. Sheep Mountain is a 5.5-acre site occupying a shallow basin overlooking Wagontire Valley. Sedimentary deposits range in depth from 2 to 6 m, and Mazama O tephra (Foit 2008) provides a site-wide buried time marker.

A large fluted biface fragment (BSQ-10-1 [Figure 1A]) was collected at nearby Big Stick Quarry. Located 3 km east of the Sheep Mountain site, its distinctly gray-banded obsidian has been shown by geochemical sourcing and visual characteristics to be a prominent variety at the site. Surveys in 2010 led to the recovery of this artifact. Geochemical sourcing confirmed its Big Stick origin, with a hydration band measurement of 5.6 µm (Skinner and Thatcher 2010b).

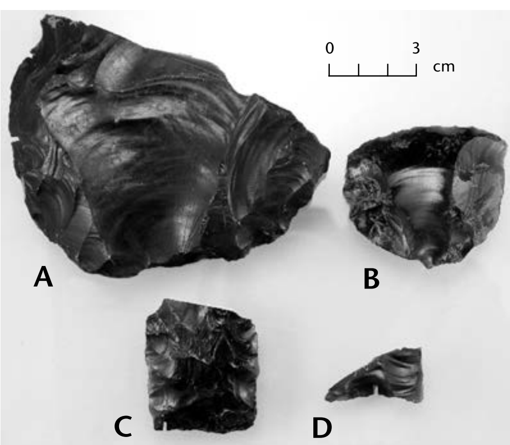


Figure 1. Artifacts described in the text: **A,** BSQ-10-1; **B,** 3667-09-6-B-5-2; **C,** 3667-10T-2; **D,** 3667-CL-3).

Patrick O'Grady (541-346-0671) University of Oregon Museum of Natural and Cultural History, 1224 University of Oregon, Eugene, OR, 97403-1224; email: pogrady@uoregon.edu

Michael Rondeau (916-419-5698) Rondeau Archaeological, 251 Rockmont Circle, Sacramento, CA 95835; email: mikerondo@yahoo.com

Scott P. Thomas (541-573-4434) Burns District Bureau of Land Management, 28910 Highway 20 West, Hines, OR, 97738; email: Scott_Thomas@blm.gov

The large biface is 82.56 mm long, 111.21 mm across, 18.0 mm wide, and weighs 198 grams. Rondeau (2010a), observing that flute removal on both faces led to a bi-concave basal cross section, attributes the transverse break to an internal flaw. Platform grinding and microflake removal adjusted the direction of flute removal, and pressure flakes on both faces are truncated by the flutes.

Specimen 3667-09-6-B-5-2 (Figure 1B) is a fluted base fragment that has been reshaped into a unifacial scraper. The artifact was recovered from level 5 of Excavation Unit 2 at Sheep Mountain, underlying Mazama O tephra. It is 47.07 mm long, 57.75 mm wide, 12.78 mm thick, and weighs 36.2 grams. It is fluted on one face, and several pressure flakes are truncated by the flute. The opposite face has percussion scar remnants that establish the beveled fluting platform for removal of the flute flake (Rondeau 2010b). It is made of Buck Springs obsidian. Hydration cuts in both the fluting flake scar and the distal scraping edge produced measurements of 8.9 μm. It is the first fluted artifact to be found in a buried context at Sheep Mountain. Two stemmed points and the ear of a possible Black Rock Concave Base point (Rondeau 2010a:12) were recovered below the Mazama tephra within 5 m of this fluted base. Specimen 3667-CL-1, a complete fluted point (O'Grady et al. 2009; Rondeau 2007), was surface collected less than 10 m away.

Specimen 3667-10T-2 (Figure 1C) is an end-thinned biface fragment collected from the surface of the Sheep Mountain site, with evidence of failed flute preparation in the form of two pronounced basal scars (Rondeau 2010a:12). Other characteristics are consistent with fluted-point preparation, including pressure edge retouch beveling on both faces of the proximal margin, overface flake scars, and a center ridge exhibiting ridge set-up scars on either side. Breakage occurred as the result of a twisting fracture. The biface is made of obsidian from the Glass Buttes 6 source, with a hydration measurement of 7.6 μm (Skinner and Thatcher 2010b).

Specimen 3667-CL-3 (Figure 1D) is a fluted-point base made of Tank Creek obsidian with a hydration rim measurement of 7.6 μm (Skinner and Thatcher 2010a). It was a surface find on the east side of the site, in the same general vicinity as the previously recovered fluted points. It is 19.35 mm long, 34.43 mm wide, 6.52 mm thick, and weighs 3.2 grams. Damage to the point is attributed to a transverse bending fracture (Rondeau 2010a), and the base is missing one ear. Edge grinding is not evident on the base, and the lateral margins are too damaged to reveal such evidence. Single flute scars are present on both faces, and the basal cross section is bi-concave. Pressure and percussion flake scars on one side have been truncated by the flute.

Three seasons of field investigations and two previous surveys led to the recovery of six artifacts that bear evidence of fluting or technological approaches associated with the practice. Such finds, and results from previous archaeological and geomorphological explorations provide guidelines for continuing work at the site.

References Cited

Foit, F. F. 2008 Letter Report to William Lyons Regarding Sheep Mountain Tephra Sample. Washington State University School of Earth and Environmental Sciences, Pullman.

O'Grady, P., S. P. Thomas, and M. F. Rondeau 2009 Recent Fluted Point Finds in Eastern Oregon. *Current Research in the Pleistocene* 26:100–02.

Rondeau, M. F. 2007 Fluted Points and Bifaces from the Burns District, Bureau of Land Management, Oregon. *CalFLUTED Research Report* 43, Rondeau Archaeological, Sacramento.

——— 2008 Research on Eight Additional Bifaces from the Burns District, Bureau of Land Management, Hines, Oregon. *CalFLUTED Research Report* 53, Rondeau Archaeological, Sacramento.

——— 2010a Eight Early Bifaces from the Burns BLM District, Harney County, Oregon. *CalFLUTED Research Report* 79, Rondeau Archaeological, Sacramento.

——— 2010b An Unfinished Fluted Biface from the Sheep Mountain Site, 35HA3667, Burns BLM District, Harney County, Oregon. *CalFLUTED Research Report* 77, Rondeau Archaeological, Sacramento.

Skinner, C. E., and J. J. Thatcher 2010a Northwest Research Obsidian Studies Laboratory Report 2010-99. On file at the Burns District BLM Office, Hines, OR.

——— 2010b Northwest Research Obsidian Studies Laboratory Report 2010-128. On file at the Burns District BLM Office, Hines, OR.

Clovis in Southeast Idaho's Teton Valley

Bonnie L. Pitblado and Benjamin Fowler

➤ **Keywords**: Clovis, southeast Idaho, New World settlement

In summer 2010, Utah State University (USU) archaeologists recorded three Clovis sites in the Teton Valley, southeastern Idaho (Figure 1). The sites are located within 4 km of each other on the western margin of the Teton Valley at elevations ca. 1830 m asl, and they occupy the same low terrace of the Teton River in what are now plowed fields. We have temporarily designated them the LH1, TH1, and LP1 Clovis sites.

The LH1 site came to our attention in spring 2010, thanks to a private citizen who found an artifact while picking potatoes decades ago on her family's farm near Driggs, ID. The tool, a Clovis preform, had been transferred intact in a clod of dirt onto the inspection conveyor belt along with the potatoes she was sorting. The preform's raw material is a butterscotch-colored volcanic rock unusual for the area. Its pristine condition and provenience suggest it may once have been part of a cache.

The LH1 preform led us to the Teton Valley in July 2010 where, with the help of the artifact's owner, we documented its locality in general terms. However, the property had changed hands, and the new owners were unavailable to grant access to the precise spot where the preform emerged from the ground. Thus, for the moment, we must view it as an isolated occurrence that may or may not have been part of a cache or other Clovis site.

During our reconnaissance, two more Teton Valley landowners alerted us to the LP1 and TH1 sites and granted us permission to survey and record them.

Bonnie L. Pitblado and Benjamin Fowler, Anthropology Program, Utah State University, Logan, UT 84322; e-mails: bonnie.pitblado@usu.edu b.fowler@aggiemail.usu.edu

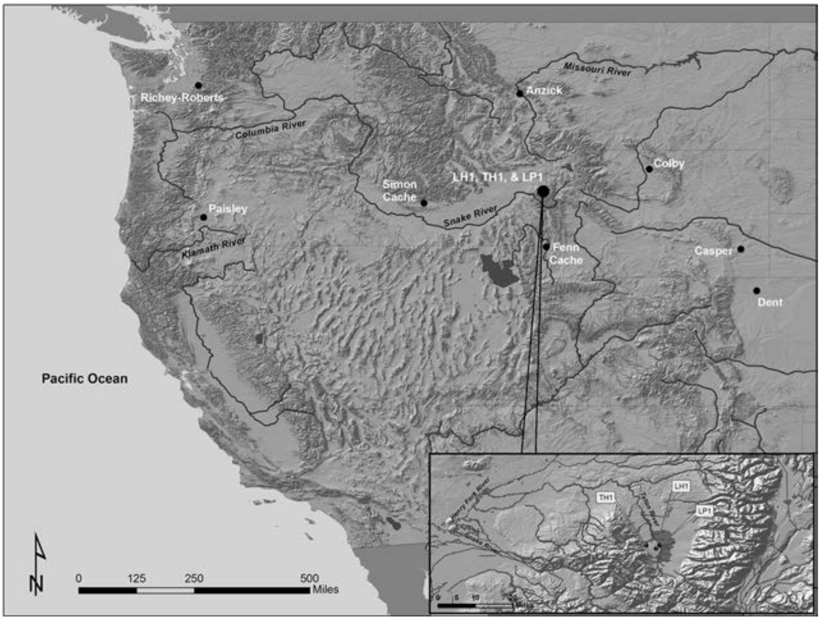


Figure 1. Map showing the location of Teton Valley Clovis sites (inset) and other well-known Clovis and peopling-related sites in the western United States. Note that the Teton Valley could have been readily accessed by Clovis people moving west from the Plains or east using the Snake River Plain as a travel corridor. Note also the well-documented Clovis cache sites located north, south and west, respectively, of the Teton Clovis localities.

The LP1 site produced four Clovis bifaces in various stages of manufacture, including an obsidian preform. The TH1 site yielded two complete Clovis points (one of burnt chert found in two pieces at different times, and one of unfinished obsidian), an unfinished obsidian Clovis point midsection, an early-stage Clovis biface, mastodon long-bone fragments, and numerous flakes. All the TH1 site material had been churned up during a year of deep plowing in a 100-by-100-m area.

Future work at these Teton Valley Clovis sites will include survey of the LH1 site and tests to determine if intact buried material remains at any of them. The sites support Kornfeld et al.'s (2010:73) contention that the Rocky Mountains "teem" with Clovis finds, although the TH1 site's apparent mastodon kill/processing focus expands a sparse database of megafaunal-human associated sites in the Rockies. The sites' locations may speak to the directionality of Clovis settlement of the New World, whether west to east, east to west, or via some other trajectory (e.g., Anderson and Gillam 2000, Beck and Jones 2010, Pitblado 2011) (Figure 1).

Thanks so much to the three private landowners lucky enough to find Clovis artifacts on their property and generous enough to share their finds and insights with USU archaeologists. Additional thanks to the citizens of the Teton Valley who attended USU's July 2010 "Artifact Road Show" in Victor, ID and showed great interest in our Paleoindian pursuits—and in many cases significantly furthered them. We are grateful to the USU students and others who helped document the Teton

Valley Clovis sites and who organized and staffed the Victor "Road Show": Holly Andrew, Wes Andrew, Alex Hildreth, Jason Patten, Ashley Smith, and Andrew Straup. We thank Molly Cannon and Holly Andrew for their help drafting Figure 1 and as always, Richard and Joyce Shipley for their ongoing support of USU's efforts to understand Paleoamerican occupation of southeastern Idaho and northern Utah.

References Cited

Anderson, D. G., and J. C. Gillam 2000 Paleoindian Colonization of the Americas: Implications from an Examination of Physiography, Demography, and Artifact Distribution. *American Antiquity* 65:43–66.

Beck, C., and G. T. Jones 2010 Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* 75:81–116.

Kornfeld, M., G. C. Frison, and M. L. Larson 2010 *Prehistoric Hunter-Gatherers of the High Plains and Rockies* (3rd edition). Left Coast Press, Walnut Creek, CA.

Pitblado, B. L. 2011 A Tale of Two Migrations: Reconciling Biological and Archaeological Evidence for the Pleistocene Peopling of the Americas. *Journal of Archaeological Research* 19(4):327–75.

The Mead Site, a Late-Pleistocene/Holocene Stratified Site in Central Alaska

Ben A. Potter, Phoebe J. Gilbert, Charles E. Holmes, and Barbara A. Crass

➤ **Keywords**: Paleoeconomy, site structure, late Pleistocene, eastern Beringia

Excavations at Broken Mammoth and Swan Point in central Alaska have revealed late-Pleistocene records that share some similarities, but reveal significant differences in assemblage variability (Holmes 2001; Yesner 2001; see review in Hoffecker and Elias 2007). The Mead site has often been linked with both of these sites in various contexts, but it has received relatively limited testing. We present here initial analyses on the earliest two components (Cultural Zones [CZ] 3 and 4) derived from 2009 excavations, totaling 54 m^2.

Mead is located on a 10-m-high bedrock upland overlooking Shaw Creek flats, in the mid Tanana River basin. Stratigraphy and radiocarbon dating indicate five occupations (Figure 1). There is moderate cryoturbation in the upper 50 cm of loess (OAB), but little evidence of post-depositional disturbance in the lower paleosols associated with CZ3 and CZ4.

Cultural Zone 3 includes 2 hearths with contemporaneous dates (12,300–11,700 CALYBP), 238 flakes, a microblade, 2 large modified flakes, and an ivory fragment. Faunal remains include avian, rodent, and bison. The overall simi-

Ben A. Potter, Phoebe J. Gilbert, and Charles E. Holmes, Department of Anthropology, University of Alaska Fairbanks. 310 Eielson Bldg., Fairbanks, AK 99775; email: bapotter@alaska.edu

Barbara A. Crass, Department of Anthropology, University of Wisconsin, Oshkosh.

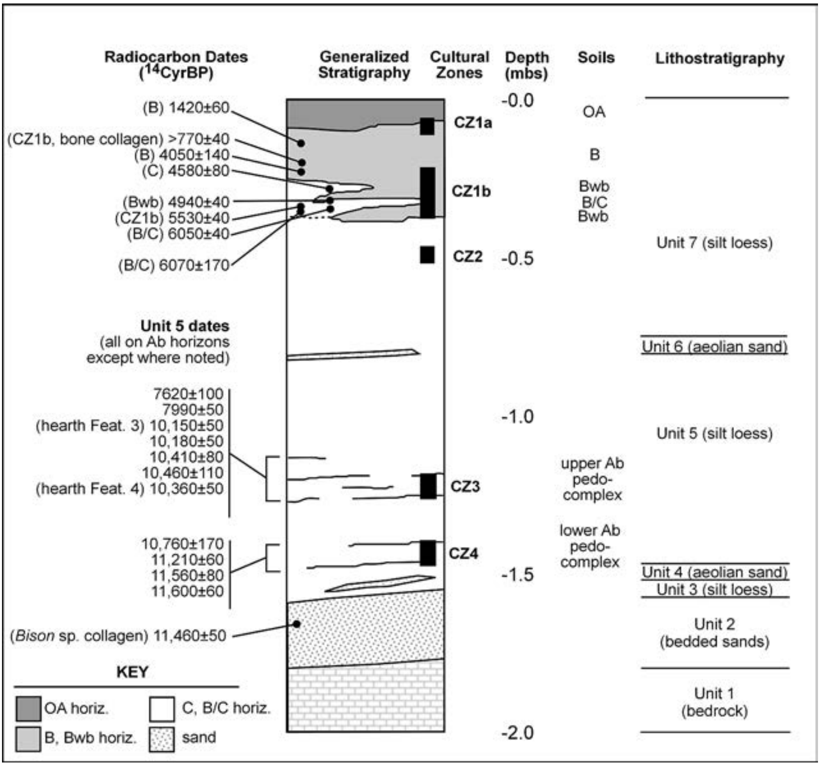


Figure 1. Mead site generalized stratigraphy and dating.

larities of the faunal assemblage associated with hearth features and expedient lithic artifacts suggests similarities with Broken Mammoth (Krasinski 2005) and Gerstle River hearths 9 and 13 (Potter 2005, 2007).

Cultural Zone 4 cultural materials, stratigraphically dated to ~13,500–13,100 CALYBP, include 323 flakes and a lithic tool, a modified flake with burin damage. Preliminary faunal identification indicates waterfowl, wapiti, and bison, and ivory fragments. A number of activity areas have been identified, including: (1) a very dense cluster of locally available quartz flakes, similar to concentrations found at Broken Mammoth; (2) a cluster of bone fragments, primarily large ungulates with few lithics.

The faunal assemblages of CZ3 and CZ4 are relatively similar. They are highly fragmented; no elements are complete, and few are identifiable. No articulation was present. The remains are relatively dispersed; some concentrations are associated with features, and others are not. These patterns resemble later-stage Gerstle River processing (i.e., dominated by secondary processing and marrow extraction (Potter 2007)). These data suggest diverse subsistence economies (exploitation of large ungulates as well as small mammals and waterfowl). CZ4 is characterized by diffuse lithic and bone scatters punctuated by spatially limited activity areas, suggestive of intermittent short-term occupations. CZ3 data match expectations for spike camps where game was processed on site (Potter 2007).

Both CZ3 and CZ4 contain obsidian, which, added to the obsidian at Broken Mammoth CZ4 and Swan Point CZ4 (Holmes 2001), suggests that long-distance trading and/or high levels of mobility were present in these earliest populations. In terms of lithic variability, the initial Mead CZ4 data correspond more closely to largely expedient assemblage at Broken Mammoth than to the older microblade- and burin-dominated assemblage at Swan Point.

Funding was provided by UAF and Denali—The Alaska Gas Pipeline, LLC.

References Cited

Hoffecker, J. F., and S. A. Elias 2007 *Human ecology of Beringia.* Columbia University Press, New York.

Holmes, C. E. 2001 Tanana River Valley Archaeology Circa 14,000 to 9000 BP. *Arctic Anthropology* 38(2):154–70.

Krasinski, K. E. 2005 Intrasite Spatial Analysis of Late Pleistocene/Early Holocene Archaeological Material from the Broken Mammoth Site. M.A. thesis, University of Alaska, Anchorage.

Potter, B. A. 2005 Site Structure and Organization in Central Alaska: Archaeological Investigations at Gerstle River. Ph.D. dissertation, University of Alaska Fairbanks, Fairbanks. University Microfilms, Ann Arbor.

——— 2007 Models of Faunal Processing and Economy in Early Holocene Interior Alaska. *Environmental Archaeology* 12:3-23.

Yesner, D. R. 2001 Human Dispersal into Interior Alaska: Antecedent Conditions, Mode of Colonization, and Adaptation. *Quaternary Science Reviews* 20(1-3):315–27.

Linda's Point: Results from a New Terminal-Pleistocene Human Occupation at Healy Lake, Alaska

Robert A. Sattler, Thomas E. Gillispie, Norman A. Easton, and Michael Grooms

➤ **Keywords:** Healy Lake Chindadn, Younger Dryas, Beringian archaeology

The Tanana Valley contains the largest concentration of late-Pleistocene archaeological sites in eastern Beringia (Potter 2008). Among these is the

Robert A. Sattler and Thomas E. Gillispie, Natural and Cultural Resources, Tanana Chiefs Conference, 122 First Avenue, Suite 600, Fairbanks, AK 99701; e-mails: rsattler@tananachiefs.org tom.gillispie@tananachiefs.org

Norman Alexander Easton, School of Liberal Arts, Yukon College, 500 College Drive, Whitehorse, YT, Canada; e-mail: northeaston@gmail.com.

Michael Grooms, Department of Anthropology, University of New Mexico, Albuquerque, NM; e-mail: mgrooms@unm.com.

Healy Lake Village site, the first in Alaska to produce artifacts associated with dates greater than 13,000 CALYBP, and the type-site for the Chindadn Complex (Cook 1969, 1996). Cook regards Chindadn as a single component, loosely constrained between 9200 and 13,300 CALYBP. Discordant dates and uncertain relationships between excavation levels cloud this interpretation (Erlandson et al. 1991). Recent research at Linda's Point, an adjacent site of similar age, is now providing an opportunity to reexamine Healy Lake Chindadn.

Linda's Point lies 1.7 km southeast of the Village site. Whereas the Village site occupies a low peninsula projecting into the lake, Linda's Point rests on three narrow terracettes ascending a hill rising directly from the shoreline. Sediments consist of 65–80 cm of sandy loess, underlain by 10–15 cm of sand above frost-shattered bedrock. Ventifacts on bedrock indicate an erosional unconformity created by katabatic winds during the Delta and Donnelly glacial intervals (Reger et al. 2008). The modern soil is a cryocrept, and thin paleosols occur at depths of 35–60 cm.

In 2010, we excavated 51 systematic tests (50 by 50 cm) spaced at 10-m intervals, of which 18 produced buried cultural material. Vertical distribution of lithics provided evidence of three components, consistent with the Village sequence. The upper component (0–25 cm) is similar to Cook's late-Holocene Athabascan assemblage; the middle component (25–40 cm) resembles his mid-Holocene Transitional assemblage; and the lower component (≥40 cm) appears stratigraphically equivalent to the Chindadn complex.

Four tests produced artifacts at ≥40 cm, including three 1-by-1-m units. Unit 17 yielded a hearth at 40–48 cm below surface, characterized by fire-reddened loess and a lens of wood charcoal with soot-blackened pebbles. Associated with the hearth are a red jasper flake and a calcined bone fragment. The hearth is isolated from the overlying components by 15 cm of sterile loess, and extends laterally beyond our one-meter sampling unit. A split sample of wood charcoal from the hearth gave radiocarbon dates of 11,050 ± 60 (Beta-293543) and 11,150 ± 60 RCYBP (Beta-293544). One-sigma calibrated ages are 13,110–12,980 and 13,090–12,880 CALYBP, respectively (Reimer et al. 2004). We believe most cultural materials recovered from ≥40 cm below surface are correlative to these dates, based upon presence of green chert artifacts found in three units. A biface of this chert found in Test 46 at 40–50 cm below surface is a Chindadn-like preform. Tools made of a similar material occur in the Chindadn levels of the Village site.

The Chindadn-age component at Linda's Point may be contemporary with major shifts in human population and tool kits in eastern Beringia. Potter (2008) hypothesizes that human population may have peaked at 13,000–14,000 CALYBP, an interval of technological diversity, followed by a precipitous population decline at 12,000–13,000 CALYBP, a period when microblade technology predominated. The age range of the Linda's Point hearth spans this 13,000 CALYBP threshold. It also corresponds to a period of Northern Hemisphere temperature instability marking the transition from the warmer Allerød to the cooler Younger Dryas, dated 12,800–13,200 CALYBP (Steffensen et al. 2008). Several other terminal-Pleistocene occupations in the Tanana drainage radiocarbon date to within 2σ of this critical era, including Upward

Sun River (C1), Walker Road (C1), and Dry Creek (C1) (Potter 2008; Potter et al. 2011).

A recent pollen proxy record from Lost Lake, in the upper Tanana lowlands, gives evidence of biome fluctuation at the 13,000 CALYBP threshold (Tinner et al. 2006). There, *Salix* abundance rose sharply at 13,500–14,500 CALYBP, declined concurrent with a *Betula* increase, and then stabilized c.13,000–13,200 CALYBP. Dated *Salix* charcoal from hearths at Swan Point (14,000 CALYBP; Holmes 2011) and Upward Sun River (13,200 CALYBP; Potter 2008) bracket the decline. Temporal concordance among these events may reflect causal linkages.

Opposing such linkage is a proxy study that concludes no Younger Dryas event occurred in central Alaska (Kokorowski et al. 2008). This implies no climatic fluctuation occurred at the 13,000 CALYBP boundary sufficient to drive human population and technological events. We find this result questionable since the eastern Beringian records, ranked as chronologically reliable by the study's authors, split evenly between those records that show a Younger Dryas signal and those that do not. Additionally, the central Alaskan proxies used have only a multi-century scale temporal resolution, too coarse to model a climate oscillation that lasted c. 800 years (Steffensen et al. 2008: Figure 2). Set against this background, ongoing research at Linda's Point promises to expand to our understanding of the Chindadn complex and its paleoenvironmental context.

We thank the Linda's Point landowners (Josephine Beaver, Sam and Susan Freese), the Healy Lake Traditional Council, the Bureau of Indian Affairs and Tanana Chiefs Conference for making this research possible. We are also grateful to our 2010 field crew: Nick Jarman, Amy Krull, John Grieve, Evie Combs, and Raquel Derry. Support is appreciated from JoAnn and Corey Polston, Fred and Paul Kirsteatter, Jr. and E. James Dixon. Special thanks go to John P. Cook for sharing his original field data.

References Cited

Cook, J. P. 1969 The Early Prehistory of Healy Lake. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wisconsin.

——— 1996 Healy Lake. In *American Beginnings: the Prehistory and Paleoecology of Beringia*, edited by F. H. West, pp. 323–27. University of Chicago Press, Chicago.

Erlandson, J. R., R. Walser, H. Maxwell, N. Bigelow, J. Cook, R. Lively, C. Adkins, D. Dodson, A. Higgs, and J. Wilber 1991 Two Early Sites of Eastern Beringia: Context and Chronology in Alaskan Interior Archaeology. *Radiocarbon* 33(1):46–53.

Holmes, C. E. 2011 The Beringian and Transitional Periods in Alaska: Technology of the East Beringian Tradition as Viewed from Swan Point. In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit, pp. 179–91. Texas A & M University Press, College Station.

Kokorowski, H. D., P. M. Anderson, C. J. Mock, and A. V. Lozhkin 2008 A Re-evaluation and Spatial Analysis of Evidence for a Younger Dryas Climatic Reversal in Beringia. *Quaternary Science Reviews* 27:1710–22.

Potter, B. A. 2008 Radiocarbon Chronology of Central Alaska: Technological Continuity and Economic Change. *Radiocarbon* 50(2):181–204.

Potter, B. A., J. D. Irish, J. D. Reuther, C. Gelvin-Reymiller, and V. T. Holliday 2011 A Terminal Pleistocene Child Cremation and Residential Structure from Eastern Beringia. *Science* 331:1058–62.

Reger, R. D., D. S. P. Stevens, and D. N. Solie 2008 Surficial Geology of the Alaska Highway

Corridor, Delta Junction to Dot Lake, Alaska. Preliminary Interpretive Report 2008-3a, Division of Geological and Geophysical Surveys, State of Alaska, Fairbanks.

Reimer, P. J., M. G. L. Baillie, E. Bard, A. Bayliss, J. W. Beck, C. J. H. Bertrand, P. G. Blackwell, C. E. Buck, S. G. Burr, K. B. Cutler, P. E. Damon, R. L. Edwards, R. G. Fairbanks, M. Friedrich, T. P. Guilderson, A. G. Hogg, K. A. Hughen, B. Kromer, F. G. McCormac, S. W. Manning, C. B. Ramsey, R. W. Reimer, S. Remmele, J. R. Southon, M. Stuiver, S. Talamo, F. W. Taylor, J. van der Plicht, and C. E. Weyhenmeyer 2004 IntCal04 Terrestrial Radiocarbon Age Calibration, 26 - 0 ka BP. *Radiocarbon* 46:1029–58.

Steffensen, J. P., K. K. Andersen, M. Bigler, H. B. Clausen, D. Dahl-Jensen, H. Fischer, K. Goto-Azuma, M. Hasson, S. J. Johnsen, J. Jousel, V. Masson-Delmotte, T. Popp, S. O. Rasmussen, R. Röthlisberger, U. Ruth, B. Staufffer, M.-L. Siggard-Andersen, Á. E. Sveinbörnsdóttir, A. Svensson, and J. W. C. White 2008 High-Resolution Greenland Ice Core Data Show Abrupt Climate Change happens in Few Years. *Science* 321:680–83.

Tinner, W., F. S. Hu, R. Beer, P. Kaltenrieder, B. Scheurer, and U. Krähenbühl 2006 Postglacial Vegetational and Fire History: Pollen, Plant Macrofossil and Charcoal Records from two Alaskan Lakes. *Vegetation History and Archaeobotany* 15:279–93.

An American (Projectile Point) in Paris

Frédéric Sellet, David J. Meltzer, Águeda Vilhena Vialou, and Denis Vialou

➤ **Keywords:** Folsom type site, history of Paleoindian archaeology, Musée de l'Homme

Formal excavations at the Folsom type site were conducted from 1926 to 1928, and because of its importance the site proved to be a magnet for tourists (archaeological and otherwise) in later years. Subsequent visitors to the site occasionally found artifacts, primarily projectile points. Not all these specimens made their way into museum collections; some are in private hands, and of the 28 projectile points recorded as having been found at the Folsom site, 6 are missing (Meltzer 2006:255–56). In some cases, photographs of the missing specimens are available (e.g., Howard 1935: Plate 33; Wormington 1957: Figure 7); in other instances, the points are only known from brief mention in correspondence (Meltzer 2006: Table 8.2). It would appear that one of those missing points, or perhaps one not known to have gone missing, has been living in Paris since the 1930s.

Recently, one of us (FS) was examining a portion of the collections at the Musée de l'Homme, and came across a Folsom point that is part of the Colonel L. Vésignié collection. This Folsom point, made of Flattop chert, is 51.7 mm

Frederic Sellet, Department of Anthropology, University of Kansas, 637 Fraser Hall, Lawrence, KS 66045; e-mail: fsellet@ku.edu

David Meltzer, Department of Anthropology, Southern Methodist University, Dallas, TX 75275; e-mail: dmeltzer@mail.smu.edu

Águeda Vilhena Vialou and Denis Vialou, Institut de Paléontologie Humaine, 1 rue René Panhard 75013 Paris, France; e-mails: avialou@mnhn.fr dvialou@mnhn.fr

long and 24.8 mm wide (Figure 1). The point displays obvious impact damage, and has one ear broken off, perhaps the result of end shock. The point is ground along its lower edges and has a small ‘notch’ in the basal concavity, which appears to be a break that occurred after the point was no longer in its haft.

Figure 1: Folsom Point from the Vésignie Collection, Museé de l’Homme.

This specimen, along with nine other fluted points, was in a photograph accompanying a brief note—“Les pointes de Folsom”—published by Vésignié in 1937. The 10 specimens were identified as Folsom points, which was common in the 1930s (Meltzer 2006:251), though all but one are Clovis and Cumberland points from five different Eastern and Midwestern states.

There are two obvious questions raised by the lone Folsom specimen: Is it indeed from the Folsom type site? And, if so, how did it end up in Paris?

In regard to the first question, Vésignié’s figure caption explicitly identifies the source of the point as Folsom, New Mexico. He describes the photograph as illustrating “a small series of points of the Folsom type, all found in various areas of the United States, *with the exception of one, unfortunately slightly damaged, which comes from Folsom itself*” (Vésignié 1937:326, emphasis added). Only one other fluted point in the photograph—a Cumberland with a missing base—appears “slightly damaged,” but as such is far less worthy of comment than the impact-fractured Folsom point with its missing ear. The Cumberland point was also explicitly identified as coming from Kentucky.

If the Vésignié Folsom point is from the type site, how did it get to Paris? There is no archival record of an exchange of artifacts between the Musée de l’Homme and either the then-Colorado Museum of Natural History (now Denver Museum of Nature and Science) or the American Museum of Natural

History, which excavated at Folsom in 1926–1927 and 1928, respectively. As best can be determined, all the projectile points from the excavations by these institutions are accounted for (Meltzer 2006:251–52, Table 8.2).

Of the six Folsom points found by later visitors and known to be missing, five were discovered before 1937. Of those, only two are complete. One of the complete specimens, known from photographs in Howard (1935) and Wormington (1957), is not the Vésignié point. Therefore, the only remaining candidate for a trans-Atlantic crossing was a point found by Fred Howarth, the Raton, New Mexico, banker who first helped call attention to the site and was a regular visitor there during the excavations and afterward (Meltzer 2006). In the summer of 1933, he found a "good arrowhead" at the site which he described as "not the typical Folsom point but exactly the same type as the one found by [Barnum] Brown a year or two ago. But is a much better specimen, being whole, just a little tiny chip from one corner." (Howarth to Cook, July 25, 1933, HJC/AGFO; specimen Sn 19 in Meltzer 2006:Table 8.2).

Howarth's description of the condition of the point is certainly consistent with the Vésignié point. As telling, perhaps, is Howarth's observation that it is the "same type" as the point found by Brown; if "type" refers to lithic raw material, as it appears to in this context, it is noteworthy that Brown's point was also made of Flattop chert—one of only three at the site made of this toolstone (Meltzer 2006: Table 8.5).

Regardless of whether Vésignié's point is that Howarth point, or another not known to be missing from the site, the trail from the Folsom site to the Musée de l'Homme in Paris cannot be traced. The only known comment on the disposition of the point was Howarth's to Harold Cook:

> I have said nothing to the Colorado [Museum of Natural History] people about it as yet but I suppose that I should send it to them as all the data that is possibly available should be kept together where it can be studied by experts. However in this connection I will wait for your opinion on it before I say anything about it to anyone." (Howarth to Cook, July 25, 1933, HJC/AGFO).

Regardless of how this point, or some other got to France, it is known that it was part of a large collection of North American artifacts that Vésignié, the former president of the *Société Préhistorique Française,* amassed and donated, which unfortunately was never fully catalogued (Smith 1961:428). All that is known of how this Folsom fluted point came into Vésignié's hands is his statement that the specimen "has been kindly given to me by our colleague Kelley, with a series of photos and documents, for which I would like to thank him greatly" (Vésignié 1937:326). Harper Kelley, an American archaeologist in Paris, was at the Musée de L'Homme from 1917 on and was responsible for building up the institution's collections. Although he presumably had good connections with his country of birth, how a Folsom point from the type site got from Howarth (or some unknown person) to Kelley is not known.

References Cited

Howard, E. B. 1935 Evidence of Early Man in North America. *The Museum Journal,* University of Pennsylvania Museum, Vol. 24 (Nos. 2-3).

Meltzer, D. J. 2006 *Folsom: New Archaeological Investigations of a Classic Paleoindian Bison Kill.* University of California Press, Berkeley

Smith, P. 1961 Fluted Points in Paris. *American Antiquity* 26:428–31.

Vésignié, L. 1937 Les pointes de Folsom. *Bulletin de la Société Préhistorique Française* 34:326–27.

Wormington, H. M. 1957 *Ancient Man in North America.* Fourth Edition. Denver Museum of Natural History, Denver.

Looking to the North: Results from the XRF Analysis of Pre-Archaic Projectile Points from Hanging Rock Shelter, Northwest Nevada

Geoffrey M. Smith, Stephen LaValley, and Craig Skinner

➤ **Keywords**: Source provenance analysis, Paleoindians, Great Basin

Hanging Rock Shelter (HRS), located in northwest Nevada, was excavated by Thomas Layton in 1967–1968 (Layton 1970). Although undated, the recovery of over 40 stemmed and concave-base projectile points from the site's basal stratum led Layton to conclude that HRS was initially occupied between 10,000 and 12,000 CALYBP. This approximation is wholly consistent with both current estimates of the antiquity of stemmed and concave-base points in the Great Basin (Beck and Jones 1997) and the basal stratum from nearby Last Supper Cave, which was occupied as early as ~12,060 CALYBP and contained a similar number of pre-Archaic points (Smith 2008).

The stemmed and concave-base points from HRS represent one of the few sizeable assemblages of Pre-Archaic points from northwest Nevada not yet submitted for X-ray fluorescence source provenance analysis. As part of an ongoing effort to better understand pre-Archaic toolstone procurement patterns in that region, we submitted 31 obsidian stemmed points from HRS for geochemical characterization. Eleven known and one unknown geochemical types were identified. Sources of these obsidians are located in northwest Nevada, northeastern California, and south-central Oregon, and most of the points (90.3%; n = 28) are made on materials that originated within 78 km of HRS. Two geochemical types (Venator and Whitewater Draw) located more than 240 km distant are present but represented by isolated specimens (Table 1).

Our results are consistent with those derived from similar assemblages in the region including Last Supper Cave (Smith 2008), the Parman localities (Smith 2007), and the Black Rock Desert (Amick 1997; Camp 2009). Most of

Geoffrey M. Smith and Stephen LaValley, Department of Anthropology and Great Basin Paleoindian Research Unit, University of Nevada, Reno, 1664 No. Virginia Street/MS0096, Reno, NV 89557; emails: geoffreys@unr.edu sjlavalley@gmail.com

Craig Skinner, Northwest Research Obsidian Studies Laboratory, 1414 NW Polk, Corvallis, OR 97330; email: cskinner@obsidianlab.com

Table 1. Geochemical types represented in the sample of obsidian pre-Archaic projectile points from Hanging Rock Shelter.

Geochemical type	N	Percentage	Distance to nearest source (km)
Badger Creek, NV	1	3.2	27
Bordwell Springs/Pinto Peak/ Fox Mountain, NV	7	22.6	23
Buck Mountain, CA	2	6.5	70
Buffalo Hills, NV	1	3.2	78
Cowhead Lake, CA	2	6.5	64
Coyote Spring, NV	2	6.5	7
Hawks Valley, NV/OR	1	3.2	51
Massacre Lake/Guano Valley, NV/OR	11	35.5	17
Surveyor Spring, NV/OR	1	3.2	68
Venator, OR	1	3.2	244
Whitewater Ridge, OR	1	3.2	267
Unknown	1	3.2	Unknown
Total	**31**	**100.0**	

the material was procured locally—a finding that is not surprising given the abundance of high-quality obsidian in northwest Nevada. No sources of obsidian from south of the Black Rock Desert are represented in the HRS sample, which is consistent with the results of a recent synthesis of source provenance work in the area that suggests there was little long-distance north-south movement of toolstone in the western Great Basin (Smith 2010). As such, we do not think that Pre-Archaic groups in northwest Nevada had strong socioeconomic ties to the western Great Basin and instead likely possessed a greater affinity with pre-Archaic populations to the north. This possibility is supported by marked similarities in toolstone procurement and mobility strategies (Smith 2011), perishable textile technologies (Connolly and Barker 2004), and rock-art styles (Woody 1996) in northwest Nevada and south-central Oregon.

Funding for this project was provided by the Great Basin Paleoindian Research Unit, Department of Anthropology, University of Nevada, Reno. Craig Skinner conducted the XRF analysis of artifacts from Hanging Rock Shelter. Thanks to the staff of the Nevada State Museum for making the artifacts available for study and Tom Layton for establishing much of what we know about the prehistory of the High Rock Country of northwest Nevada.

References Cited

Amick, D. S. 1997 Geochemical Source Analysis of Obsidian Paleoindian Points from the Black Rock Desert, Nevada. *Current Research in the Pleistocene* 14:97–99.

Beck, C., and G. T. Jones 1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. *Journal of World Prehistory* 11(2):161–236.

Camp, A. J. 2009 Pre-Archaic Occupations in the West Arm of the Black Rock Desert. Unpublished M.A. thesis, Department of Anthropology, University of Nevada, Reno.

Connolly, T. J., and P. Barker 2004 Basketry Chronology of the Early Holocene in the Northern Great Basin. In *Early and Middle Holocene Archaeology of the Northern Great Basin*, edited by D. L. Jenkins, T. J. Connolly, and C. M. Aikens, pp. 241–50. University of Oregon Anthropological Papers 62, Eugene.

Layton, T. N. 1970 High Rock Archaeology: An Interpretation of the Prehistory of the Northwestern Great Basin. Unpublished Ph.D. dissertation, Department of Anthropology, Harvard University, Cambridge.

Smith, G. M. 2007 Pre-Archaic Mobility and Technological Activities at the Parman Localities, Humboldt County, Nevada. In *Paleoindian or Paleoarchaic?: Great Basin Human Ecology at the Pleistocene-Holocene Transition*, edited by K. E. Graf and D. N. Schmitt, pp. 139–55. University of Utah Press, Salt Lake City.

——— 2008 Results from the XRF Analysis of Pre-Archaic Projectile Points from Last Supper Cave, Northwest Nevada. *Current Research in the Pleistocene* 25:144–46.

——— 2010 Footprints Across the Black Rock: Temporal Variability in Prehistoric Foraging Territories and Toolstone Procurement Strategies in the Western Great Basin. *American Antiquity* 75(4):865–85.

——— 2011 Shifting Stones and Changing Homes: Using Toolstone Ratios to Consider Relative Occupation Span in the Northwestern Great Basin. *Journal of Archaeological Science* 38:461–69.

Woody, A. 1996 Layer by Layer: A Multigenerational Analysis of the Massacre Lake Rock Art Site. Unpublished Ph.D. dissertation, Department of Anthropology, University of Nevada, Reno.

Geometric Morphometrics and the Effect of Raw-Material Quality on the Shape of Clovis Points

Heather Smith

➤ **Keywords:** Fluted points, geometric morphometrics, raw-material quality

Determining the relative proportions of various raw materials in stone-tool assemblages has traditionally focused on distinguishing between high- and low-quality raw materials and their use in making formal versus expedient tools (Andrefsky 1994; Jones 1979; Kilby 2008; Kuhn 1991). The effect on artifact shape of so-called "high-quality" raw materials, however, has not been directly addressed. It is well known that Clovis assemblages are characteristically made of fine-grained, high-quality raw materials, and that cached Clovis artifacts are also made of a variety of high-quality toolstones (Goodyear 1979; Kelly and Todd 1988; Kilby 2008).

To determine if the shape of projectile point was determined by the type of high-quality raw material used, a landmark-based approach to geometric morphometrics was used. First, Cartesian coordinates were plotted around the perimeter of each artifact following Smith (2010). Then coordinate data were imported into the tps Relative Warps program (tpsRelw) (v. 1.46; Rohlf 2008), which generated partial warp scores, relative warp scores, and centroid size for each artifact. Relative warp scores serve as principal components, following Bookstein (1991). The first four scores, constituting 94.75% of shape variability for the dataset, were used in statistical analysis.

Hierarchical multivariate cluster analysis using Ward's method was done on

Heather Smith, Center for the Study of the First Americans, Department of Anthropology, Texas A&M University, College Station, TX 77843-4352; e-mail: hls2112@tamu.edu

three assemblages of projectile points: Fenn cache, Lehner site, and Drake cache (Figure 1). Data on raw materials were drawn from Frison and Bradley (1999:10–19, 40–45, 96), Haury et al. (1959:18), and Kilby (2008:86–87).

Artifacts from the Fenn cache were tested to determine whether points made from Utah agate clustered closer together than points made from Green River chert, obsidian, quartz, red jasper, and chert possibly from the Amsden Formation in Wyoming (Kilby 2008). If the type of raw material affected point shape, then we would expect tools made from Utah agate to be most closely similar in shape to each other and consequently generate the shortest

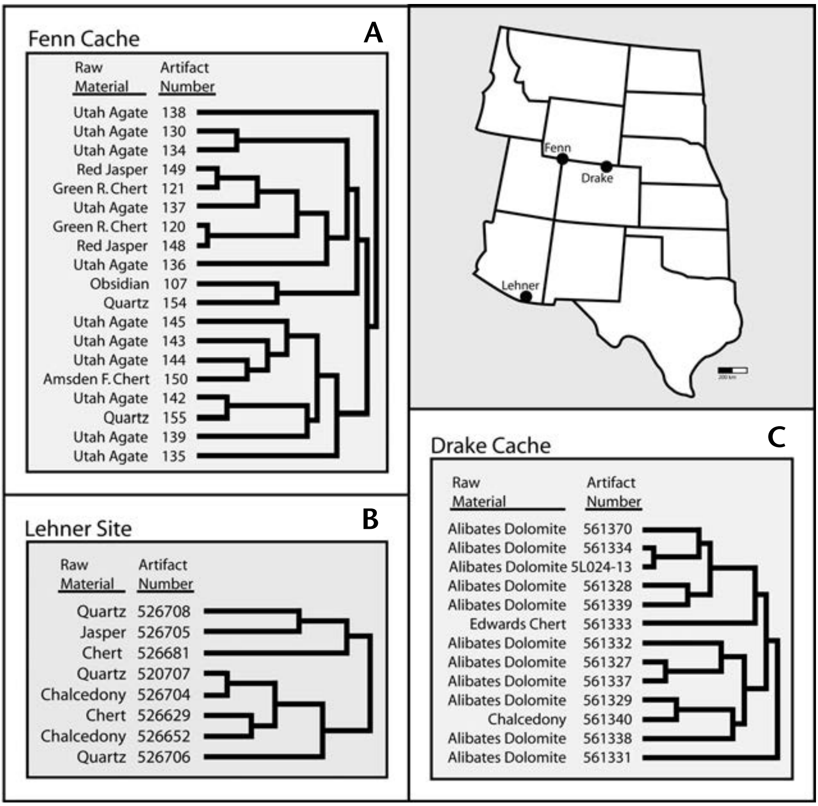


Figure 1. Results of the multivariate cluster analysis conducted within the fluted-point assemblages from the Fenn cache, Lehner site, and Drake cache.

Euclidian distances. The resulting Euclidean distance matrix and corresponding dendrogram (Figure 1A) shows that the two projectile points within the Fenn cache most similar in shape are those made from Green River chert (120) and red jasper (148). Points made of Green River chert (121) and red jasper (149) also formed the next-closest affinity. The third-closest relationship was between projectile points made from quartz (155) and Utah agate (142). Furthermore, the pair of points within the Fenn cache least similar in shape were both made from Utah agate (138 and 130). Projectile points made from the same toolstone did not cluster together, and the type of raw material thus had no effect on the variability of shape of projectile points in the Fenn cache.

If shape was affected by the type of toolstone in the Lehner assemblage, then chert, quartz, chalcedony, and jasper should form specific groups in the cluster diagram (Figure 1B). However, the two projectile points most similar in shape were made of two different materials, quartz (520707) and chalcedony (526704), and the second-most similar in shape were points made from chert (526629) and chalcedony (526652). Conversely, the two points with the greatest Euclidean distances (least similar in shape) were the only two points made from the same material, quartz (526708 and 520707). Thus, the points from the Lehner site do not cluster according to the type of raw material.

If the type of raw material constrained the shape of fluted points in the Drake cache, then the two projectile points not made from Alibates dolomite should fall outside the multivariate cluster of Alibates points (Figure 1C). The greatest similarity of shape within the Drake point assemblage was found in four points of Alibates dolomite; however, the third-most similar were a chalcedony point and an Alibates dolomite point. Moreover, the point made from Edwards chert did not become an outlier to the Drake cluster. Two points, both made from Alibates dolomite, were even less similar in shape to the majority of the Drake cache points than the point made of Edwards chert. The type of raw material is therefore not a factor that determines shape within the Drake cache.

Multivariate cluster analyses made on the assemblages of the Fenn, Drake, and Lehner sites determined that the shape of projectile points was not determined by the kind of high-quality raw material used. Artifact shape can therefore be better attributed to cultural factors influencing tool manufacture such as normative templates of tool style or the skill level of the knapper.

This analysis could not have been conducted without the help and guidance of Ted Goebel, Michael Waters, David Carlson, and Tom DeWitt. I am most appreciative of Dennis Stanford and Pegi Jodry for allowing me to analyze fluted points from the Drake cache and Lehner Site, as well as Michael Waters and Ted Goebel for allowing me to analyze the Fenn cache. I am also grateful to David Kilby for his helpful feedback.

References Cited

Andrefsky, W., Jr. 1994 Raw-Material Availability and the Organization of Technology. *American Antiquity* 59(1):21–34.

Bookstein, F. L. 1991 *Morphometric Tools for Landmark Data: Geometry and Biology.* Cambridge University Press, New York.

Frison, G., and B. Bradley 1999 *The Fenn Cache: Clovis Weapons and Tools.* One Horse Land and Cattle Company, Santa Fe.

Goodyear, A. C. III 1979 *A Hypothesis for the Use of Cryptocrystalline Raw Materials among Paleoindian Groups of North America.* Research Manuscript Series 156, South Carolina Institute of Archaeology and Anthropology. University of South Carolina, Columbia.

Haury, E. W., E. B. Sayles, and W. W. Wasley 1959 The Lehner Mammoth Site, Southeastern Arizona. *American Antiquity* 25(1):2–30.

Jones, P. R. 1979 Effects of Raw Materials on Biface Manufacture. *Science* 204:835–36.

Kelly, R. L., and L. C. Todd 1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53(2):231–44.

Kilby, D. J. 2008 *An Investigation of Clovis Caches: Content, Function, and Technological Organization.* Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Kuhn, S. L. 1991 "Unpacking" Reduction: Lithic Raw Material Economy in the Mousterian of West-Central Italy. *Journal of Anthropological Archaeology* 10:76–106.

Rohlf, F. J. 2008 *Relative Warps.* Version 1.45. Department of Ecology and Evolution, State University of New York, Stony Brook.

Smith, H. L. 2010 A Behavioral Analysis of Clovis Point Morphology Using Geometric Morphometrics. Unpublished masters thesis, Department of Anthropology, Texas A&M University, College Station.

New Evidence for the Paleoindian Occupation of the Narragansett Basin, Rhode Island and Massachusetts

Kevin P. Smith, Amy Smith, and Nina Hellebrekers

➤ **Keywords:** Paleoindian, New England, lithics

The Paleoindian occupation of the Narragansett Basin in Rhode Island and adjacent Massachusetts is poorly understood. The Wapanucket 8 site produced a small suite of early-Paleoindian diagnostics from mixed contexts (Bradley and Boudreau 2006a; Robbins and Agogino 1964), and several fluted points have been identified in Massachusetts collections (Bradley and Boudreau 2006b, 2008). But only three diagnostic Paleoindian points were known from Rhode Island before 2002 (Rhode Island Historical Preservation and Historical Commission 2002).

The Haffenreffer Museum of Anthropology curates nearly 40,000 stone tools from Rhode Island and Massachusetts purchased from local collectors in the early 20th century by Rudolf F. Haffenreffer, Jr., and donated to Brown University in 1955 (Robinson 1986, Gregg 1994). In a recent reevaluation of this major collection, we identified 13 diagnostic Paleoindian points, 9 Paleoindian tools, and 4 fluted-point preforms from the Narragansett Basin. Three additional Paleoindian projectile points and a trianguloid scraper-graver from Massachusetts are also most likely from the Narragansett Basin. Typological assessment of these previously undocumented objects (following Bradley et al. 2008) indicates significant early- and late-Paleoindian activity in the region.

The early-Paleoindian diagnostics include two complete Bull Brook/West

Kevin P. Smith and Amy Smith, Haffenreffer Museum of Anthropology, Brown University, Box 1925, Providence, Rhode Island 02912; e-mails: Kevin_P_Smith@brown.edu a.e.smith0287@gmail.com

Nina Hellebrekers, Department of Earth Sciences, Utrecht University, P.O.Box 80.021 3508 TA, Utrecht, The Netherlands; N.Hellebrekers@students.uu.nl

Athens Hill points from southwestern RI manufactured on Onondaga and black Normanskill/Mount Merino cherts (Funk 2004); a yellow jasper channel flake and a black Normanskill chert endscraper-graver, both from Diamond Hill, RI; an endscraper on a fractured gray chert fluted-point base from Attleboro, MA; a green Normanskill chert combination end/sidescraper with graver spurs from the Palmer River in Barrington, RI; and a rhyolite composite scraper-graver from North Rehoboth, MA.

During the Younger Dryas, currently inundated portions of Narragansett Bay were deep valleys carrying rivers that flowed into embayments located 25–30 km south of the present shoreline and 35–37 m below current sea level (McMullen et al. 2007, 2008, 2009). The scattered distribution of early-Paleoindian materials in the Haffenreffer Museum collections suggests extensive foraging within the upland headwaters of these now-drowned valley systems. Relying on lithic raw materials originating in formations 150–250 km distant is consistent with high mobility and has regional parallels in assemblages from Bull Brook (Robinson et al. 2009) and Wapanucket 8 (Bradley and Boudreau 2006a).

In contrast, late-Paleoindian specimens in the Museum collection cluster in two geographically separate parts of the basin. One cluster—on the morainal divide between the Narragansett and Boston Basins near Attleboro, MA—includes four Cormier-Nicholas points, two bifaces similar to Hi-Lo points (Ellis 2004), and a finely serrated quartz lanceolate point with pronounced basal thinning. The second cluster—from an area bounded by the confluences of the paleo-channels of the Providence, Pawtuxet, and Taunton Rivers—includes four Cormier-Nicholas points from South Swansea, MA, and Barrington, RI, as well as an assemblage of five late-Paleoindian projectile points, three trianguloid endscrapers (one fluted, another on a jasper channel flake), one composite scraper-graver, and two fluted performs from Riverside, RI. The Riverside assemblage suggests particularly intensive activity at the now-drowned confluence of the Pawtuxet and Providence Rivers.

These two clusters, each roughly 15 km in diameter, are separated by a zone of nearly equal distance from which no late-Paleoindian materials are known, despite comparable attention by early collectors. Recently, three additional Cormier-Nicholas points were reported from previously undocumented locations in Massachusetts (Bradley and Boudreau 2006b). All were found within the geographic boundaries of the two clusters defined here, suggesting that their coherence reflects more than the collecting preferences of the individuals who made Haffenreffer's collections.

Tentatively, we suggest that these clusters represent focal areas for increasingly redundant and/or enduring patterns of settlement and/or resource use in the uplands and headwaters of the basin's drowned late-Pleistocene river systems. This intensive, focused pattern contrasts with the extensive, scattered distribution of early-Paleoindian diagnostics from the same region. Significantly, nearly all late-Paleoindian tools in the Haffenreffer collection are made from fine-grained igneous rocks available within 75–100 km of the locations where they were found, reinforcing a sense of groups settling into the region rather than moving through it. One Cormier-Nicholas point, however, appears to be manufactured from Mount Jasper or Jefferson (New Hampshire) rhyolite (Pollock et al. 2008), suggesting the existence of some long-distance interactions.

These new data significantly expand the number of Paleoindian tools known from the Narragansett Basin; suggest shifts from extensive land-use patterns during the Little Dryas to intensive, regionally focused strategies afterwards; and document shifts in raw material preferences at the end of the Pleistocene. These initial findings provide foundations for future research and reaffirm the value of curated collections for contemporary research.

References Cited

Bradley, J. W., and J. Boudreau 2006a Re-assessing Wapanucket: Paleoindians in Southeast MA. *Bulletin of the Massachusetts Archaeological Society* 67(2):59–72.

——— 2006b Unusual Paleoindian Points from Southeast MA. *Bulletin of the Massachusetts Archaeological Society* 67(1):36–39.

——— 2008 Additional Paleoindian Sites and Finds in Southeast Massachusetts. *Bulletin of the Massachusetts Archaeological Society* 69(2):72–83.

Bradley, J. W., A. E. Spiess, R. A. Boisvert, and J. Boudreau 2008 What's the Point?: Modal Forms and Attributes of Paleoindian Bifaces in the New England-Maritimes Region. *Archaeology of Eastern North America* 36:119–72.

Ellis, C. 2004 Hi-Lo: An Early Lithic Complex in the Great Lakes Region, in *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments (Mercury Series, Archaeology Paper 165),* ed. by L. J. Jackson and A. Hinshelwood, pp. 57–83. Canadian Museum of Civilization, Gatineau, QC.

Funk, R. E. 2004 *An Ice Age Quarry-Workshop: The West Athens Hill Site Revisited.* New York State Museum Bulletin 504. The University of New York and the New York State Education Department, Albany.

Gregg, D. S. 1994 Archaeological Collections, in *Passionate Hobby: Rudolf Frederick Haffenreffer and the King Philip Museum,* edited by Shepard Krech III. Haffenreffer Museum of Anthropology, Bristol, RI.

McMullen, K. Y., L. J. Poppe, J. F. Denny, T. A. Haupt, and J. M. Crocker 2008 *Sidescan-Sonar Imagery and Surficial Geologic Interpretations of the Sea Floor in Central Rhode Island (Report Series 2007-1366).* U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.

McMullen, K. Y., L. J. Poppe, T. A. Haupt, and J. M. Crocker 2009 *Sidescan-Sonar Imagery and Surficial Geologic Interpretations of the Sea Floor in Western Rhode Island Sound (Open File Report 2008-1181).* U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.

McMullen, K. Y., L. J. Poppe, E. R. Twomey, W. W. Danforth, T. A. Haupt, and J. M. Crocker 2007 *Sidescan Sonar Imagery, Multibeam Bathymetry, and Surficial Geologic Interpretations of the Sea Floor in Rhode Island Sound, off Sakonnet Point, Rhode Island (U.S. Geological Survey Open-File Report 2007-1150).* U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.

Pollock, S. G, N. D. Hamilton, and R. A. Boisvert 2008 Archaeological Geology of Two Flow-banded Spherulitic Rhyolites in New England, USA: Their History, Exploitation and Criteria for Recognition. *Journal of Archaeological Science* 35:688–703.

Rhode Island Historical Preservation and Heritage Commission 2002 *Native American Archaeology in Rhode Island.* Rhode Island Historical Preservation and Heritage Commission, Providence.

Robbins, M., and G. A. Agogino 1964 The Wapanucket No. 8 Site: A Clovis-Archaic Site in Massachusetts. *American Antiquity* 29(4):509–13.

Robinson, B. S. 1986 *A Guide to Rhode Island Archaeological Collections.* Haffenreffer Museum of Anthropology, Bristol, RI.

Robinson, B. S., J. C. Ort, W. A. Eldridge, A. L. Burke, and B. G. Pelletier 2009 Paleoindian Aggregation and Social Context at Bull Brook. *American Antiquity* 74(3):423–47.

New Finds and Related Obsidian Studies at the Sage Hen Gap Fluted-Point Site, Harney County, Oregon

Scott P. Thomas, Patrick W. O'Grady, and Michael F. Rondeau

➤ **Keywords**: Fluted points, obsidian, Great Basin

Sage Hen Gap (35HA3548) is a fluted-point site on the northern perimeter of the Harney Basin in southeastern Oregon. The site was initially recorded in 1984, and five fluted-point discoveries were reported by O'Grady et al. (2008) (3548-CL1 through 5). Six additional fluted points recovered since that time are reported here (3548-CL6 through 11). All are obsidian and surface finds.

Rondeau (2008) reports that specimen 3548-CL6 exhibits classic fluted-point attributes (Figure 1A). Specimens 3548-CL7–CL9 were found in 2009 (Figure 1B–D). While 3548-CL8 has single flute scars on both sides, two of the three specimens (3548-CL7 and 3548-CL9) have multiple flute scars on one face and single flute scars on the other (Rondeau 2010a). Rondeau considers the multiple flute scars a possible deviation from "classic" fluted-point at-

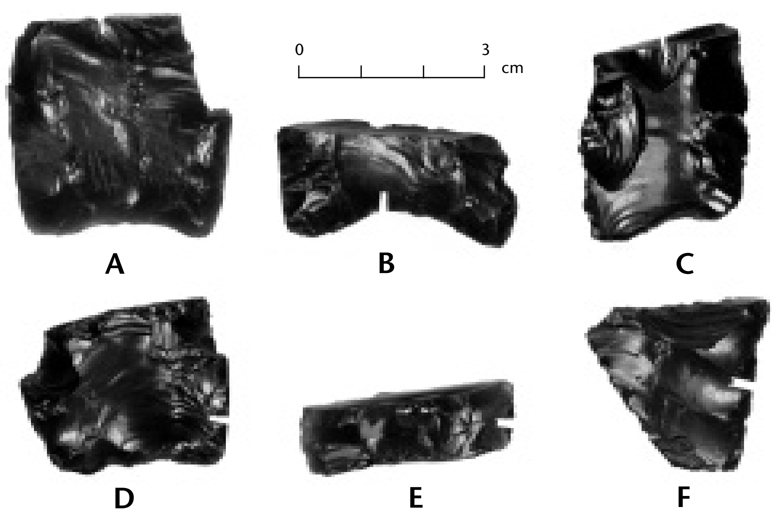


Figure 1. Six fluted specimens from Sage Hen Gap.

Scott P. Thomas, Burns District Bureau of Land Management, 28910 Highway 20 West, Hines, OR, 97738; e-mail: scott_thomas@blm.gov

Patrick O'Grady, University of Oregon Museum of Natural and Cultural History, 1224 University of Oregon, Eugene, OR, 97403-1224; e-mail: pogrady@uoregon.edu

Michael F. Rondeau, Rondeau Archeological, 251 Rockmont Circle, Sacramento, CA, 95835; e-mail: mikerondo@yahoo.com

tributes, but concludes all three specimens share other attributes (edge grinding, flute scratches, and size) that support Western Clovis designation. 3548-CL10 (Figure 1E) is a medial fragment of a point with biconcave cross section, a single flute scar on each face, and flute scratching on one flute surface (Rondeau, 2010b). Its size and other technological attributes align it with Western Clovis. Specimen 3548-CL11 (Figure 1F) is a triangular-shaped medial fragment with a single flute scar on one face. Step fractures on the opposite face reflect repeated impact damage (Rondeau 2010b). This fragment has a biconcave cross section and discontinuous edge grinding on the remaining lateral margin. Although the piece is fragmentary, its attributes confirm its similarity to Western Clovis points.

A summary of obsidian XRF sourcing and obsidian-hydration analyses of the fluted points is shown in Table 1 (Skinner and Thatcher 2007, 2008a, 2008b, 2010a, 2010b, 2010c). The Buck Spring source is available on site, while the Rimrock Spring and Big Stick sources are 15 and 30 km from Sage Hen Gap, respectively. As is commonly known, different obsidian sources can hydrate at different rates. Rimrock Spring and Big Stick sources consistently hydrate at a much slower rate than Buck Spring, hence their thinner hydration rinds.

The mean obsidian-hydration-rind measurements for fluted points made of Buck Spring obsidian is 10.1 μm. Although the individual hydration-rind measurements for the fluted points vary widely, the population of Buck Spring (n = 181, mean = 9.8 μm) obsidian hydration measurements from the site has a very low (0.09) coefficient of variation (CV). Such a low CV suggests the obsidian was discarded at the site during one event or multiple events closely spaced in time. A tentative hydration rate (8μm^2/1000 years) for Buck Spring obsidian has been calculated using pairs of absolute dates (^{14}C and tephra) with associated hydration-rind measurements from other sites in the Harney Basin (Thomas and O'Grady 2006). If this rate is applied to the mean hydra-

Table 1. XRF sourcing and obsidian hydration data for fluted points from Sage Hen Gap, (35HA3548).

Specimen no.	Obsidian source	Obsidian hydration rind thickness (μm)	Estimated hydration rate(μm²/1000 years)	Estimated age (CALYBP)
3548-CL1	Buck Spring	9.7	8.00	11,800
3548-CL2	Big Stick	7.3	unknown	no estimate
3548-CL3	Buck Spring	10.8	8.00	14,600
3548-CL4	Buck Spring	9.2	8.00	10,600
3548-CL5	Rimrock Spring	6.1	unknown	no estimate
3548-CL6	Buck Spring	8.2	8.00	8,400
3548-CL7 (CL-09-01)	Buck Springs	10.4	8.00	13,500
3548-CL8 (CL-09-2)	Rimrock Spring	5.8	unknown	no estimate
3548-CL9 (CL-09-3)	Rimrock Spring	5.9	unknown	no estimate
3548-CL10	Big Stick	5.2■	unknown	no estimate
3548-CL11	Buck Spring	11.8	8.00	17,400
3548 summary	**Buck Spring specimens**	**N = 6 Mean = 10.01 μm**	**8.00**	**12,500**

■This hydration rind has a diffuse hydration boundary and has been weathered.

tion-rind thickness of the Sage Hen Gap fluted points made of Buck Spring obsidian, a date of 12,500 CALYBP is derived. Tentative hydration rates for Rimrock Spring and Big Stick have not been calculated because the appropriate ^{14}C/hydration rind thickness data pairs have not been obtained. None of the specimens has been associated with ^{14}C dates, and work continues at Sage Hen Gap and other sites in the region to find fluted points in stratigraphic and datable contexts. Nevertheless, it is clear that these fluted points with the size and technological attributes of Western Clovis yield some of the largest hydration rinds for any obsidian source in this region.

References Cited

O'Grady, P. W., S. P. Thomas, and M. F. Rondeau 2008 The Sage Hen Gap Fluted-Point Site, Harney County, Oregon. *Current Research in the Pleistocene* 25:127–29.

Rondeau, M. F. 2008 Research on Eight Additional Bifaces from the Burns District, Bureau of Land Management, Hines, Oregon. *CalFLUTED Research Report* No. 53. Rondeau Archeological, Sacramento.

——— 2010a Three Additional Fluted Points from the Sage Hen Gap Site, Burns BLM District, Harney County, Oregon. *CalFLUTED Research Report No.* 73. Rondeau Archeological, Sacramento.

——— 2010b Eight Early Bifaces from the Burns BLM District, Harney County, Oregon. *CalFLUTED Research Report No.* 79, Draft. Rondeau Archeological, Sacramento.

Skinner, C. E., and J. J. Thatcher 2007 NWROSL Results 2007:40. Manuscript on File at Burns BLM District Office.

——— 2008a NWROSL Results 2008:21. Manuscript on File at Burns BLM District Office.

——— 2008b NWROSL Results 2008:83. Manuscript on File at Burns BLM District Office.

——— 2010a NWROSL Results 2010:15. Manuscript on File at Burns BLM District Office.

——— 2010b NWROSL Results 2010:99. Manuscript on File at Burns BLM District Office.

——— 2010c NWROSL Results 2010:151. Manuscript on File at Burns BLM District Office.

Thomas, S. P., and P. W. O'Grady 2006 Fluted Projectile Points: A Close Examination of Finds from Burns District BLM Lands in the Northern Great Basin. Paper presented at the 30th Great Basin Anthropological Conference, Las Vegas.

A Submerged Suwannee Point Site from Lake George, St. Johns River, Florida

David K. Thulman

➤ **Keywords**: Paleoindian, Florida, Suwannee

The Lake George Point site (PU1470) is a newly identified Suwannee site submerged in Lake George in the St. Johns River in northeast Florida. Until recently recorded Paleoindian points were rare in this region of the state

David K. Thulman, Anthropology Department, The George Washington University, 2110 G St. NW, Washington, DC 20052; email: dthulman@gwu.edu

(Dunbar 1991), and only one Paleoindian site had been recorded (Edwards 1954). In 2000 a local collector reported several Suwannee points (Figure 1) from Lake George. Over several years he collected more than 40 whole points and snapped bases from the site by probing the lake bottom, along with many unifacial tools and Pleistocene faunal remains. His entire collection from the region around Lake George and nearby Crescent Lake includes 88 Paleoindian hafted bifaces (Thulman 2006a; images and data on these points are available on the PIDBA website), all but 10 of which were found in the lakes or along their shorelines. Suwannee-age material has never been dated but is presumed to be post-Clovis in age (ca. 10,500–10,200 RCYBP; Daniel and Wisenbaker 1987).

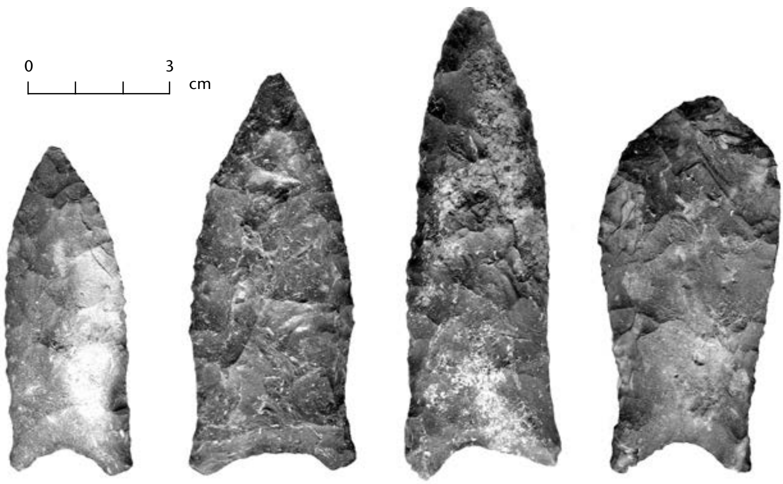


Figure 1. Four complete Suwannee points from the Lake George Point site.

The site is located on the end of a submerged sand spit (~1 m in depth) that extends approximately 150 m from the northeast shore of the lake. Lake George is a broad (10 km by 18 km) shallow (average depth ~3–4 m) lake intersected by the St. Johns River. Several springs discharge into the western side of the lake. During the late Pleistocene the lake would have been a dry, flat broad plain, and the site would have provided its occupants with an advantageous vantage point (Thulman 2009).

Most of the points are made of Ocala chert, whose nearest known sources are 65 km to the west, near Silver Springs, Marion County. The complete points are all resharpened. Other than the points, it was not possible to identify with confidence which tools had come from the site. However, a cursory review showed they are dominated by unifaces similar to tools found at the Suwannee/Bolen site of Harney Flats in Hillsborough County (Daniel and Wisenbaker 1987) and another collection of Paleoindian/early Archaic tools from the Santa Fe River in Alachua County (Thulman 2006b).

In 2009, an underwater survey was made of the site to determine whether any of the Paleoindian occupation remained. The depth of the site ranged from approximately 1m to 2 m (although parts of the site may remain undisturbed in deeper water), and the survey was conducted by divers along several transects and at random loci. Although not deep, the water was dark, which made surveying difficult. We found no diagnostic Paleoindian artifacts, although many unstained remains of Pleistocene fauna were recovered, including horse, giant tortoise, mammoth, and mastodon. Holocene species were also recovered, but most of that material was stained, indicating that the Pleistocene deposits are segregated from the modern surface. Previous coring by the USGS in this area of the lake found deep deposits of preserved vegetation, indicating that conditions are favorable for preserving Paleoindian–age organic artifacts. Future plans call for mapping portions of the lake bottom, searching for promising landforms and conducting additional surveys.

References Cited

Daniel, R. I., and M. Wisenbaker 1987 *Harney Flats: A Florida Paleo-Indian Site*. Baywood Publishing, Farmingdale, NY.

Dunbar, J. S. 1991 Resource Orientation of Clovis and Suwannee Age Paleoindian Sites in Florida. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 185–213. Center for the Study of the First Americans, Oregon State University, Corvallis.

Edwards, W. E. 1954 The Helen Blazes Site of Central Eastern Florida: A Study in Method Utilizing the Disciplines of Archaeology, Geology, and Pedology. Unpublished Ph.D. dissertation, Department of Geology, Columbia University, New York City.

Thulman, D. K. 2006a *A Reconstruction of Paleoindian Social Organization in North Central Florida*. Ph.D. dissertation, Department of Anthropology, Florida State University, Tallahassee.

——— 2006b A Suwannee/Bolen Artifact Assemblage from the Santa Fe River. *The Florida Anthropologist* 59: 21–34.

——— 2009 Freshwater Availability as the Constraining Factor in the Middle Paleoindian Occupation of North-Central Florida. *Geoarchaeology* 24:243–76.

Archaeology of Latin America

The Paleoamerican Occupation of Cueva Bautista: Late-Pleistocene Human Evidence from the Bolivian Highlands

Juan Albarracin-Jordan and José M. Capriles

➤ **Keywords:** Dry cave archaeology, lithic artifacts, Bolivia

Research on the early peopling of the Americas has progressed enormously during the last several decades. Unfortunately, archaeological research on late-Pleistocene human colonization in current Bolivian territory has received little attention. Here we report the first archaeologically documented late-Pleistocene human occupation from southwest Bolivia (Figure 1A). In 2008, we surveyed the Sora River valley, a narrow basin defined by two parallel outcrops of ignimbrite rock within the extremely high and dry Lípez desert (Albarracin-Jordan 2000). During this survey, a number of caves and rock shelters with stratified prehistoric sequences were discovered.

Test units were excavated in three of the caves, providing abundant evidence of pre-Hispanic occupations. Major findings came from Cueva Bautista (AL03) located at 3930 m above sea level and about 20 m above the nearby river. A 1-m^2 test unit located at the center of the cave produced the following stratigraphic sequence (Figure 1B), described from top downward. The first layer was a thick deposit (45 cm) of compacted llama and sheep manure that extended throughout the entire cave. Beneath this protecting event lay an ashy lens capping a cultural fill that contained a variety of fragmented artifacts, including pre-Hispanic ceramics, lithics, camelid bones, as well as rodent and camelid dung. At 75 cm beneath the surface, a ritual leather bag was discovered. The bag contained a set of eight polished stones and was embedded in a feature of well-preserved grass and cobbles. A leather fragment of the bag was AMS dated to 3111 ± 54 RCYBP or 3384–3101 CALYBP (AA84157). Beneath this layer, a thick organically rich fill was deposited containing

Juan Albarracin-Jordan, Fundación Bartolomé de las Casas, Av. Sánchez Lima 2520, La Paz, Bolivia; email: albarracinjordan@yahoo.com

José M. Capriles, Department of Anthropology, Washington University in St. Louis, One Brookings Drive, Campus Box 1114, St. Louis, MO 63130; email: jcaprilesflores@wustl.edu

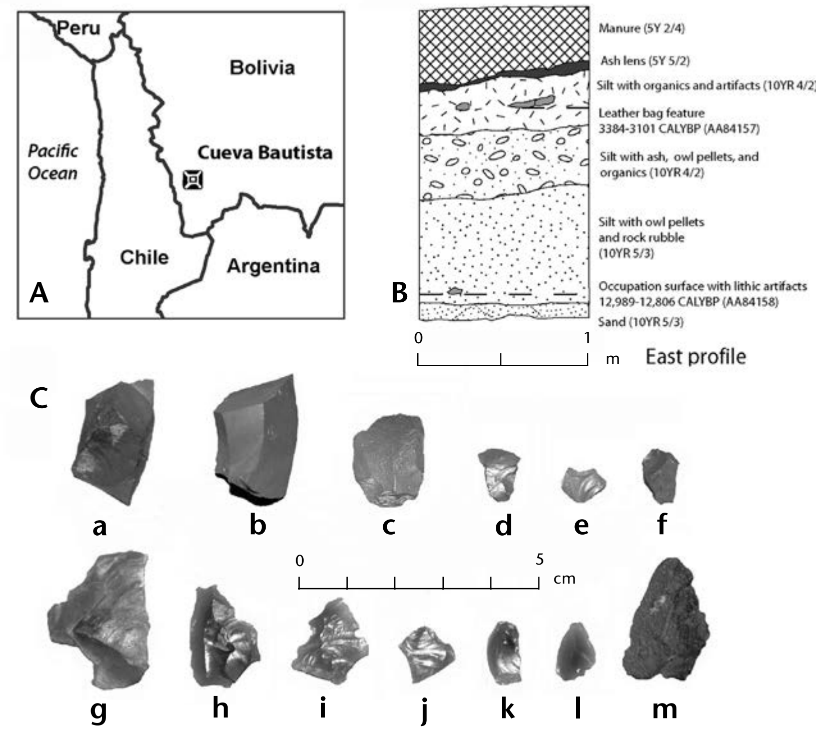


Figure 1. **A,** map of Cueva Bautista region; **B,** stratigraphy of the east profile of the 2008 test excavation; **C,** lithic artifacts recovered from the late-Pleistocene human occupation.

smaller densities of artifacts and a great quantity of regurgitated owl (probably barn owl, *Tyto alba*) pellets. A layer followed composed of rock and wall fall deposited within sandy silt. This layer included several owl pellets and rodent bones but was otherwise culturally sterile. About 1.70 m below the surface, lithic artifacts were found in association with charcoal fragments from an ephemeral ash lens. A charcoal sample was AMS dated to 10,917 ± 69 RCYBP or 12,989–12,806 CALYBP (AA84158). Excavations stopped at 1.80 cm below the surface at what appeared to be culturally sterile fill.

The lithic artifacts recovered from the late-Pleistocene stratum at Cueva Bautista included five light brown chert flakes, one red jasper flake, one chalcedony flake, five obsidian flakes, and one black basalt flake (Figure 1C). One of the obsidian flakes had been retouched and was possibly used as a lateral scraper (i, Figure 1C). Most of the identified lithic raw materials are locally and regionally available; the closest known obsidian sources are Cerro Zapaleri and Caldera Vilama, near the Bolivian-Argentinean-Chilean border, and roughly 150 km southeast of the site (Nielsen 2004; Yacobaccio et al. 2004).

The late-Pleistocene human occupation surface recorded at Cueva Bautista represents the first radiocarbon-dated Paleoamerican site from southwest

Bolivia. Contextual evidence suggests the site was unused between this early occupation event and the Early Formative Period (ca. 3300 CALYBP). Paleoclimatological studies from the Bolivian Southern Altiplano report the presence of a minor lake cycle (Coipasa), between 13,000 and 11,000 CALYBP, accompanied by a much moister and warmer climate regime than today (Baker et al. 2001; Placzek et al. 2006; Rigsby et al. 2005; Sylvestre et al. 1999). Similarly, research carried out in the neighboring Chilean Atacama Desert suggests the terminal Pleistocene was characterized by a humid climate phase, followed by incremental aridity that peaked during the middle Holocene and caused major population displacements (Grosjean et al. 2005; Moreno et al. 2009; Nester et al. 2007; Núñez et al. 2002). Accordingly, Lípez was probably an attractive environment for foraging bands during episodes of climatic amelioration. Our research in Lípez continues, identifying additional sites and activities connected with early human adaptation to high altitude environments and changing climatic conditions.

Archaeological research in Lípez is supported by the National Geographic Society, Bartolomé de Las Casas Foundation, Monopol Ltda., the Viceministerio de Culturas of Bolivia, and the communities of Alota and San Agustín. Radiocarbon dating was supported by the NSF-AMS Facility at the University of Arizona.

References Cited

Albarracin-Jordan, J. 2000 *San Cristóbal: La Carretera Hacia el Océano Pacífico (vía Ollagüe) y el Impacto a los Sitios Arqueológicos. Informe de Prospección Arqueológica.* Report presented to the Dirección Nacional de Antropología y Arqueología de Bolivia, La Paz.

Baker, P. A., G. O. Seltzer, S. C. Fritz, R. B. Dunbar, M. J. Grove, P. M. Tapia, S. L. Cross, .D. Rowe, and J.P. Broda 2001 The History of South American Tropical Precipitation for the Past 25,000 Years. *Science* 291(5504):640–43.

Grosjean, M., L. Núñez, and I. Cartajena 2005 Palaeoindian Occupation of the Atacama Desert, Northern Chile. *Journal of Quaternary Science* 20(7-8):643–53.

Moreno, A., C. M. Santoro, and C. Latorre 2009 Climate Change and Human Occupation in the Northernmost Chilean Altiplano over the Last ca. 11,500 cal. BP. *Journal of Quaternary Science* 24(4):373–82.

Nester, P.L., E. Gayó, C. Latorre, T. E. Jordan, and N. Blanco 2007 Perennial Stream Discharge in the Hyperarid Atacama Desert of Northern Chile during the Latest Pleistocene. *Proceedings of the National Academy of Sciences* 104(5):19724–29.

Nielsen, A. E. 2004 Aproximación a la Arqueología de la Frontera Tripartita Bolivia-Chile-Argentina. *Chungará, Revista de Antropología Chilena* 36(2):861–78.

Núñez, L., M. Grosjean, and I. Cartajena 2002 Human Occupations and Climate Change in the Puna de Atacama, Chile. *Science* 298:821–24.

Placzek, C., J. Quade, and P. J. Patchett 2006 Geochronology and Stratigraphy of Late Pleistocene Lake Cycles on the Southern Bolivian Altiplano: Implications for Causes of Tropical Climate Change. *Geological Society of America Bulletin* 118(5/6):515–32.

Rigsby, C. A., J. P. Bradbury, P. A. Baker, S. M. Rollins, and M. R. Warren 2005 Late Quaternary Palaeolakes, Rivers, and Wetlands on the Bolivian Altiplano and their Palaeoclimatic Implications. *Journal of Quaternary Science* 20(7-8):671–91.

Sylvestre, F., M. Servant, S. Servant-Vildary, C. Causse, M. Fournier, and J. P. Ybert 1999 Lake-Level Chronology on the Southern Bolivian Altiplano (18°–23°S) during Late-Glacial Time and the Early Holocene. *Quaternary Research* 51(1):54–66.

Yacobaccio, H. D., P. S. Escola, F. X. Pereyra, M. Lazzari, and M. D. Glascock 2004 Quest for

Ancient Routes: Obsidian Sourcing Research in Northwestern Argentina. *Journal of Archaeological Science* 31(2):193–204.

GIS Archaeological Site Record and Remarks on Paleoindian Finds in the Rio Negro River Basin, Central Uruguay

Jorge Femenías, Hugo G. Nami, Andrés Florines, and Arturo Toscano

➤ **Keywords:** GIS database, Fishtail points, Uruguay

Systematic Paleoindian research began in Uruguay at the end of the 1990s, and since then various activities have been conducted and reported on Pleistocene topics (Cavalloto et al. 2002; López et al. 2001; Nami 2001a, 2001b, 2001c, 2008a, 2010). Identifying Paleoindian sites with stratigraphic evidence has been a significant focus of these surveys, among them a long-term project in the basin of the Rio Negro (Nami 2007, 2008b, 2009, 2010; Nami and Castro 2010), which had been a focus of archaeological interest during previous years (i.e., Baeza et al. 2001; Taddei 1980). This region is characterized by a large amount of flaked- and ground-stone remains, mostly Holocene projectile points, scrapers, blade and flake cores, and other artifacts, but Paleoindian Fishtail, or Fell, projectile points are also widespread compared with other parts of South America.

Beginning in the 1970s, Femenías recorded and photographed more than 120 specimens throughout Uruguay. Most of the Fell points were found by collectors and amateur archaeologists, who had varying motivations. Some destroyed archaeological deposits or removed surface artifacts without making any records. Generally, they sold them on the black market, which is characterized by commercialization of legitimate artifacts as well as falsifications, and some may have ended up in recognized museums (Meneghin 2008). A few individuals who are aware of the scientific value of Fishtail points have made surface collections when the water level falls in the river and behind the Gabriel Terra dam. They have carefully recorded their finds and have allowed profes-

---

Jorge Femenías, Former director, Museo "Antonio Taddei", Parque Gral. Artigas, Canelones, República Oriental del Uruguay. We regret that Jorge Femenías passed away during production of this article.

Hugo G. Nami, CONICET-Instituto de Geofísica Daniel A. Valencio (INGEODAV), Dpto. Ciencias Geológicas, FCEN, UBA. Ciudad Universitaria, Pab. II, (C1428EHA) Ciudad Autónoma de Buenos Aires, Argentina; Associated researcher, National Museum of Natural History, Smithsonian Institution, Wa. D.C., USA; e-mail: hgnami@fulbrightmail.org

Andrés Florines and Arturo Toscano, Museo Nacional de Antropología, Avda. de las Instrucciones 948, Montevideo, República Oriental del Uruguay; e-mails: florines@adinet.com.uy toscano@adinet.com.uy

sional archaeologists to study them (Frison 1984). In this physiographically complex area, their information is helpful in a number of ways. In the case reported here, they have been helpful in identifying Paleoamerican surface and stratigraphic sites, and discussing typological and technological topics.

We used geographical information system (GIS) software to produce a regional site database along the Negro River basin, where the Gabriel Terra dam was constructed in 1945. Its construction raised the river level ca. 15–20 m and formed the Rincón del Bonete Lake (Figure 1A). Our site database was augmented by data from field notes by the pioneering Uruguayan archaeolo-

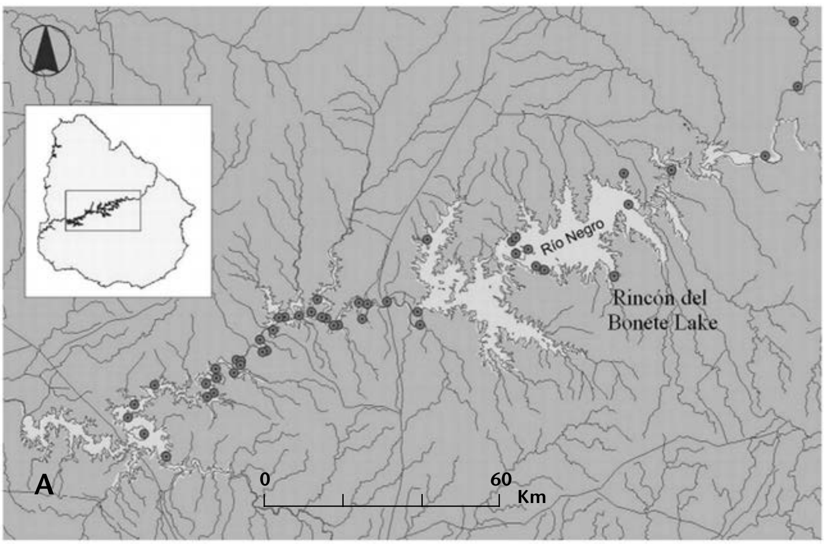


Figure 1A. Map of the Negro River basin and location of recorded sites.

gist Antonio Taddei and by information provided by collectors living in the region. Most of the sites show vestiges of Holocene occupations, but indubitable Paleoindian remains were encountered on the surface of pre-dam sand dunes and eroded deposits along the post-dam basin (i.e., Paso del Puerto) (Nami 2001a, 2007; Taddei 1980). A remarkable feature is that most finds are located near the mouths of small creeks such as the Cacique, Minas de Callorda (MC), and Los Molles (LM) sites. Several of them yielded diverse kinds of Paleoindian surface finds, mainly Fell points (Figure 1F–I). Hence, they have been visited to evaluate their potential to provide stratified material. MC and LM have stratigraphic sections with evidence of multicomponent archaeological layers, and both sites are being excavated. A probable late-Pleistocene/early-Holocene layer has been identified at MC (Nami 2007), and the archaeological layer at the top of the probable late-Pleistocene "Dolores formation" at LM is being dated. Scattered Paleoindian artifacts have been found along the deposits eroded by the river and Rincón del Bonete Lake; in many cases, however, their precise locations were not registered, so their interpretation must be used with caution. This is also the case with a Fishtail

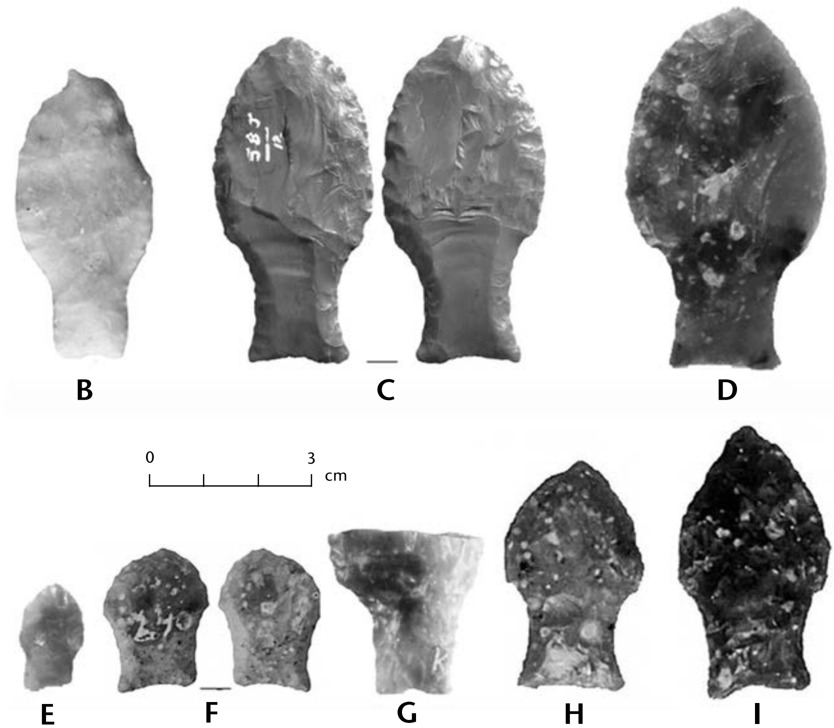


Figure 1B. Examples of Fishtail points from the Negro River basin: **(B–E)** of unknown origin; **(F–I)** of known origin . **B,** probably from Taján lands near Paso de los Toros city; **C,** Rincón del Bonete Lake area; **D,** Tres Arboles creek basin; **E,** San Gregorio de Polanco beach; **F,** Minas de Callorda site; **G,** Paso del Puerto site; **H–I,** Arroyo Cacique site. Collections credits: **B,** Junta Local Autónoma de Paso de los Toros; **C,** M. E. Vera; **D, H–I,** S. Bálsamo; **E,** W. Suárez; **F,** W. Aizpún. Photographs: B, D, E, H–I, H. Nami; C, G, U. Meneghin; F, J. Femenías.

miniature recently recovered south of San Gregorio de Polanco beach (Figure 1E), which was studied before it was sold to an Uruguayan collector. Another well-made specimen from Tres Arboles Creek basin was also sold by its discoverer (Figure 1D). Some collectors have forgotten the precise locations of their finds (Figure 1C). In other cases, information has been lost because of the death of a collector, for example, the collection of Mr. Derici currently curated by the *Junta Local Autónoma de Paso de los Toros,* and mostly recovered from the now consolidated sand dunes located on Mr. Olindo Taján's lands (e.g., Figure 1B).

In summary, Paleoindian archaeological remains are abundant in Uruguay, especially in the Rio Negro basin, although late-Pleistocene archaeological research is in its infancy. Useful information can be obtained from materials recovered by nonprofessionals, but extreme caution must be exercised in its interpretation.

We are indebted to the University of Buenos Aires and CONICET (PIP-114-200801-00344) for their continuous support; W. Aizpún and S. Bálsamo, who provided invaluable information, help and cooperation during the GIS mapping and survey; and Betty Meggers, who edited an earlier draft of this paper.

References Cited

Baeza, J., J. Femenías, R. Suárez, and A. Florines 2001 Investigación arqueológica en el río Negro medio (Informe preliminar). In *Arqueología uruguaya hacia el fin del milenio (X Congreso Nacional de Arqueología, Colonia del Sacramento, 16–19 de junio, 1997)*, 1, pp. 285–95.

Cavalloto, J. L., R. Violante, and H. G. Nami 2002 Late Pleistocene-Holocene paleogeography and coastal evolution in the mouth of the Río de la Plata: Implications for the human peopling of South America. *Current Research in the Pleistocene* 19:13–16.

López, F., J. Femenías, and H. G. Nami 2001 Fell evidence and new data on Late-Pleistocene landscape from Canelones, Uruguay. *Current Research in the Pleistocene* 18:41–44.

Frison, G. C. 1984 Avocational Archaeology: Its Past, Present, and Future. In *Ethics and Values in Archaeology*, edited by E. L. Green, pp. 184–93. New York: The Free Press.

Meneghin, U. 2008 *Falsificaciones arqueológicas en el Uruguay*. Fundación Arqueología Uruguaya, Montevideo.

Nami, H. G. 2001a New Data on Fell Lithic Technology from Paso del Puerto, Río Negro Basin, Uruguay. *Current Research in the Pleistocene* 18:47–50.

——— 2001b *Consideraciones tecnológicas preliminares sobre los artefactos líticos de Cerro de los Burros (Maldonado, Uruguay)*. Comunicaciones Antropológicas de los Museos Nacionales de Historia Natural y Antropología de Montevideo 3(1).

——— 2001c Paleoindian Archaeological Evidence and Two Cases of Land Bridges in Southern South America. *Continental Shelves during the Last Glacial Cycle*, edited and compiled by W.W.-S. Yim and A. R. Chivas, pp. 43–45. Department of Earth Sciences, University of Hong Kong.

——— 2007 Research in the Middle Negro River Basin (Uruguay) and the Paleoindian Occupation of the Southern Cone. *Current Anthropology* 48:164–76.

——— 2008a Paleomagnetic Results from the Urupez Paleoindian Site, Maldonado Department, Uruguay *Current Research in the Pleistocene* 25:40–43.

——— 2008b Observaciones experimentales sobre las puntas de proyectil Fell de Sudamerica. *II International Congress Experimental Archaeology*, edited by A. Morgado, J. Baena Preysler, and D. García González. Asociación Española de Arqueología Experimental, Universidad de Granada, Universidad Autónoma de Madrid, Museo de Ronda, Consejería de Cultura de la Junta de Andalucía, and Consejería de Innovación, Ciencia y Empresa de la Junta de Andalucía, pp. 31–33.

——— 2009 Crystal Quartz And Fishtail Projectile Points: Considerations on Raw Materials Selection by Paleo-Southamericans. *Current Research in the Pleistocene* 26:9–12.

——— 2010 *Tecnologia Paleoindia de Sudamérica: Nuevos Experimentos y Observaciones para Conocer la Secuencia de Reducción Fell*. Fundación Arqueología Uruguaya, Montevideo.

Nami, H. G., and A. Castro 2010 New Paleoindian Finds and Micro-Wear Analysis at Arroyo Cacique Site, Tacuarembó Department, Uruguay. *Current Research in the Pleistocene* 27:25–28.

Taddei, A. 1980 Un yacimiento de cazadores superiores en el Río Negro (Paso del Puerto) (Uruguay). In *Anales, III Congreso Nacional de Arqueología (1974)*. Montevideo.

Coast-inland Mobility during the Early Holocene in the Semiarid North of Chile: La Fundición Site

Donald Jackson, César Méndez, and Antonia Escudero

➤ **Keywords**: Mobility, hunter-gatherers, semiarid northern Chile

In the semiarid north of Chile, the first coastal human occupations are regionally known as the Huentelauquén Cultural Complex (Jackson and Méndez 2005; Llagostera et al. 2000). These contexts show a first phase (13,000–11,000 CALYBP) with a clear coastal adaptation, while in a second phase (11,000–9000 CALYBP) evidence shows humans being more hunting oriented, with settlements being located along ravines that connected coastal, inner valleys, and mountain range environments (Jackson and Méndez 2005).

Within this framework, the La Fundición site is located in the inner valley of Chile in the semiarid region (Lat. 29° S.), 60 km from the coast. The site shows an extensive hunter-gatherer residential camp with strong typological links to the Huentelauquén Complex (Castillo and Rodríguez 1978; Llagostera et al. 2000).

The archaeological deposit of this settlement is 70 cm deep, without significant changes in the stratigraphy. However, two previously obtained radiocarbon dates and one new AMS date (Table 1) indicate at least three occupational events. The earliest date of the site should be regarded as somewhat later taking into account that it is a marine mollusk sample uncorrected for local reservoir effect; consequently, the beginning of the occupation probably dates back to 10,200 CALYBP.

Table 1. Radiocarbon dates of the La Fundición site (Beta 108308 – Beta 108307; Llagostera et al., 2000).

Code Lab.	^{14}C date, RCYBP	δ^{13}C	Calibrated age, CALYBP (2σ)	Calibrated midpoint, CALYBP	Stratigraphic provenience	Material
BETA 108308	8730 ± 90		10,119–9489	9675	30–40 cm	Charcoal
BETA 108307	9640 ± 150		11,385–10,524	10964	60–70 cm	Shell
UGAMS 8095	9130 ± 40	-20.6	10,484–9954	10231	30–35 cm	Bone

The site contains stemmed lanceolate projectile points (Figure 1), blanks and blank production debitage, knives, scrapers, and grinding stones among other implements, among which some polygonal stones similar to those recorded in coastal Huentelauquén sites stand out. Associated with this lithic assemblage are combustion features (i.e., hearths) and faunal remains that basically correspond to very fragmented camelid bones (*Lama guanicoe*), some with signs of fire exposure, as well as some rodent remains, bone fragments of otariids, and mollusk shells (Castillo and Rodríguez 1978; Llagostera et al. 2000). Among the mollusk remains are 120 fragments representing eight

Donald Jackson, César Méndez, and Antonia Escudero, Facultad de Ciencias Sociales, Universidad de Chile, Departamento de Antropología, Ignacio Carrera Pinto 1045, Nuñoa, Santiago, Chile; e-mails: djackson@uchile.cl cmendezm@uchile.cl aescudero@gmail.com

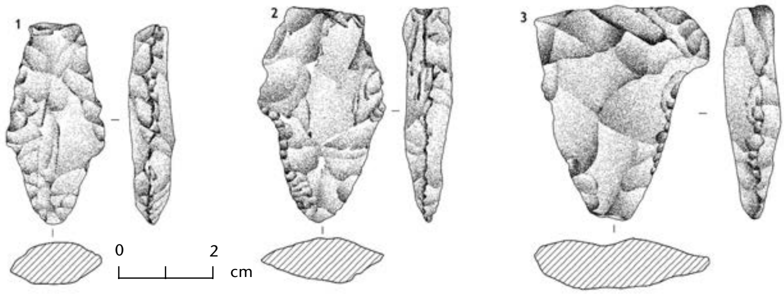


Figure 1. Stemmed projectile points from La Fundición site.

species, with a predominance of bivalves (61.3%) over gastropods (38.7%), in addition to the presence of some equinoderm remains (*Loxechinus albus*). The shell remains of some of these mollusks show anthropic signs (cuts and trimming) that indicate artifacts in their process of elaboration.

La Fundición also has yielded a burial of six individuals, including four male adults, one young adult, and a child of indeterminate sex. Two of the individuals were in flexed positions, while the remaining appear to represent secondary burials, following the same funeral pattern of sites along the coast (Costa-Junqueira 2001; Costa-Junqueira and Quevedo 1997).

The above-described characteristics of La Fundición suggest it served as a repeatedly occupied winter residential camp that was oriented essentially to hunting guanaco (*Lama guanicoe*), procuring lithic raw materials, and producing bifacial tools. The presence of some otariid remains and the abundant mollusk remains link this settlement to the coast, whereas the presence of obsidian and other siliceous raw materials suggests links to inter-Andean valleys.

This settlement is strongly connected to coastal Huentelauquén Complex occupations, which contain evidence of partial transport of camelid anatomical parts and lithic raw materials from the interior. Likewise, analogous sites in the inter-Andean valleys such as La Fortuna, located some 120 km from the coast, show the presence of sea mollusks and radiocarbon dates (8160 ± 160 RCYBP[9056 CALYBP]) (Gambier 1974) consistent with those obtained from La Fundición as well as coastal sites.

The evidence from La Fortuna site and other settlements situated in the middle valleys of the semiarid north of Chile (Jackson 1998; Méndez and Jackson 2008) supports the interpretation that the Huentelauquén Cultural Complex, after 10,000 CALYBP, was characterized by a mobility-settlement pattern that articulated coastal, valley, and mountain-range environments, with more of a hunting-oriented than marine-resource-oriented economy.

Special thanks to Museo Arqueológico de La Serena for allowing the researchers to look through La Fundición.artifact collection. Research was funded by Fondecyt grant 1090044.

References Cited

Castillo, G., and A. Rodríguez 1978 Excavaciones preliminares en el sitio La Fundición; Una Industria tipo Cárcamo. *Boletín del Museo Arqueológico de La Serena* 19:125–44.

Costa-Junqueira, M. 2001 Modalidades de enterramientos humanos Arcaicos en el Norte de Chile. *Chungara, Revista de Antropología Chilena* 33 (1):55–62.

Costa-Junqueira, M., and S. Quevedo 1997 La Bioantropología de sepultamientos Arcaicos de la Cultura Huentelauquén. *Contribuciones Arqueológicas Museo Regional de Atacama* 5:511–18.

Gambier, M. 1974 Horizonte de cazadores tempranos en Los Andes Argentino-Chilenos. *Revista Hunuc Huar* II: 44-103*, Instituto de Investigaciones Arqueológicas y Museo, Universidad Nacional de San Juan.*

Jackson, D. 1998 Evaluación de las ocupaciones del Complejo Huentelauquén al interior de la costa del semiárido. *Valles* 4:139–53.

Jackson, D., and C. Méndez 2005 Primeras ocupaciones humanas en la costa del semiárido de Chile: Patrones de asentamiento y subsistencia. Actas del XVI Congreso Nacional de Arqueología Chilena, Ediciones, Museo de Historia Natural de Concepción, pp.493–502.

Llagostera, A., R. Weisner, G. Castillo, M. Cervellino, and M. Costa-Junqueira 2000 El Complejo Huentelauquén bajo una perspectiva macroespacial y multidisciplinaria. *Contribuciones Arqueológicas Museo Regional de Atacama* 5:461–80.

Méndez, C., and D. Jackson 2008 La Ocupación Prehispánica de Combarbalá (Norte Semiárido, Chile): Una propuesta sintética. *Chungara, Revista de Antropología Chilena* 40(2):5–17.

A New Fishtail-Point Find from South Brazil

Lisiane da Silva Lopes and Hugo G. Nami

➤ **Keywords:** Fishtail points, lithic technology, Brazil

A long-term investigation of Paleoindian topics has included the technology and distribution of Fishtail or Fell projectile points. As a consequence, finds in the Southern Cone have become more numerous during the past two decades and a significant number of radiocarbon dates have been obtained that define their time span between ca. 11,000 and 10,000 uncalibrated RCY (Nami 2007). Although this tradition was reported several decades ago (Schobinger 1974, Politis 1991, Prous and Piazza 1977), these sorts of finds are scarce in Brazil and careful typological and technological studies have not been performed. Hence, to add new data on Fishtail technology and its continental distribution, we report an example found in 1997 by Carla Morgana de Oliveira and Pedro Brasil de Oliveira in a small cavity formed by soil erosion while a municipal team was working along Aloys Jacob Kerber Street in the urbanized part of Montenegro, Rio Grande do Sul (Figura 1A). Following its discovery, the object was displayed in a fish tank until one of its discoverers showed it at

Lisiane da Silva Lopes, Graduate fellow: Conselho Nacional de Desenvolvimento Científico e Tecnológico; Pontifícia Universidade Católica do Rio Grande do Sul – PUCRS; Museu Histórico Nice A. Schuler, Montenegro; Rio Grande do Sul, Brazil; Ramiro Barcelos Street, No. 1027, apartment 404, Montenegro, Rio Grande do Sul, Brazil, e-mail: jlmotta@terra.com.br

Hugo G. Nami, CONICIT Instituto de Geofísica Daniel A. Valencio (INGEODAV) , Dpto. Ciencias Geológicas, FCEN, UBA. Ciudad Universitaría, Pab.II, (C1428EHA), Ciudad Autónoma de Buenos Aires, Argentina and Research Associate, National Museum of Natural History, Smithsonian Institution, Washington DC; e-mail:hgnami@fulbrightmail.org

a local school. The teacher recognized it as an archeological specimen, and it was identified as a Fishtail point by archeologist Pedro I. Schmitz (Instituto Anchietano de Pesquisas). It is now curated at the Museu Histórico Nice A. Schüler in Montenegro.

The specimen is made of high-quality pale brown chert (Figure 1B). It is 60.6 mm long and 23.2 mm wide, and has a symmetrical biconvex transversal cross section. Thickness is 7 mm in the middle part and 6 mm at the blade/stem intersection. The stem is 17 mm long, 15 mm wide in the middle, and 18 mm wide in the base. As usual in Fell points, the borders of the stem show abrasion along the edges. Between the blade and the stem is a slightly rounded shoulder, constituting a lanceolate variant observed in other Brazilian examples of Fishtail points (Nami 2010). A color difference between the original faces and the retouch scars on both faces suggests the stone was heated to improve its flaking qualities. It was made without the use of bifacial thinning

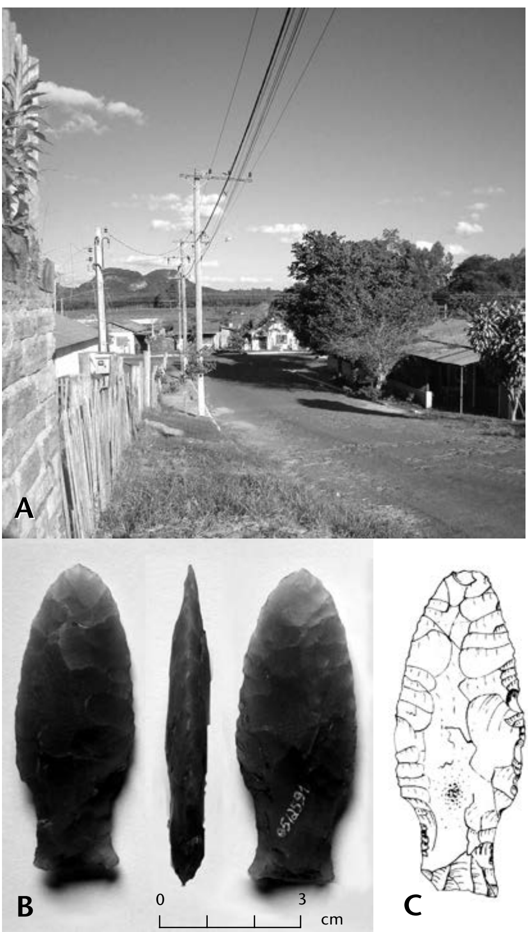


Figure 1. **A,** Location of the Fishtail point found in Rio Grande do Sul, Brazil; **B,** Fishtail point from Montenegro village; **C,** fragment from near the Jaguaruna 11 *sambaquí* (from Prous and Piazza 1977 Fig. 39).

and mostly flaked using a pressure technique that left short retouches not farther than 10–12 mm from the edges. A high proportion of retouch terminations show step and hinge fractures due to the flat surface of the flake blank that impeded the precise spread of the force (Nami 2010). It has been pointed out by several authors that removing thin flakes, then pressure retouching with short increments to finish the product is a typical Fell technological feature, which extends from northern to southern South America (i.e. Bird 1969, Mayer-Oakes 1986, Nami 2010).

The northernmost example of this kind of artifact is from the state of Bahia on the central Brasilian coast (Meggers and Barbosa, pers. com. 2006; Nami 2010 Lámina IIk). Finds are mainly located in the southern states, especially Rio Grande do Sul and Santa Catarina (Politis 1991, Schobinger 1974). The Montenegro specimen is remarkably similar to a specimen found near the Jaguaruna 11 sambaqui in Santa Catarina (Figure 1C). It is also similar in form and technology to a broken example from level XII CI at RS-C-43 site, which was also made with short retouches on a flake blank (Dias 1994, Fig. 30:2) Similar specimens have been found in several places in the Southern Cone, among them Cañada de Acaguá, Cerro Largo (Bosch et al 1980, Fig. 17), and the Río Negro basin, Uruguay; Paso Otero 5, Buenos Aires, Argentina (Martínez 2001), and Fell's Cave, Magallanes, Chile (Bird 1969, Fig. 3f,5o).

In summary, the specimen reported here adds new data on the technology and distribution of this Paleo South American artifact, thereby contributing to reconstruction of the latest-Pleistocene human dispersal across the eastern part of South America (Nami 2007).

We are indebted to the University of Buenos Aires and CONICET (PIP-114-200801-00344) for their continuous support; *Museu Histórico Nice A. Schüler* and its *Comissão de Acervo* for allowed study the Fishtail specimen; Mrs. Rosani Brochier Nicoli and Mr. Renato Antônio Kranz, of the SEPAHC - Serviço de Patrimônio Histórico e Cultural and Secretaria Municipal de Educação e Cultura of Montenegro, respectively, for their support; and Betty Meggers especially for editing an earlier draft of this paper.

References Cited

Bird, J. 1969 A Comparison of South Chilean and Ecuatorial "Fishtail" Projectile Points. *The Kroeber Anthropological Society Papers*, California, pp. 40.

Bosch, A., J. Femenías, and A. J. Olivera 1980 Dispersión de las puntas líticas pisciformes en el Uruguay. *III Congreso Nacional de Arqueología. Anales*. Centro de Estudios Arqueológicos, Montevideo.

Dias, S. A. 1994 *Repensando A Tradição Umbu a partir de um estudo de caso.* Maters Thesis, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, pp. 170.

Martinez, G. 2001 "Fish-tail" Projectile Points and Megamammals: New Evidence from Paso Otero 5 (Argentina). *Antiquity* 75:523–28.

Mayer-Oakes, W. 1986 El Inga. A Paleoindian Site in the Sierra of Northern Ecuador. *Transctions of the American Philosophical Society* 76 (4), Philadelphia, pp. i-235.

Nami, H. G. 1997 Investigaciones actualísticas para discutir aspectos técnicos de los cazadores-recolectores del tardiglacial: El problema Clovis-Cueva Fell. *Anales del Instituto de la Patagonia (Serie Ciencias Sociales)* 25:152–86.

——— 2007 Research in the Middle Negro River Basin (Uruguay) and the Paleoindian Occupation of the Southern Cone. *Current Anthropology* 48: 164–74.

——— 2010 *Tecnologia Paleoindia de Sudamerica: Nuevos Experimentos y Observaciones para Investigar la Secuencia de Reducción Fell.* Fundación Arqueología Uruguaya, Montevideo, pp. 42.

Politis, G. 1991 Fishtail Projectile Points in the Southern Cone of South America: An Overview. *Clovis. Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 287–302, Corvallis.

Prous, A., and W. Piazza 1977 *Documents por la préhistoria du Brésil méridional. 2. L´Etat de Santa Catarina.* Cahier d´archaéologie d´Ámerique dus Sud, 4, Ecole des Hautes Etudes en Sciences Sociales, Paris, pp. 179.

Schobinger, J. 1974 Nuevos hallazgos de puntas "Cola de Pescado" y consideraciones en torno al origen y dispersión de la Cultura de Cazadores Superiores Toldese en Sudamérica. *Atti del XL Congresso Internazionale degle Americanisti* 1, pp. 33–50, Roma-Genova.

Equus and *Palaeolama* Direct ^{14}C Ages at Las Monedas Site, Semiarid North of Chile

César Méndez, Donald Jackson, and Roxana Seguel

➤ **Keywords:** Extinct fauna, Pleistocene ^{14}C ages, semiarid north of Chile

Direct dating of extinct fauna is of key significance for understanding the paleoecological scenario of the Pleistocene-Holocene transition in any region. Besides characterizing coexisting faunas, it is crucial for interpreting extinction rates and climatic implications, and for assessing the availability and diversity of prey during the first peopling of a given area. Despite the frequent detection of extinct faunal bones at Los Vilos (~31° S) along the Pacific coast of South America (Méndez et al. 2004), direct radiometric dating has been stubbornly difficult because of collagen loss (i.e., Méndez and Jackson 2006; Núñez et al. 1994). The only previous local ^{14}C dates were the 9100 ± 300 RCYBP age on mastodon (possibly *Cuvieronius*) obtained at the Quereo site (Paskoff 1971) and the 13,500 ± 65 RCYBP on *Mylodon* sp. at El Membrillo site (Jackson 2003). The former is difficult to link to the limited human evidence at the site, and the latter comes from a surface context where, despite some suggestive associations, wind deflation has severely affected site integrity.

In this paper we present the first direct ^{14}C AMS dates and stable-isotope analyses on *Equus* and *Palaeolama* from the Los Vilos coast and the wider region of central Chile (30° to 34° S). Las Monedas site is located along a small ravine, 2 km from the edge of the sea. Excavations in a 15-m^2 area adjacent to an exposed profile yielded 33 well-preserved bones of extinct fauna in low-energy fine-grained sands (Méndez and Jackson 2006; Méndez et al. 2005–6) (Figure 1). Though three lithic artifacts were recorded within the same stratigraphic unit, their association with the bones remains ambiguous owing

César Méndez and Donald Jackson, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Ignacio Carrera Pinto 1045, Nuñoa, Santiago, Chile; e-mails: cmendezm@uchile.cl djackson@uchile.cl

Roxana Seguel, Laboratorio de Arqueología, Centro Nacional de Conservación y Restauración, Dirección de Bibliotecas, Archivos y Museos, Tabaré 654, Santiago, Chile; e-mail: rseguel@cncr.cl

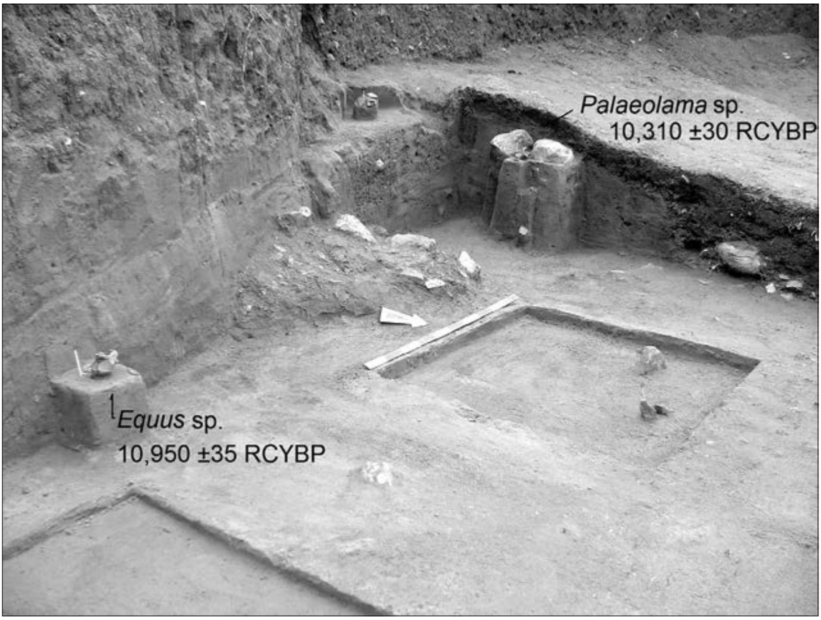


Figure 1. Excavations at Las Monedas showing the dated specimens.

to the complex formation processes in a fluvial environment (Méndez 2010). We selected one sample identified as a thoracic vertebra of *Equus* sp. (unit D4, #33a, depth 330 cm), and one lumbar vertebra of a juvenile *Palaeolama* sp. (unit D6, #18, depth 314 cm) for ^{14}C analyses. Results are presented in Table 1. Both ^{14}C dates are of late-Pleistocene age; however, they are significantly different at 95% level, indicating bones are not contemporaneous and that major rates of sedimentation prevailed. Though both samples, as well as all the rest of the bone assemblage, were identified within the same stratigraphic unit (layer 6), they were located at different depths and could be regarded as secondarily deposited as was previously suggested by Méndez et al. (2005–6; see also Méndez 2010).

Stable-isotope results are as yet quite limited and should be regarded as part of an initiating program for building a database for understanding the isotopic ecology of extinct mammalian taxa. Results for the largest extant artiodactyl *Lama guanicoe* (C3 feeder) in central Chile have mean values of -19.47‰ (sd: 0.58) for δ^{13}C col and of 4.97‰ (sd: 0.9) for δ^{15}N (Falabella et al. 2007), and are similar to those obtained for our *Equus* sp. sample.

Table 1. Radiocarbon and isotopic data presented in this paper. Dates were 2σ calibrated with OxCal 4.1 (Bronk Ramsey 2009) using IntCal 09.

Lab. code	Species	Skeletal element	^{14}C age, RCYBP	Age, CALYBP	$\delta^{13}C_{col}$	$\delta^{13}C_{ap}$	$\delta^{15}N_{col}$
UGAMS 7605	*Equus* sp.	Thoracic vertebra	10,950 ± 35	12,951–12,655	-16.3‰	-13.9‰	5.5‰
UGAMS 7606	*Palaeolama* sp.	Lumbar vertebra	10,310 ± 30	12,377–11,983	-24.4‰	-12.7‰	0.6‰

Material tested is bone collagen; ap = apatite, col = collagen

At Los Vilos there is consistent evidence supporting *Equus* sp. processing at 13,100 CALYBP at the Quebrada Santa Julia campsite (Jackson et al. 2007). However, despite the high frequency of *Palaeolama* sp. evidence (López 2007) and the simultaneous occurrence with local human occupations, there is as yet no evidence that humans consumed them. This raises several questions. Were all Pleistocene faunas equally represented in the diets of early inhabitants? And if not, what were the causes for this selectivity?

The research presented here was funded by FONDECYT 1090044 grant.

References Cited

Bronk Ramsey, C. 2009 Bayesian Analysis of Radiocarbon Dates. *Radiocarbon* 51(1):337–60.

Falabella F., M. Planella, E. Aspillaga, L. Sanhueza, and R. Tykot 2007 Dieta en sociedades alfareras de Chile Central: Aporte de análisis de isótopos estables. *Chungara Revista de Antropología Chilena* 39:5–27.

Jackson, D. 2003 Evaluating Evidence of Cultural Associations of Mylodon in the Semiarid Region of Chile. In *Where the South Winds Blow,* edited by L. Miotti, M. Salemme, and N. Flegenheimer, pp. 77–81. Center for the Study of the First Americans, Texas A&M University, College Station.

Jackson, D., C. Méndez, R. Seguel, A. Maldonado, and G. Vargas 2007 Initial Occupation of the Pacific Coast of Chile during Late Pleistocene Times. *Current Anthropology* 48(5):725–31.

López, P. 2007 Tafonomía de los Mamíferos Extintos del Pleistoceno Tardío de la Costa Meridional del Semiárido de Chile (IV Región-32° Latitud S). Alcances Culturales y Paleoecológicos. *Chungara Revista de Antropología Chilena* 39(1):69–86.

Méndez, C. 2010 Tecnología Lítica En El Poblamiento Pleistoceno Terminal Del Centro De Chile Organización, Gestos y Saberes. Unpublished PhD dissertation, Universidad Católica del Norte, San Pedro de Atacama.

Méndez, C., and D. Jackson 2006 Preliminary Results of the Excavations at Late Pleistocene Site of Las Monedas, Semiarid Coast of Chile. *Current Research in the Pleistocene* 23:67–69.

Méndez, C., D. Jackson, and R. Seguel 2004 Narrowing the Spatial Range of Megafaunal Distributions on the Semiarid Coast of Chile. *Current Research in the Pleistocene* 21:109–10.

Méndez, C., D. Jackson, P. López, and D. Jackson 2005–6 Tan Lejos, Tan Cerca: de Sitios Paleoindios y Depósitos Secundarios. Intervenciones Arqueológicas en el Nivel II del Yacimiento Pleistocénico "Las Monedas". *Revista Chilena de Antropología* 18:135–53.

Núñez, L., J. Varela, R. Casamiquela, and C. Villagrán 1994 Reconstrucción Multidisciplinaria de la Ocupación Prehistórica de Quereo, Centro de Chile. *Latin American Antiquity* 5:99–118.

Paskoff, R. 1971 Edad Radiométrica del Mastodonte de Los Vilos: 9100 ± 300 años B.P. *Noticiario Mensual del Museo Nacional de Historia Natural* 15(177):11.

Techno-Morphological and Use-Wear Analysis on Lithic and Bone Tools from Campo Laborde Site (Pampean Region, Argentina)

Pablo G. Messineo and Nélida Pal

➤ **Keywords**: Lithic tools, megamammal bone tools, use-wear analysis, Pampean region

Investigations carried out at Campo Laborde site provide new evidence for technological strategies associated with hunting and butchering a giant ground sloth (*Megatherium americanum*) during the early Holocene (Messineo and Politis 2009; Politis and Messineo 2008). Debitage analysis developed previously indicates that the last stages of the lithic reduction sequences (production and resharpening of cutting tools) were recognized both on non-local quartzite and on local raw materials such as chert and silicified dolomite (Messineo 2008; Politis and Messineo 2008). This paper reports techno-morphological and use-wear analysis performed on two lithic and two megamammal bone tools found in the site.

Both lithic tools were made on quartzite. One is interpreted as the base of a broken lanceolate bifacial projectile point. The bottom of this piece is convex with a transverse fracture, and with the edge not abraded. One face has laminar pressure-flaked scars along the base, and the opposite face has a single tiny fluting scar (Figure 1A). Use-wear analysis indicates that both edges have sedimentary abrasion and soil sheen and lack diagnostic features associated with tool use. The face with the small fluting scar, on the other hand, has fractured quartz crystals and micropolishing in the first stages of formation associated with striations and small pits (Figure 1B). This evidence suggests that this projectile point was probably used hafted. The second tool is a sidescraper made from a large flake without cortex. It has two working edges with unifacial and marginal retouches (Figure 1C). This tool has been completely modified by sedimentary abrasion and soil sheen (Figure 1D), but shows no evidence of polishing.

Both bone tools were made on megafaunal remains. One of them is made from the right distal end of a giant ground sloth rib. This implement is a fracture-based utilitarian bone tool (*sensu* Johnson 1985). Its fracture edge is rounded and polished. These modifications are localized on the end section of the fracture edge; adjoining segments of the fracture edge and the rest of the rib are unmodified (Politis and Messineo 2008: Figure 10). The second bone tool is a fragment of a rib from an unidentified megafaunal species.

Pablo G. Messineo, CONICET-INCUAPA, Facultad de Ciencias Sociales (UNCPBA), Av. Del Valle 5737, Olavarría (B7400JWI), Argentina; e-mail: pmessine@soc.unicen.edu.ar

Nélida Pal, CONICET-INCUAPA (Facultad de Ciencias Sociales, UNCPBA), Centro Austral de Investigaciones Científicas (CADIC), Bernardo Houssay 200, Tierra del Fuego (9410), Argentina; e-mail: nelidapal@cadic-conicet.gob.ar

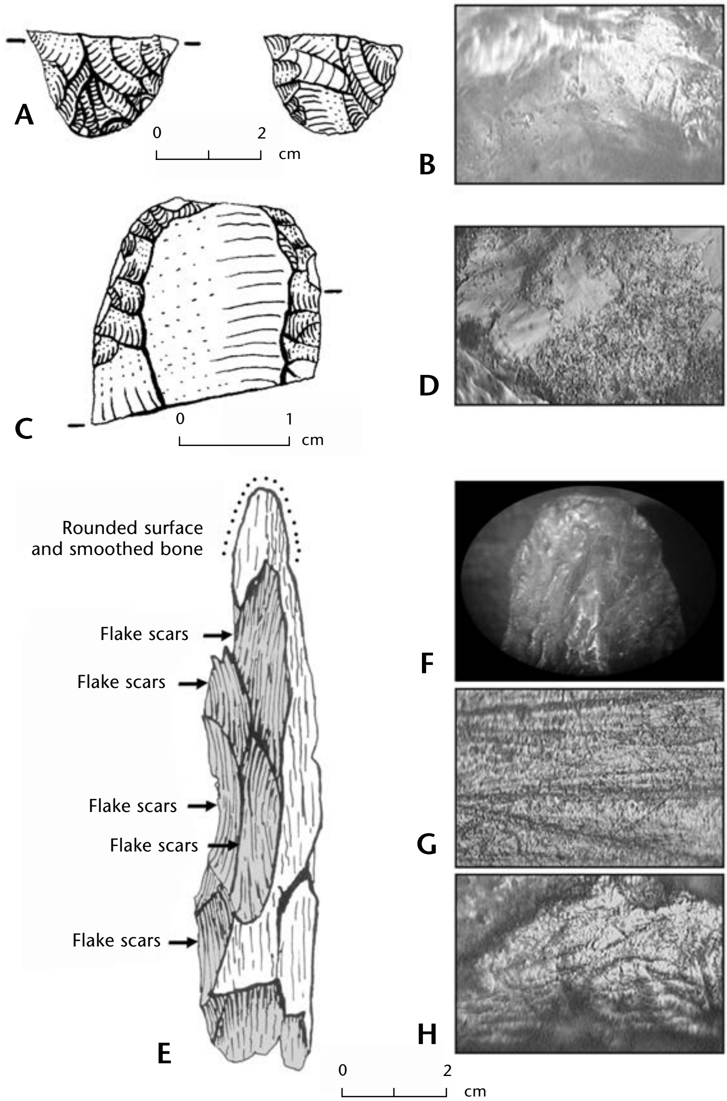


Figure 1. **A,** Projectile point; **B,** striation and small pits associated with micropolished (x 200 magnification); **C,** sidescraper; **D,** sedimentary abrasion (x 200 magnification); **E,** bone tool with negative flake scars **F,** end edge exhibiting rounded and smoothed surface (x 40 magnification); **G,** end edge polished with thin and wide parallel striation (x 200 magnification); **H,** irregular surface with sedimentary abrasion (x 200 magnification).

Along the exterior compact bone are negative flaking scars produced during tool manufacture (Figure 1E). One bone flake was refitted on one of these negatives (Messineo 2008). The end edge of this piece is rounded and polished with parallel striations and microflaking on the exterior cortical surface that are probably related to its use (Figure 1F). The rest of this piece does not show these types of modifications. Use-wear analysis of the end segment of the fracture edge (Figure 1G) detected polishing with thin and wide parallel striations. This polish was the result of contact between the bone piece and a hard material, perhaps associated with its use. In contrast, the rest of the tool has an irregular surface with moderate to severe alteration associated with a taphonomic origin (Figure 1H).

Campo Laborde was interpreted as a megamammal hunting and butchering site. For these activities, people used lithic and bone tools. Lithic tools were curated items associated with the individual toolkit of the hunters. The megamammal bones were fractured and used as expedient tools in butchering tasks. Different megafaunal species have been interpreted as food resources for hunters (Gutierrez and Martínez 2008; Politis and Gutierrez 1998; Politis and Messineo 2008). At Paso Otero 5 site megamammal bones were exploited as raw material for combustion (Martínez 2001). Campo Laborde yields the first evidence in the Pampas for megamammal bone-tool technology.

Thanks to Estela Mansur for her comments and Angélica Tivoli for her review of the English version. This article is a production of the INCUAPA, which received grants from CONICET (PIP 5424), the ANPCYT (PICT 04-12776 and 08-0430) and the Universidad Nacional del Centro de la Provincia de Buenos Aires.

References Cited

Gutierrez, M. A., and G. A. Martínez 2008 Trends in the Faunal Human Exploitation during the Late Pleistocene and Early Holocene in the Pampean Region (Argentina). *Quaternary International* 191:53–68.

Johnson, E. 1985 Current Developments in Bone Technology. In *Advances in Archaeological Method and Theory* 8, edited by M. B. Schiffer, pp. 157–235. Academic Press, New York.

Martínez, G. A. 2001 Archaeological Research in Paso Otero 5 Site. "Fish-tail" Projectile Points and Megamammals in the Pampean Region of Argentina. *Antiquity* 75(289):523–28.

Messineo, P. G. 2008 Investigaciones arqueológicas en la cuenca superior del Arroyo Tapalqué (Partidos de Olavarría y Benito Juárez, Provincia de Buenos Aires). Unpublished PhD thesis. Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata.

Messineo, P. G., and G. G. Politis 2009 New Radiocarbon Dates from the Campo Laborde Site (Pampean Region, Argentina) Support the Holocene Survival of Giant Ground Sloth and Glyptodonts. *Current Research in the Pleistocene* 26:5–9.

Politis. G. G., and M. A. Gutiérrez 1998 Gliptodontes y Cazadores-Recolectores en la Región Pampeana de Argentina. *Latin American Antiquity* 9(2):111–34.

Politis, G. G., and P. G. Messineo 2008 The Campo Laborde Site: New Evidence for the Holocene Survival of Pleistocene Megafauna in the Argentine Pampas. *Quaternary International* 191:98–114.

Exceptional Fell Projectile Points from Uruguay: More Data on Paleoindian Technology in the Southern Cone

Hugo G. Nami

➤ **Keywords:** Lithic technology, Fishtail points, Uruguay

Until recently, the largest known complete "Fishtail" or Fell projectile points with no or little resharpening barely exceeded 60–70 mm long. In Argentina, examples have been encountered at Cerro El Sombrero, Buenos Aires (Flegenheimer and Zárate 1990) and La Crucesita, Mendoza (Schobinger 1971); in Chile, at Fell's cave (Bird and Cooke 1979: Figure 12H) and Salto Chico (Dillehay 1997: Figure 3.2), and more recently in different locales from Uruguay (Nami, 2007: Fig. 7e, 2010a: Figure IId, 1, Femenías et al. 2011: Figure 1d). This paper reports technological and morphological evidence on two extraordinary additional "Fishtail" specimens from the Republic of Uruguay.

Recent explorations along the Santa Lucia River and its tributaries near San Ramón village produced paleoecological and archaeological remains (Meneghin and Sánchez 2009). A broken stemmed Fishtail point found at Arroyo Vejigas, a tributary of the Santa Lucia, deserves special attention because of its size. It is 76.1 mm long, 66.3 mm wide, and weighs 59 g. Its thickness is 9.6 mm at the middle and 10.6 mm at the blade/stem intersection. A transverse fracture probably occurred in the middle of the blade (Figure 1A), suggesting the original length may have been 130–150 mm. It is made of high-quality brown chert with different tones.

The origin of the second artifact is unknown. It is also among the largest Fell points known from South America and is now in the Rolf Nussbaum collection, currently exhibited in the Museo MAPI, Montevideo (Figure 1B). It is complete without signs of resharpening. It was made on a red silcreta from the Queguay Formation, a preferred raw material among regional Paleoindians. It is 138 mm long, 58 mm wide, and weighs 82 g. Maximum thickness at the blade-stem intersection is 10 mm; the blade is 8 mm thick. The stem is 25 mm long and 21 mm wide. The base of the stem was finished by short pressure retouch.

Both pieces have rounded shoulders, a morphological variant among Fishtail specimens (Nami 2010a). They exhibit symmetrical and longitudinal biconvex cross sections and bifacial flake scars produced by soft percussion flaking to thin the blank to a very advanced preform stage (Callahan 1979; Nami 2010a), a strategy often used in the production of large Fishtail points.

Hugo G. Nami, Instituto de Geofísica Daniel A. Valencio (INGEODAV), Dpto. Ciencias Geológicas, FCEN, UBA. Ciudad Universitaria, Pab.II, (C1428EHA), Ciudad Autónoma de Buenos Aires, Argentina; Associated researcher, National Museum of Natural History, Smithsonian Institution, Washington, D.C.; e-mail: hgnami@fulbrightmail.org

Figure 1. Exceptional stemmed Fishtail points from South America: **A,** broken piece from Arroyo Vejigas; **B,** unknown origin; **C,** Bahía state, Brazil.

The process was finished using short retouches not deeper than 10 mm from the edges that regularized the preform. This manner of obtaining the final form by using short retouches on thin flakes or biface performs might be considered a stylistic feature of Fell points (Bird and Cooke 1979; Nami 1997, 2003, 2010a). Both edges of the stem show strong abrasion.

Another exceptional fluted specimen has been found in the state of Bahia, central Brazil (Meggers and Barboza, pers. comm., 2006: Figure 1c). It is 90 mm long and 32 mm wide and was very carefully made by percussion and pressure flaking using an excellent flint-like material. Other examples have been reported from Belize (Pearson and Bostrom 1998) and Madden Lake in Panama (Bird and Cooke 1979: Figure 6c) in Central America. Another large Fishtail point has also been found in Ecuador (Nami 2010a: Figure 1g). In this context, a large fluted stem from Cerro los Burros, southern Uruguay (Meneghin 1977: Figure 20, Nami 2001) might be considered part of a large Fishtail piece.

The exceptional finds described here are adding new light to the recent technological studies on the diverse stone and bone implements in Fishtail assemblages (i.e., Nami 2010b). Contrary to earlier opinions that the human groups that used these points had a very simple technology (i.e., Orquera

1987), the new finds are showing that their technological knowledge was as refined, complex, and sophisticated as that of other Paleoindian groups in the Americas. Like Clovis, this evidence suggests that Paleo South Americans living ca. 11,000–10,000 RCYBP shared technological knowledge, signifying some kind of social or historical relationship with the second colonizing wave of humans that peopled the Americas (Goebel et al. 2008, Nami 2010b).

I am indebted to the University of Buenos Aires and CONICET (PIP-114-200801) for continuous support; the Museo Nacional de Antropología de Uruguay for sponsoring the archaeological research in that country; A. Toscano, Director of the Museum for his support; U. Meneghin, Fundación de Arqueología Uruguaya, for facilitating the study of diverse aspects of the artifacts depicted here; A. Sanchez for allowing me to study his collection; A. Florines for his constant support, help and counsel during different aspects of the research; B. Meggers and A. Barbosa for providing the images in Figure 1c and invaluable information about the Fishtail piece from Brazil; M. Meneghin Mauro for helping me improve the figure. Special thanks to B. Meggers for editing an earlier draft of this paper.

References Cited

Bird, J., and R. Cooke 1979 Los artefactos más antiguos de Panamá. *Revista Nacional de Cultura* 6:7–29.

Callahan, E. 1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition. A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7 (1):1–180.

Dillehay, T. 1997 *Monte Verde: A Late Pleistocene Settlement in Chile, Volumen 2: The Archaeological Context and Interpretation.* Smithsonian Institution Press, Washington, D.C.

Femenías, J., H. G. Nami, A. Florines, and A. Toscano 2011 GIS Archaeological Site Record and Remarks on Paleoindian Finds in the Rio Negro River Basin, Central Uruguay. *Current Research in the Pleistocene* 28:398–401.

Flegenheimer, N., and M. Zárate 1990 Paleoindian Occupations at Cerro El Sombrero Locality, Buenos Aires Province Argentina. *Current Research in the Pleistocene* 6:12–13.

Goebel, T., M. R. Waters, and D. H. O'Rourke 2008 The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science* 319:1497–1502.

Meneghin, U. 1977 *Nuevas investigaciones en los yacimientos del "Cerro delos Burros".* Imprenta Timón, Montevideo.

Meneghin, U., and A. Sánchez 2009 *Hallazgo de artefactos líticos y megafauna en el cauce de los arroyos Vejigas y Pilatos (Depto. de Canelones, Uruguay).* Fundación de Arqueología Uruguaya, Montevideo.

Nami, H. G. 1997 Investigaciones actualísticas para discutir aspectos técnicos de los cazadores-recolectores del tardiglacial: El problema Clovis-Cueva Fell. *Anales del Instituto de la Patagonia (Serie Ciencias Sociales)* 25:152–86.

——— 2001 Consideraciones tecnológicas preliminares sobre los artefactos líticos de Cerro de los Burros (Maldonado, Uruguay). *Comunicaciones Antropológicas de los Museos Nacionales de Historia Natural y Antropología de Montevideo* III (1):1–24.

——— 2003 Experimentos para explorar la secuencia de reducción Fell de la Patagonia Austral. M*agallania* 30:107–38.

——— 2007 Research in the Middle Negro River Basin (Uruguay) and the Paleoindian Occupation of the Southern Cone. *Current Anthropology* 48(1):164–74.

——— 2010a *Tecnologia Paleoindia de Sudamerica: Nuevos Experimentos y Observaciones para Investigar la Secuencia de Reducción Fell.* Fundación de Arqueología Uruguaya, Montevideo.

——— 2010b Late Pleistocene Technology in the New World: Bone Artifacts from Cueva del Medio and other Sites in the Southern Cone of South America. In *Ancient and Modern Bone Artefacts from America to Russia. Cultural, Technological and Functional Signature,* edited by A. Legrand-Pineau, I. Sidéra, N. Buc, E. David, and V. Scheinsohn, pp. 279–86. BAR International Series, Oxford.

Orquera, L. A. 1987 Advances in the Archaeology of the Pampa and Patagonia. *Journal of the World Prehistory* 1:333–413.

Pearson, G., and P. Bostrom 1998 A New Fluted Stemmed Point from Belize and its Implication for a Circum-Caribbean Paleoindian Culture Area. *Current Research in the Pleistocene* 15:34–37.

Schobinger, J. 1971 Una punta de tipo "Cola de Pescado" de La Crucesita (Mendoza). *Anales de Arqueología y Etnología* XXVI:89–97.

Rescue of *Mammuthus* sp. Remains Associated with a Possible Artifact at Villa Hidalgo, Zacatecas, Mexico

Silvia Puga Pérez, Carlos A. Carrillo Rodríguez, and Ciprian F. Ardelean

➤ **Keywords**: Mammoth, lithics, Mexico

Ongoing research on late-Pleistocene megafauna at Laguna El Salitre, near Villa Hidalgo (Mexican state of Zacatecas), provided the motivation for salvage excavation in 2010 of a buried *Mammuthus* sp. skull threatened by modern sediment extraction associated with mud-brick manufacture. Beyond rescuing the remains, another goal was to study the possible association of the proboscidean with other Pleistocene species previously reported for the region but without clear contextual data. The coordinates of the site are 22° 23′ 2.23″ N, 101° 46′ 10.03″ W, altitude 2,107 m.a.s.l.

Aside from the report of a *Mammut americanum* mandible fragment (Polaco et al. 1998) and pioneering research in nearby regions (Mirambell 1982), little is known about the Pleistocene archaeology of this area. Earlier geological studies provided preliminary information about the area's sediments, mainly lagoonal deposits (Cárdenas 1992). The stratum containing mammoth remains consists of gray lacustrine silts that are soft when wet, but become rock-hard when dry.

Locals digging out mud discovered the cranium, destroyed the frontal portion including most of the tusks, and then refilled the pit before archaeologists arrived. Our analysis later determined that the skull showed an inverted position with the tips of the damaged tusks clearly intruding downward into

Silvia Puga Pérez, Unidad Académica de Antropología, Universidad Autónoma de Zacatecas, Campus 2 Humanidades, Av. Preparatoria s/n, Fracc. Progreso, Col. Hidráulica, CP 98680, Zacatecas, Zac., Mexico; e-mail: duck_itztli@yahoo.com

Carlos A. Carrillo Rodríguez, Unidad Académica de Antropología, Universidad Autónoma de Zacatecas, Campus 2 Humanidades, Av. Preparatoria s/n, Fracc. Progreso, Col. Hidráulica, CP 98680, Zacatecas, Zac., Mexico; e-mail: nemesisdivinae@yahoo.com

Ciprian F. Ardelean, Unidad Académica de Antropología, Universidad Autónoma de Zacatecas, Campus 2 Humanidades, Av. Preparatoria s/n, Fracc. Progreso, Col. Hidráulica, CP 98680, Zacatecas, Zac., Mexico / Department of Archaeology, University of Exeter, Laver Building, North Park Road, Streatham Campus, EX4 4QE, Exeter, Devon, United Kingdom; e-mail: cfa202@exeter.ac.uk

sediments. Related and well-preserved vertebrae and a scapula were found near the skull. They belong to the same individual, showing little post-depositional disturbance.

The interesting discovery is a small piece of reddish brown flint (Munsell 10R3/4-4/6) found buried at a depth of 141 cm, just a few centimeters north of the mammoth's skull, clearly in an undisturbed portion of the same deposit as the animal (Figure 1). It is the only rock encountered in the excavation. This object lacks the "classic" features of an artifact, but it shows a uniform shiny patina all over its surface. It proves to be the proximal end of a thick,

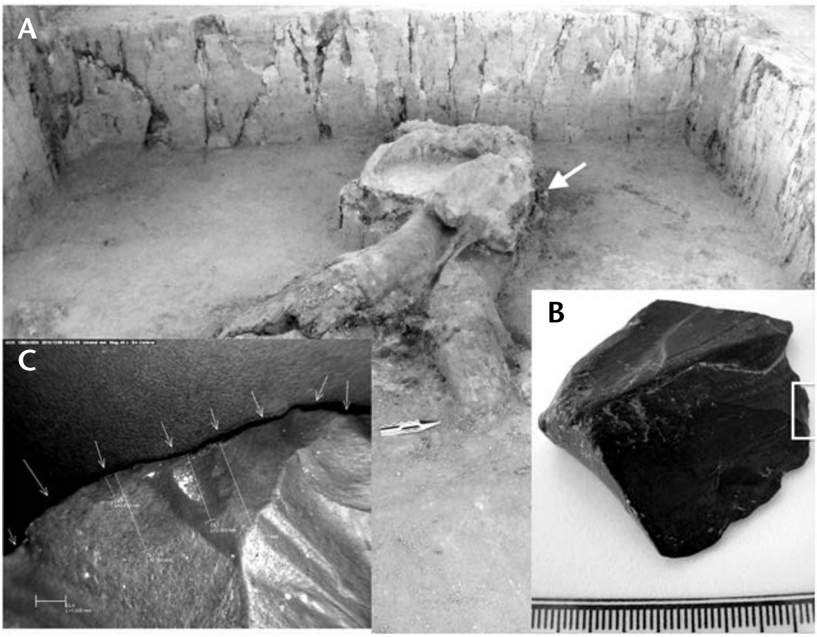


Figure 1. **A,** the inverted cranium of a mammoth uncovered in lacustrine silt deposits at Villa Hidalgo, Zacatecas, Mexico, as seen from the east. The white arrow points to the place of discovery of the flint flake, almost adjacent to the skull on its north side. **B,** the flint fragment; the rectangle on the edge indicates the area shown in **C,** 40x magnification of microflaking possibly generated by scraping shown magnified on the left.

heavily worn and reworked flake extracted from a square-sided nodule. Its edges are slightly smoothed by natural polish. Signs of contact with fire are visible in color changes and tiny fractures on the proximal end and across the flat ventral side. It has a triangular cross section, and its distal portion is wedge shaped by fracture. This possible artifact is 45.1 mm long, 37.9 mm wide, and 17.4 mm thick. The right convex edge shows small-scale, continuous bifacial micro-flaking most likely caused by use of the flake as a scraper.

Stratigraphic layers above the level of the mammoth yielded rare dispersed and mixed faunal remains (like an *Equus* sp. molar), but no lithics or other traces of human presence.

References Cited

Cárdenas Vargas, J. (editor) 1992 *Geological Mining Monograph of the State of Zacatecas.* Consejo de Recursos Minerales, Secretaría de Energía, Minas e Industrias Paraestatales, Subsecretaria de Industria Básica, Mexico City.

Mirambell, L. 1982 *Laguna de Las Cruces, Salinas, SLP.* Colección Científica no. 128, Instituto Nacional de Antropología e Historia, Mexico City.

Polaco, O. J., J. Arroyo-Cabrales, and B. García-Uranga 1998 The American Mastodon in Mexico. *Current Research in the Pleistocene* 15:123–24.

Paleoindian Occupation in the Central Mountains of Argentina: Was It a Failed Colonization?

Diego Rivero and Eduardo Berberián

➤ **Keywords**: Peopling, Pleistocene/Holocene transition, central Argentina

The aim of this report is to present information about human presence during the Pleistocene/Holocene transition in the Central Mountains of Argentina and to discuss its implications for the peopling of the Southern Cone of South America. The Central Mountains are located in Córdoba and San Luis provinces, in central Argentina. They consist of a number of main strands, with heights ranging between 1,000 and 2,800 m above sea level, extending along a north-south direction more than 600 km (Figure 1).

The Paleoindian occupation of the Central Mountains dates from the Pleistocene/Holocene transition. At the El Alto 3 site (EA3), in the basal unit was uncovered the oldest evidence for human presence in the region. Two charcoal concentrations associated with the cultural remains were dated to 9790 ± 80 (LP-1420) and 11,010 ± 80 RCYBP (LP-1506). In the context of the human peopling model proposed by Borrero (1994) for southern South America, these results were interpreted as an occupation assignable to the territorial exploratory stage (Rivero and Roldán 2005). Recently a new charcoal sample from this site associated with quartz flakes was dated to 9371±51 RCYBP (AA94987).

Recent ^{14}C analysis of human bones from the Gruta de Candonga site (GC) have yielded one date of 10,450 ± 50 RCYBP (SRLA-1062; Cornero y Neves 2011).

Other evidence for Paleoindian occupation in the Central Mountains is scarce and consists only of three Fishtail projectile points found in surface collections from two localities (Laguens et al. 2007; Politis 1991). This Paleoindian occupation is of low density, especially when compared with the

Diego Rivero, Centro de Estudios Históricos "Prof. Carlos S. A. Segreti" – CONICET, Raúl Casariego 4096 (C.P. 5008) Córdoba, Argentina; e-mail: ayampitin1@yahoo.com.ar

Eduardo Berberián, Centro de Estudios Históricos "Prof. Carlos S. A. Segreti" – CONICET, San Lorenzo 550 piso 11 departamento "B" (C.P. 5000) Córdoba, Argentina; e-mail: eduardoberberian @conicet.gov.ar

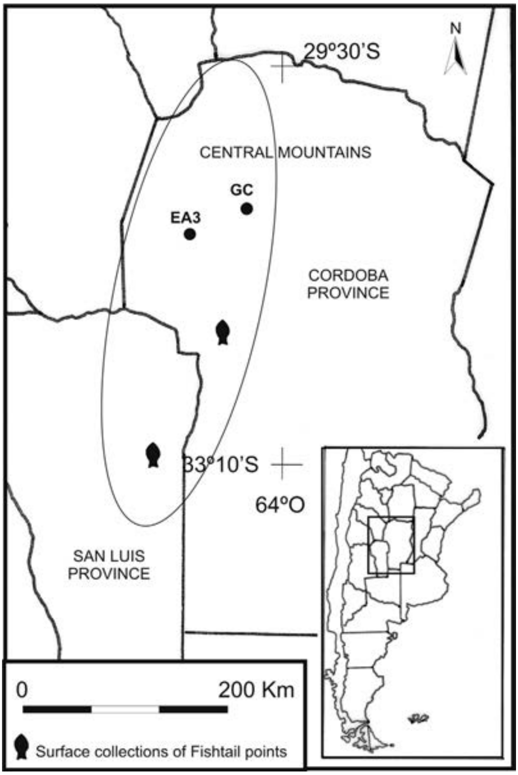


Figure 1. Locations of the EA3 and GC archaeological sites and surface collections of Fishtail projectile points.

Paleoindian record from other sectors of the Southern Cone of South America like Uruguay, Chile, and the *Pampas* and Patagonia in Argentina (e.g., Steele and Politis 2009; Suárez 2003).

The scarce Paleoindian records of the Central Mountains belong to groups with a technology of Fishtail projectile points. This is followed by a period of ca. 9300–8000 RCYBP, which has yielded no archaeological evidence (Rivero 2010). Only after ca. 8000 RCYBP does the archaeological signal resurface in the region (González 1960; Rivero and Berberián 2008). This archaeological record is characterized by sites with a technology of lanceolate or foliate projectile points, known as "ayampitín," dated ca. 8000–6000 RCYBP (e.g., González 1960; Rivero 2009, 2010; Rivero et al. 2009).

These scarce archaeological data for the Pleistocene/Holocene transition in the region were not due to sampling problems. The Central Mountains have been intensively investigated for the last 20 years (e.g. Laguens et al. 2007; Rivero 2009; Rivero and Berberián 2008; Rivero and Roldán 2005). To date, more than 700 archaeological sites have been recorded, and a total of 62 ^{14}C dates are available. Only four dates and two archaeological sites belong to the Pleistocene/Holocene transition. The remaining dates and archaeological sites belong to the period after ca. 8000 RCYBP.

These observations have strong implications for the peopling of the Southern Cone of South America because we could be facing failed colonization situations in certain regions. In the Central Mountains of Argentina, this situation might be produced because the Paleoindian groups may have been few and far between, hindering the maintenance of reproductive viability (e.g., Anderson and Gillam 2001; Moore and Moseley 2001).

Only after ca. 8000 RCYBP could there have occurred a new Exploration and Colonization Process (*sensu* Borrero 1994) in the Central Mountains of Argentina, which finally led to the effective settlement of the region.

This project is funded by CONICET PIP 11220080102678.

References Cited

Anderson, D., and J. Gillam 2001 Paleoindian Interaction and Mating Networks: Reply to Moore and Moseley. *American Antiquity* 66:530–35.

Borrero, L. 1994 Spatial Heterogeneity in Fuego-Patagonia. In *Archaeological Approaches to Cultural Identity*, edited by S. Shennan, pp. 258–66. Routledge, London and New York.

Cornero, S., and W. Neves 2011 Ocupaciones tempranas en las Sierras Centrales: la Gruta de Candonga, Córdoba, Argentina, aportes a su antigüedad. *Actas de Resúmenes del 1° Congreso Internacional de Arqueología de la Cuenca del Plata*, pp. 218–19. Ciudad Autónoma de Buenos Aires.

González, A. 1960 La Estratigrafía de la Gruta de Intihuasi, (Prov. De San Luis, R. A.) y sus relaciones con otros sitios Precerámicos de Sudamérica. *Revista del Instituto de Antropología* Tomo 1:1–290. Córdoba, Argentina.

Laguens, A., E. Pautassi, G. Sario, and R. Cattáneo 2007 ELS1, a Fishtail Projectile-Point Site from Central Argentina. *Current Research in the Pleistocene* 24:55–57.

Moore, J., and M. Moseley 2001 How Many Frogs does It Take to Leap around the Americas?: Comments on Anderson and Gillam. *American Antiquity* 66:526–29.

Politis, G. 1991 Fishtail Projectile Points in the Southern Cone of South America: an Overview. In *Clovis. Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 287–301. Center for the Study of the First Americans, Oregon State University, Corvallis.

Rivero, D. 2009 *Ecología de cazadores-recolectores del sector central de las Sierras de Córdoba (Rep. Argentina)*. BAR International Series 2007, Oxford.

——— 2010 The Intensity of Human Occupation during Pleistocene-Holocene Transition (11,000–9000 BP) in the Central Ranges of Argentina. Paper presented at the V Simposio Internacional "El Hombre Temprano en América" *El poblamiento temprano de América: a un siglo del debate Ameghino-Hrdlicka*, La Plata.

Rivero, D., and E. Berberián 2008 El poblamiento de la región central del territorio argentino durante la Transición Pleistoceno-Holoceno (12,000–9000 A.P.). *Revista Española de Antropología Americana* 38(2):17–37.

Rivero, D., and F. Roldán 2005 Initial Peopling of the Córdoba Mountains, Argentina: First Evidence from El Alto 3. *Current Research in the Pleistocene* 22:33–35.

Rivero, D., S. Pastor, and M. Medina 2009 Intensificación en las sierras de Córdoba. El abrigo rocoso Quebrada del Real 1 (ca. 6000–500 AP, Córdoba, Argentina). *Anales de Arqueología y Etnología* 64:227–46.

Steele, J., and G. Politis 2009 AMS 14C Dating of Early Human Occupation of Southern South America. *Journal of Archaeological Science* 36 (2009) 419–29.

Suárez, R. 2003 Paleoindian Components of Northern Uruguay: New Data for Early Human Occupations of the Late Pleistocene and Early Holocene. In *Where the South Winds Blow: Ancient Evidence of Paleo South Americans*, edited by L. Miotti, M. Salemme, and N. Flegenheimer, pp. 29–36. Center for the Study of the First Americans, Texas A&M University Press, College Station.

Early Hunter-Gatherers and Miners (ca. 12,000 CALYBP) in the Arid Coast of Northern Chile

Diego Salazar, Donald Jackson, and Douglas Jackson

➤ **Keywords:** Hunter-gatherers, mining, Chile

The early hunter-gatherers and fishers of the Pacific coast of South America have been regarded as rather simple societies, dependent on subsistence and technological imperatives (De France et al. 2001; Jackson and Méndez 2005; Lavallée et al. 1999; Llagostera 1979; Sandweiss et al. 1998; Stothert 1988). However, the recent discovery of the site San Ramón 15 (SR-15) in the northern coast of Chile (Lat. 25 S.) shows that these early coastal groups conducted a complex operation to mine iron oxide, probably for ritual purposes.

The San Ramón 15 site is located in a ravine 800 m from the coastline in the arid coast of northern Chile. The settlement is associated with an iron oxide mine with a stratigraphic sequence of 6 m, which was heavily exploited during early (12,543 CALYBP) and late (4350 CALYBP) Holocene times. Evidence of mining and cutting technology consists of numerous lithic hammers and debitage. Also present are some essentially marine faunal remains (Salazar et al. 2011).

Evidence from early levels includes trimming debitage from biface pieces and a discoidal stone, which, in conjunction with its chronology (Table 1), links this settlement to groups with a marine/coastal adaptation regionally known as the Huentelauquén cultural complex (Jackson and Méndez 2005; Llagostera 1979; Llagostera et al 2000). Possibly related to the San Ramón mine is a small shelter some 9 km north of the site called Quebrada Cascabeles, with two occupational events attributed to the Huentelauquén cultural complex dating to 11,000 CALYBP (Casteletti et al. 2009).

Table 1. Radiocarbon dates of the San Ramón 15 (Salazar et al., 2011).

Lab no.	^{14}C date, RCYBP	Calibrated age, CALYBP (2σ)	Stratigraphic provenience	Material
Beta -255687	9160 ± 80	10,519– 9948	Unit 2/Layer 2-3	Charcoal
UGAMS – 5440	9250 ± 30	10,490–10,246	Unit 1/Layer 4	Charcoal
UGAMS – 5441	9360 ± 30	10,651–10,301	Unit 1/Layer 6	Charcoal
UGAMS – 5442	9390 ± 30	10,666–10,421	Unit 1/Layer 7	Charcoal
POZ – 32943	9310 ± 50	10,570–10,264	Unit 1/Layer 9	Charcoal
Beta – 280992	10,430 ± 60	12,543–12,095	Unit 2/Layer 5	Shell

Diego Salazar and Donald Jackson, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Ignacio Carrera Pinto 1045, Nuñoa, Santiago, Chile; e-mails: dsalazar@uchile.cl djackson@uchile.cl

Douglas Jackson, Sociedad Chilena de Malacología, Museo Nacional de Historia Natural, Interior Quinta Normal S/N, Santiago, Chile; e-mail: sillitus@hotmail.com

The stratigraphy of the early levels of the San Ramón mine reveals evidence of repeated mining operations using lithic hammers along with fragments of mollusks (*Choromytilus chorus, Argopecten purpuratus,* and *Concholepas concholepas*). Striations and signs of wear suggest they were used to extract iron oxide from narrow seams and veins.

The associated faunal remains consist of unidentified mammal skeletons, bird remains (penguin, *Spheniscus sp.*) and at least five fish species (*Citharichthys gilberti, Hydrolagus macropthalamos, Synodontis violacea, Trachurus symmetricus* and *Paralichthys microps*). Marine fauna remains consist of 19 mollusk species (MNI 221), including 10 gastropod, 6 poliplacofor, and 3 bivalve, and one echinoderm species, all of them present in the rocky intertidal zone. Marine faunal remains show signs of fire exposure, suggesting they were transported to the site and consumed as food by workers engaged in mining.

The exceptional evidence from this site shows a diversified settlement pattern that included systematic mining exploitation in a hunter-gatherer-fisher context, in which pigments were acquired for multiple uses, probably linked to ritual activities. The multiplicity of activities suggests a more complex and sophisticated society than previously thought.

Research funded by FONDECYT 1080666 grant.

References Cited

Casteletti J., O. Reyes, G. Maltrain, I. Martínez, P. Galarce, H. Velásquez, and J. Ogalde 2009 Ocupaciones en abrigos rocosos en la costa de Taltal: Patrón de uso del espacio desde momentos Holocénicos Tempranos. Actas del XVII Congreso Nacional de Arqueología Chilena, pp. 685–95. Valdivia, Chile.

De France, S., D. Keefer, J. Richardson, and A. Umire 2001 Late Paleo-Indian Coastal Foragers: Specialized Extractive Behavior at Quebrada Tacahuay, Perú. *Latin American Antiquity* 12(4):413–26.

Jackson D., and C. Méndez 2005 Primeras ocupaciones humanas en la costa del semiárido de Chile: Patrones de asentamiento y subsistencia. Actas del XVI Congreso Nacional de Arqueología Chilena, Ediciones, Museo de Historia Natural de Concepción, pp.493–502.

Llagostera, A. 1979 9,700 Year of Maritime Subsistence on the Pacific: An Analysis by Means of Bioindicadores in the North of Chile. *American Antiquity* 44(2):309–24.

Lavallée D., M. Julien, P. Béarez, P. Usselmann, M. Fontugney, and A. Bolaños 1999 Pescadores-Recolectores Arcaicos del Extremo Sur Peruano. *Bull. Inst. Fr. Études Andines* 28(1):13–52.

Llagostera, A., R. Weisner, G. Castillo, M. Cervellino, and M. Costa-Junqueira 2000 El Complejo Huentelauquén bajo una perspectiva macroespacial y multidisciplinaria. *Contribuciones Arqueológicas Museo Regional de Atacama* 5:461–80.

Salazar D., D. Jackson, J. Guendon, H. salinas, D. Morata, V. Figueroa, G. Manríquez, and V. Castro 2011 Early Evidence (ca. 12,000 B.P.) for Iron Oxide Mining in the Pacific Coast of South America. *Current Anthopology*, 52 (5):463–75.

Sandweiss, D., H. Mcinnis, R. Burger, A. Cano, B. Ojeda, R. Paredes, M. Sandweiss, and M. Glascock 1998 Quebrada Jaguay: Early South American maritime adaptations. *Science* 281:1830–32.

Stothert, K. 1988 *La* prehistoria temprana de la Península de Santa Elena, Ecuador: Cultura Las Vegas. *Miscelánea Antropológica Ecuatorina.* Serie Monográfica 10.

Two Directly Dated Early-Holocene Archaic Burials from Pains, State of Minas Gerais, Brazil

André Strauss, Edward Koole, Rodrigo Elias de Oliveira, Mariana Inglez, Tatiana Nunes, Pedro Da-Gloria, Alexandre Robazzini, Fernando Costa, and Walter Neves

➤ **Keywords**: Archaeology of death, funerary rituals, cremation

Here we report two early-Holocene burials from the karstic region of Pains, eastern central Brazil. In 2003 and 2004 the archaeological site located at the Loca do Suin rockshelter (UTM 23K 417314L/7752410S) was excavated by a team coordinated by one of the authors (Koole 2007). These are referred to as Burials 1 and 2. Lithic, pottery, and animal bones were also recovered but are not described in this contribution.

Within the pit of Burial 1 bones of at least four different individuals were present. The bones were poorly preserved, highly fragmented, and mixed. No anatomical order could be detected, but two adults could be confidently distinguished. One was heavily cremated (individual 1B) while the other was not cremated at all (individual 1A). Together they account for approximately 90% of the bones from Burial 1. In spite of the high level of fragmentation of both individuals 1A and 1B, complete skeletons seem to be represented. Charcoal was not present within the grave.

Age at death was estimated to be 20 years for Burial 1A and 50 for Burial 1B. In the absence of more reliable indicators sex was estimated from the lateral angle of the petrous bone (Nóren et al. 2005). Accordingly, individual 1A is male and 1B is indeterminable.

In individual 1A osteophytoses were observed in the cervical vertebrae. In the proximal articular surface of the left halux there is marked osteoarthritis. In both external acoustic meatus, severe tori (exostoses) were observed. Caries are almost absent, with a single occurrence in the third left inferior molar.

Individual 1B also presents severe exostoses in both meatus. In one of the few vertebrae that could be observed and confidently associated with these

André Strauss, Max Planck Institute for Evolutionary Anthropology, Department of Human Evolution, Deutscher Platz 6, 04103, Leipzig, Germany; e-mail: andre_strauss@eva.mpg.de

Edward Koole, Museu de Arqueologia e Etnologia, Universidade de São Paulo, Av. Prof. Almeida Prado, São Paulo, SP. 05508-900, Brazil; e-mail: dukoole@yahoo.com.br

Rodrigo Elias de Oliveira, Mariana Inglez, Tatiana Nunes, and Walter Neves, Laboratório de Estudos Evolutivos Humanos, Departamento de Genética e Biologia Evolutiva, Instituto de Biociências, Universidade de São Paulo, Rua do Matão 277, São Paulo, SP. 05508-090, Brazil; e-mails: eliaso@usp.br mariana_inglez@hotmail.com tatianalnunes@gmail.com waneves@ib.usp.br

Pedro Da-Gloria, Department of Anthropology, The Ohio State University, 4034 Smith Laboratory 174 W 18th Avenue, Columbus, OH. 43210-1106; e-mail: totora@uol.com.br

Alexandre Robazzini and Fernando Costa, Museu de Arqueologia e Etnologia, Universidade de São Paulo, Av. Prof. Almeida Prado, São Paulo, SP. 05508-900, Brazil; e-mails: alexandre.robazzini@usp.br fwscosta65@gmail.com

individuals there is a strong presence of osteophytes. Osteoarthritis was also observed within the glenoid fossa of the left temporal bone. Variation of structural and chromatic modifications indicates the presence of different levels of burning, ranging the entire scale proposed by Stiner et al. (1995). The presence of thumbnail fractures and warping, together with the fact that all anatomical regions were represented, suggests that the corpse was still fresh when exposed to heat (but see Gonçalves et al., 2011) (Figure 1). The regions mostly spared from burning are the calvaria, mandible, glenoid region of the scapula, and some bones of the feet. Our interpretation is that individual 1B was intentionally cremated as part of a funerary ritual.

Bones of two other individuals were also recognized within Burial 1. One of them, labeled 1C, is a child of about five years in age represented by a set of both deciduous and permanent teeth (RM_1 present a cavity on its buccal face), the left humerus, and the left temporal. None of these bones present signs of burning. The other individual, labeled 1D, is a very young child, probably a stillborn, from whom only a talus and half of a burned humerus were identified.

The poor preservation and highly fragmented nature of these remains make it very difficult to determine the sequence of events associated with Burial 1. We do not believe there is enough information even to determine whether individuals 1A and 1B represent independent interments. While the burned nature of Burial 1B makes it by definition a case of secondary burial, the chaotic disposition of the bones from Burial 1A could be the result of grave disturbance added to post-depositional processes. Therefore, although we believe individual 1A is not a primary burial, the most conservative judgment is that it is not possible to fully determine its nature.

An unburned fragment of rib bone was directly dated yielding a non-calibrated age of 7440 ± 50 RCYBP (Beta-210400; $^{13}C/^{12}C$ = -19.5). Although unburned, it is not possible to be sure if this fragment belonged to individual 1A or 1B.

Burial 2 was composed of a single male individual (Black 1978). Although fragmented and poorly preserved, the bones are better preserved in comparison with Burial 1. Although the majority of bones were not articulated, the recognizable anatomical organization suggests that this was a primary burial later disturbed by post-depositional agents. Age at death was estimated to be between 20 and 24 years based both on the pubic symphysis (Brooks and Suchey 1990) and dental wear (Lovejoy 1985). In spite of his young age, this individual exhibits a high incidence of caries (20%). No sign of osteopathology could be identified. A fragment of rib bone was directly dated, yielding an age of 7530 ± 50 RCYBP (Beta-210401; $^{13}C/^{12}C$ = -20.9).

In sharp contrast to the Andean region, which presents a relative abundance of early- and middle-Holocene sites where human burials were found (Santoro et al. 2005), in South American lowlands skeletons from this time are extremely rare (Strauss 2010). Findings from Pains constitute an important step in the direction of changing this situation and dictate further exploration in the region. Moreover, if the dated bone from Burial 1 belongs to the cremated individual, this would constitute one of the oldest directly dated cases of such practice in South America. Further investigations will clarify this point.

References Cited

Black III, T. K. 1978 A New Method for Assessing Sex of Fragmentary Skeletal Remains: Femoral Shaft Circumference. *American Journal of Physical Anthropology* 48:227–32.

Brooks, S., and J. M. Suchey 1990 Skeletal Age Determination Based on the Os Pubis: a Comparison of the Acsádi-Nemeskéri and Suchey-Brooks Methods. *Human Evolution* 5:227–38.

Gonçalves, D., T. J. U. Thompson, and E. Cunha 2011 Implications of Heat-Induced Changes in Bone on the Interpretation of Funerary Behavior and Practice. *Journal of Archaeological Science* 38:1308–13.

Koole, E. K. M. 2007 Pré-história da província cárstica do Alto São Francisco, Minas Gerais: a industria lítica dos caçadores-coletores arcaicos [Pre-history of the carstic region of the high São Francisco, Minas Gerais: the lithic industry of archaic hunter gatherers]. Unpublished M.A. thesis, Museum of Archaeology and Ethnology, São Paulo University.

Lovejoy, C. O. 1985 Dental Wear in the Libben Population: Its functional pattern and Role in the Determination of Adult Skeletal Age at Death. *American Journal of Physical Anthropology* 68:47–56.

Nóren, A., N. Lynnerup, A. Czarnetzki, and M. Graw 2005 Lateral Angle: A Method for Sexing Using the Petrous Bone. *American Journal of Physical Anthropology* 128:318–23.

Santoro, C. M., V. G. Standen, B. T. Arriaza, and T. D. Dillehay 2005 Archaic Funerary Pattern or Postdepositional Alteration? The Patapatane Burial in the Highlands of South Central Andes. *Latin American Antiquity* 16:329–46.

Stiner, M. C., S. L. Kuhn, S. Weiner, and O. Bar-Yosef 1995 Differential Burning, Recrystallization, and Fragmentation of Archaeological Bone. *Journal of Archaeological Science* 22:223–37.

Strauss, A. 2010 As práticas mortuárias dos caçadores coletores pré-históricos da região de Lagoa Santa (MG): um estudo de caso do sítio arqueológico “Lapa do Santo” [The mortuary practices of pre-historic hunter-gatherers from Lagoa Santa region: a case study of the Santo Rockshelter archaeological site]. Unpublished M.A. thesis, Department of Genetics and Evolutionary Biology, São Paulo University.

First Early Human Occupations in Caves and Rockshelters in Uruguay and Diverse Landscapes Utilized by Early South Americans

Rafael Suárez, David S. Leigh, and Mario Trindade

➤ **Keywords**: Early Holocene, AMS dates, southeastern South America

Research on the first Americans in northern Uruguay is a long-term project that started over 10 years ago. All Pleistocene and early-Holocene transition sites documented so far in Uruguay are open-air sites. Recent field work

Rafael Suárez, Museo de Arqueología y Ciencias Naturales (Salto), Universidad de la República Departamento de Arqueología and Sistema Nacional de Investigadores SNI-ANII, Coronel Raíz 1107, CP 12900, Montevideo, Uruguay; e-mail: suarezrafael23@gmail.com

David S. Leigh, The University of Georgia, Department of Geography, Athens, GA, 30601; e-mail: dleigh@uga.edu

Mario Trindade, Museo de Arqueología y Ciencias Naturales (Salto), Zorrilla de San Martin 116, Salto, Uruguay; e-mail: museoarq@salto.gub.uy

conducted since 2008 by the research team of the Museum of Archaeology and Natural Sciences of Salto led to the discovery of a series of caves (n = 5) and rockshelters (n = 4) with early human occupations among the rolling hills of Cuchilla de Haedo. Additionally, surveys helped to identify an additional 112 archaeological sites, including quarries for raw materials (silicified sandstone and translucent agate), rock-art sites, and stone structures (cairns and stone circles). Between November 2009 and May 2010 test excavations were conducted in three rockshelters (ZT-1, TN 1, TN9). In this paper we present the results obtained at the Zanja del Tigre 1 site (ZT-1) an overhang 6.75 m long, 2.25 m wide, and 3.00 m high (Figure 1). In ZT-1 we excavated a 2.00-by-0.50-m unit, which recovered 5,652 pieces of debitage and 43 formal tools (bifaces, projectile points, unifacial tools, and abraders). The two main raw materials are local silicified sandstone (92%) and chalcedony-agate (5.4%). A very low frequency of raw material is silicified limestone (0.2%), whose source is over 150 km from the site. Other raw materials are present (2.4%), such as quartz, jasper, opal, basalt, and unidentified. The test excavation reached a depth of 0.47 m, then encountered a probable collapse of roof rock. Two charcoal samples taken at a depth of 0.37–0.40 m were dated by AMS at 8770 ± 30 (UGAMS 7459) and 8750 ± 30 RCYBP (UGAMS 7460), or approximately 9750 CALYBP. These are the oldest dates obtained in a rockshelter in Uruguay and reveal new perspectives for comparing the occupation in rockshelters (or confined spaces) with chronologically similar occupations in southern Brazil and the Pampa-Patagonia region in Argentina. In 2011 we will excavate a more extensive area in the ZT-1 rockshelter and the Cueva del Tigre site ZT-2.

The early-Holocene occupation at circa 10,000 CALYBP at ZT-1 provides new evidence that indicates the presence of early sites in environments and landscapes not previously recognized. Our research confirms that early occupations in Uruguay were not limited to open-air sites. The presence of heterogeneous sites with diverse functions (residential, logistical, supply quarries, lithic workshops) existed in virtually every area of Uruguay, suggesting great human diversity during the Pleistocene-Holocene transition (ca. 11,000–8500 RCYBP). Early hunter-gatherers occupied various environments and practically all the landscapes available in Uruguay. The Uruguayan early occupation sites occur in Atlantic coastal dunes, grasslands surrounding ponds and lakes margins, on top of hills, on floodplains and different terraces of major rivers (Uruguay, Cuareim, Arapey, Negro, etc.), and on inland eolian dunes along the Tacuarembó River and the middle Negro River (Suárez 2011); now we integrate new sites from the rolling hills of Cuchilla de Haedo. These landscapes would have offered diverse resources (fauna, vegetation, water, firewood, raw materials, etc.) that were exploited by early hunter-gatherers from the end of the Pleistocene. Moreover, early South American generalists or foragers engaged in exploring this part of the continent would have found in these various environments great diversity of animal species for hunting (extinct and present-day fauna).

We thank the Intedencia Municipal de Salto for their encouragement and constant help, including the Intendente Germán Coutinho and the Secretaria General María Cecilia Eguiluz. Juan Suárez for

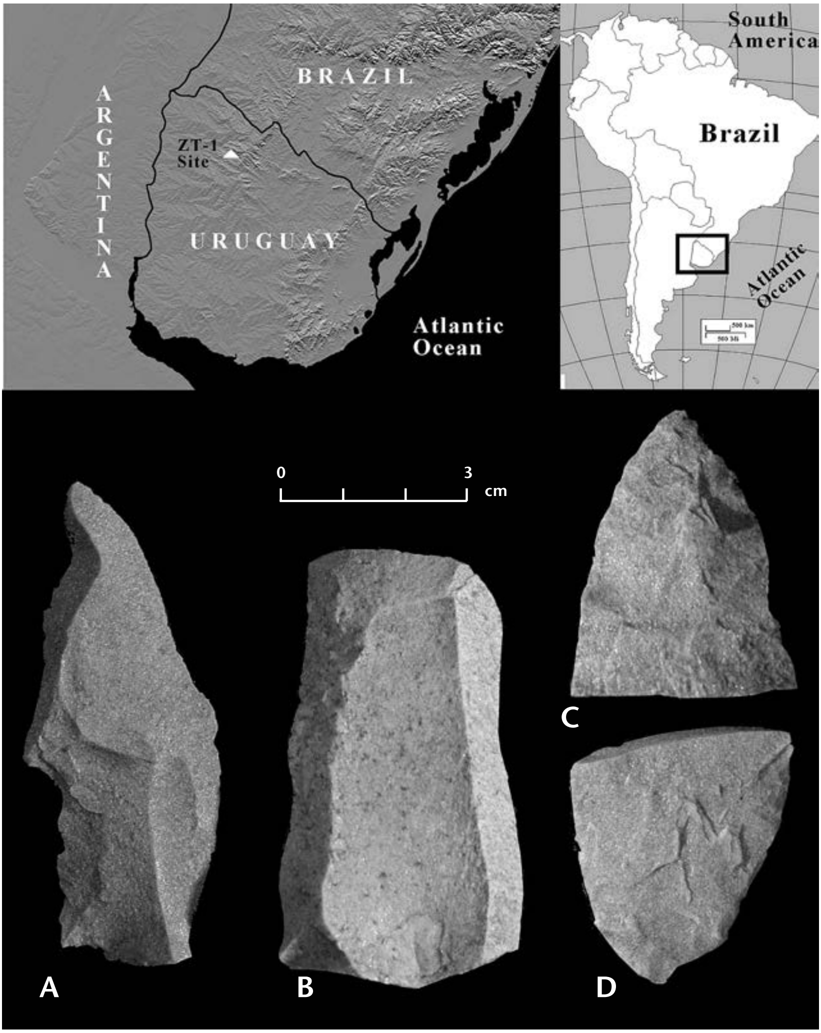


Figure 1. Map of location of the Zanja del Tigre locality and ZT-1 rockshelter. Artifacts recovered from excavation at ZT-1: **A,** bladelet; **B,** blade; **C** and **D,** broken bifaces.

his help in both the field and lab, Héctor Silva and Daniel Donatto collaborated in field work. We also thank Walter López and Sandra Langorte by the access to their ranches (estancias) and the logistic support.

References Cited

Suárez, R. 2011 *Arqueología Durante la Transición Pleistoceno Holoceno: Componentes Paleoindios, Organización de la Tecnología y Movilidad de los Primeros Americanos en Uruguay.* British Archaeological Reports - BAR International Series 2220. Archaeopress, Oxford.

Geosciences

Lunette Distribution on the High Plains of Kansas—A Guide to Seeking Paleoindian Sites

Mark W. Bowen and William C. Johnson

➤ **Keywords**: Lunettes, GIS mapping, Kansas High Plains

For at least the last 12,000 years, several thousand ephemeral, internally drained playa wetlands distributed throughout the High Plains have provided essential food, water, and shelter to wildlife (Smith 2003). These "oases of the Plains" were also widely utilized by Native American cultures and their ancestors: Playas were used prolifically because they supplied some of the only reliable water sources, which also attracted game. Lunettes, isolated eolian dunes found along the downwind margin of some larger playas, were ideal for seasonal and permanent use as campsites (e.g., south-facing slopes of lunettes provided protection from the predominantly northern winds while admitting maximum winter insolation). Use of playas and lunettes by Paleoindian peoples is well documented on the High Plains (Holliday 1997; LaBelle et al. 2003; Mandel and Hofman 2002; Mandel et al. 2004).

The goal of this project was to develop a comprehensive geospatial database that includes all lunettes associated with playas on the High Plains of Kansas. To accomplish this, 1:24,000-scale digital raster graphics (DRGs) were loaded in a GIS environment, and then visually scanned in one-square-mile intervals for 46 counties in western Kansas. All isolated ridges, identified by subcircular to crescentic-shaped closed contour lines associated with playas, were digitized on-screen and included in the lunette database, followed by limited ground-truthing. All playas, mapped earlier by Bowen et al. (2010), with a surface area greater than 5 ha were also visually inspected in GIS to inventory lunettes. Only larger playas were individually inspected because lunettes are typically only associated with larger, deeper playas (Reeves 1990; Sabin and Holliday 1995).

Results of the lunette inventory indicate that 135 playa-lunette systems with a total of 174 lunettes occur in Kansas (Figure 1). Of these, 105 consist of a

Mark W. Bowen, Department of Geography and Urban Planning, Sage Hall 4455, University of Wisconsin Oshkosh, Oshkosk, WI 54901; e-mail: bowenm@uwosh.edu

William C. Johnson, Department of Geography, The University of Kansas, 1475 Jayhawk Blvd., Lawrence, KS 66045; email: wcj@ku.edu

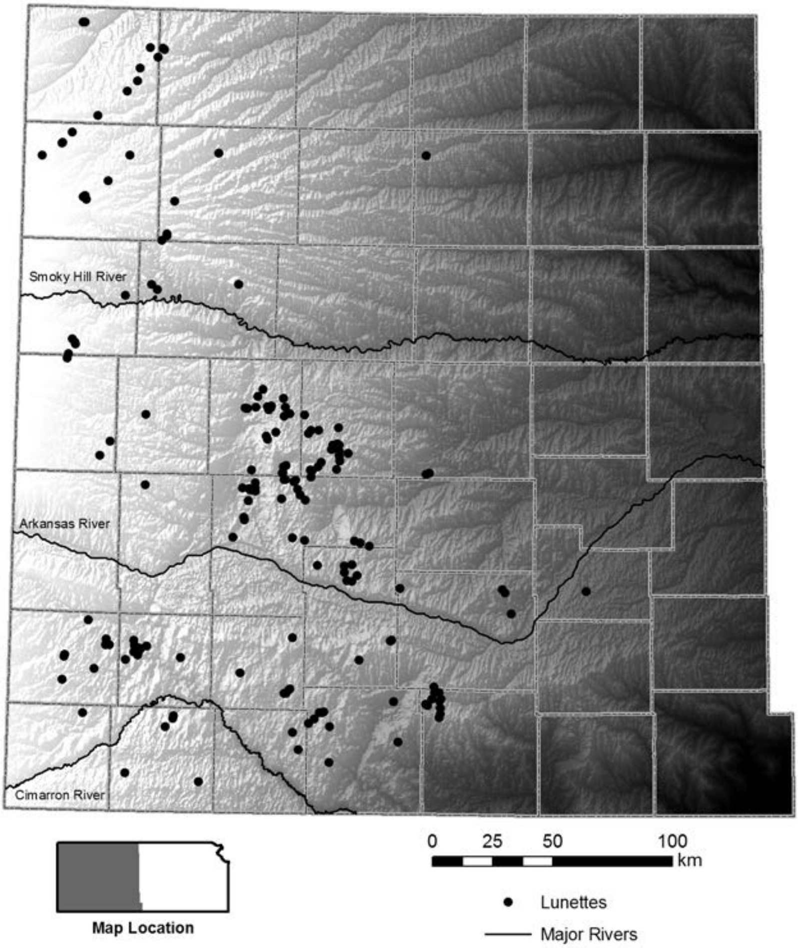


Figure 1. Distribution of lunettes on the High Plains of western Kansas. Data were derived from DRG contour data. Owing to small map scale, lunettes are plotted as point data, rather than as polygons.

single lunette associated with a single playa, while 30 PLSs consist of multiple lunettes associated with a single playa or multiple playas in immediate proximity to one another. As a result of predominantly north-to-northwest winds throughout much of the Quaternary period (Muhs and Bettis 2003), most of the lunettes (157) are located along the southern, southeastern, or eastern margin of playas. Lunette surface area ranges from 0.6 to ~150 ha; mean surface area is 20 ha, and median surface area is 7 ha. The dataset is biased towards larger lunettes because smaller, shorter lunettes were not discernible on DRGs. Playa and lunette geospatial databases are available at the State of Kansas GIS Data Access and Support Center at www.kansasgis.org.

References Cited

Bowen, M. W., W. C. Johnson, S. L. Egbert, and S. T. Klopfenstein 2010 A GIS-based Approach to Identify and Map Playa Wetlands on the High Plains, Kansas, USA. *Wetlands* 30(4):675–85.

Holliday, V. T. 1997 *Paleoindian Geoarchaeology of the Southern High Plains.* University of Texas Press, Austin.

LaBelle, J. M., V. T. Holliday, and D. J. Meltzer 2003 Early Holocene Paleoindian Deposits at Nall Playa, Oklahoma Panhandle. *Geoarchaeology: An International Journal* 18(1):5–34.

Mandel, R. D., and J. L. Hofman 2002 Geoarchaeology of the Winger Site: A Late Paleoindian Bison Bone Bed in Southwestern Kansas. *Geological Society of America Abstracts with Programs* 34(6):182–83.

Mandel, R. D., J. L. Hofman, S. Holen, and J. M. Blackmar 2004 Buried Paleoindian Landscapes and Sites on the High Plains of Northwest Kansas. In *Fieldtrips in the Southern Rocky Mountains, USA: Geological Society of America Field Guide 5*, edited by E. P. Nelson and E. A. Erslev. Geological Society of America, Boulder.

Muhs, D. R., and E. A. Bettis 2003 Quaternary Loess-Paleosol Sequences as Examples of Climate-driven Sedimentary Extremes. *Geological Society of America Special Paper 370.*

Reeves, C. C., Jr. 1990 *A Proposed Sequential Development of Lake Basins, Southern High Plains, Texas and New Mexico.* Bureau of Economic Geology, Austin.

Sabin, T. J., and V. T. Holliday 1995 Playas and Lunettes on the Southern High Plains: Morphometric and Spatial Relationships. *Annals of the Association of American Geographers* 85(2):286–305.

Smith, L. M. 2003 *Playas of the Great Plains.* University of Texas Press, Austin.

Soil Stratigraphy of the Lindenmeier Folsom Site

Vance T. Holliday

➤ **Keywords:** Lindenmeier, Folsom, soil stratigraphy

The well-known Lindenmeier site in northern Colorado was among the first stratified Paleoindian sites subjected to careful geological scrutiny (Bryan and Ray 1940; Haynes 2003). Subsequent work (Haynes and Agogino 1960) resulted in a standardized lithostratigraphic scheme (e.g., Wilmsen and Roberts 1978). This paper presents additional geoarchaeological data focused on the Folsom soil-stratigraphic record. Soils are important at Lindenmeier because: 1) they are a significant component of the stratigraphy, 2) they may have affected the distribution of artifacts, and 3) they indicate local environments when they formed.

Field work (1995, 2007) focused on continuous exposures of valley fill along the main arroyo. It did not include the bison kill/processing area east of the arroyo. From bottom to top, Haynes and Agogino (1960) identified seven lithostratigraphic units (A–G) and nine unconformities (Z1–Z9) (Figure 1). Buried soils are numbered top to bottom (b1–b7). The key strata here are B and D, and soils b5, b6, and b7.

Vance T. Holliday, School of Anthropology & Department of Geosciences, University of Arizona, Tucson, AZ 85721; e-mail: vthollid@email.arizona.edu

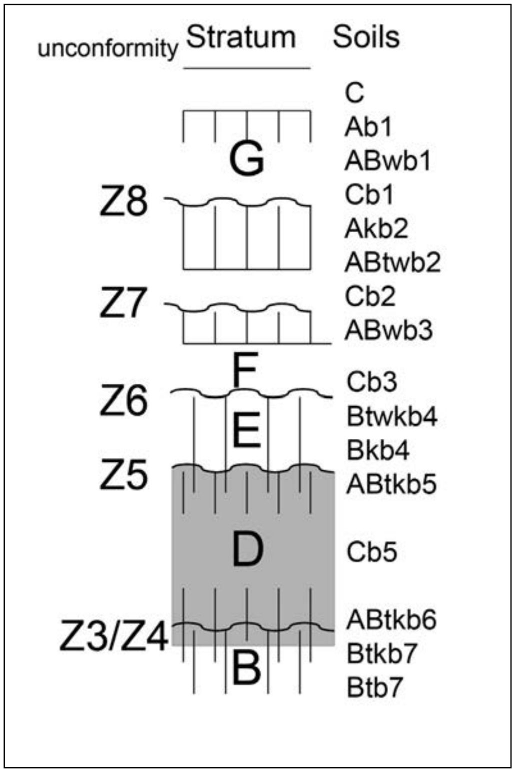


Figure 1. Generalized stratigraphic section for the Lindenmeier site, along the main arroyo, showing the relation of the lithostrata (B, D–G) and unconformities (Z3–Z8) (from Haynes and Agogino 1960) to the soil stratigraphy. Zones yielding Folsom artifacts are shaded gray. Stratum C is not shown because it is localized. Z9 is the modern arroyo erosion.

Stratum B, up to 2 m thick, is a massive pale brown to brown (10YR 6/3, 5/3, 4/3) silt. This silt is probably Peoria Loess, the youngest and most widespread upper-Pleistocene loess unit on the Great Plains (Bettis et al. 2003). A well-developed soil (Btkb7-Btb7) ("Deposition B, Unit c" in Haynes and Agogino 1960:7) formed in the loess. The A horizon was truncated by erosion (Z3) before burial, but the B horizon is welded to the soil formed in overlying Stratum D. Stratum C is a local accumulation of alluvium that thins out against B. The top of Stratum C and locally upper B were truncated by erosion (Z4).

Stratum D is a clay loam with localized lenses of gravel, subdivided into: lower D (dark grayish brown to dark brown, 10YR 4/2 and 3/3), middle D (a lighter gray gravel lens), and upper D (dark grayish brown to dark brown, 10YR 4/2 and 3/3) (equivalent to Da, Db, and Dc of Haynes and Agogino 1960:12, respectively). Z5 truncates the top of D. Stratum D varies from 50 to 100 cm thick due to local erosion and local gravel deposition, and it thins upslope.

Stratum D also represents a pedocomplex (ABtkb5-Cb5-ABtkb6) resulting from soil formation throughout the valley following Z4 erosion. The thickness of the pedocomplex is indicative of a cumulic soil that slowly aggraded on the valley floor. The thick, dark, base-rich character of the soil suggests significant biological productivity, perhaps a dense, continuous grass cover. The soil geomorphology suggests a broad valley with a gentle south slope, similar to the modern valley. The carbonate in the Stratum B soil is likely related to formation of the cumulic A horizon in Stratum D, because carbonate is superimposed on the Bt horizon and it is immediately below the A horizon in Stratum D.

The Folsom artifacts were found in upper B, on Z4, and in D. Haynes and Agogino (1960:9, 11–12) suggest that the Folsom material was found only in lower D, whereas Roberts and Wilmsen (1978:37) state that it was “throughout this unit.” The artifact assemblages could represent multiple Folsom occupations in the valley in the late phases of Stratum C deposition through Stratum D formation. Alternatively, the Folsom presence could have been more limited. Bison bones were noted at the base of D (Wilmsen and Roberts 1978:35, fig. 154), and bones and associated occupation debris were noted on top of B, buried by D (C. V. Haynes, pers. comm. 2007). Human activity and post-depositional processes could have mixed the finer occupation debris, such as charcoal, through upper B and lower D, but large bone is unlikely to be mixed up or down. Backplots of artifacts from Stratum D also suggest multiple occupations during the cumulization processes (J. LaBelle, pers. comm. 2007).

The archaeological and pedological records indicate that the site was subjected to repeated occupation during cumulization, resulting in at least some mixing of artifacts. The erosion forming Z5 also resulted in redeposition of Folsom-age charcoal and artifacts. Interpretations of the Folsom archaeological record and future field work at Lindenmeier clearly should include consideration of soil-forming processes. Pedogenesis was likely an important factor in site formation. Micromorphological analyses of thin sections might be able to detect subtle evidence for occupation surfaces and/or microlamination. A search for vertical refits among the considerable Folsom lithic assemblage would provide insights regarding the degree of soil mixing.

This work benefited from the assistance and insights of Vance Haynes, Adrienne Anderson, Diane Holliday, and Jason LaBelle.

References Cited

Bettis, E. A., D. R. Muhs, H. M. Roberts, and A. G. Wintle 2003 Last Glacial Loess in the Conterminous USA. *Quaternary Science Reviews* 22:1907–46.

Bryan, K., L. Ray 1940 *Geologic Antiquity of the Lindenmeier Site in Colorado.* Smithsonian Miscellaneous Collections 99, Washington, D.C.

Haynes, C. V., Jr. 2003 Dating the Lindenmeier Folsom Site, Colorado, U.S.A., Before the Radiocarbon Revolution. *Geoarchaeology* 18:161–74.

Haynes, C. V., Jr., and G. A. Agogino 1960 *Geological Significance of a New Radiocarbon Date from the Lindenmeier Site.* The Denver Museum of Natural History, Proceedings 9, Denver, CO.

Wilmsen, E. M., and F. H. H. Roberts 1978 *Lindenmeier, 1934–1974: Concluding Report of Investigations.* Smithsonian Contributions to Anthropology 24, Washington, D.C.

Post–Last Glacial Maximum Dune Sequence for the "Parsonburg" Formation at Elliott's Island, Maryland

Darrin Lowery, John Wah, and Torben Rick

➤ **Keywords:** Paleoenvironments, geosciences, dune formation

Elliott's Island (~1.3 km wide and ~2.3 km long) is located on Fishing Bay, Maryland, a tidal tributary of Chesapeake Bay. Elliott's Island consists of an arc-shaped ridge of well-sorted, very fine to medium-grained sands. The island is a barchanoid dune and part of the Parsonburg Formation (Denny et al. 1979). Markewich et al. (2009: 409–425) recently suggested that Parsonburg formation dunes in the region formed as a result of strong mid-latitude WNW-NW winds coeval with rapid growth of the Laurentide ice sheet during the last glacial maximum (LGM).

Research along exposed coastal bank profiles indicates that Elliott's Island formed as a result of episodic post-LGM dune-building events. A 15-cm-thick upland freshwater peat was buried by eolian deposits. Depth to the peat ranges from 1.5 to 5.0 m. Plant macrofossils collected from the peat stratum on Elliott's southern shore were dated to 20,400 ± 90 RCYBP (OS-81222), with a second sample from the northern shore exposure dated to 20,020 ± 80 RCYBP (Beta-286851). Calibrated ages of 24,342 ± 305 and 23,946 ± 318 CALYBP for the peat stratum make it coeval with the LGM and associated with one of the coldest episodes recorded in the GISP2 ice core dataset (see Alley 2004). The Elliott's Island LGM peat is contemporaneous with the "Tilghman Soil" within loess along the western flanks of the Delmarva Peninsula (Lowery et al. 2010).

Six Clovis points have been found along the eroded shorelines adjacent to Fishing Bay. On northern Elliott's, a regionally uncommon "Fishtail" Clovis point (Brown 1979) was found on the surface near a 5-m-high eroded bank at site 18DO440 (Figure 1). It is likely that the Clovis occupation is at the top of a truncated paleosol buried by ≥1 m of eolian sand. However, no Pleistocene artifacts have yet been found in situ.

Elliott's Island documents complex landscape evolution, LGM vegetation and climate, and regional dune-building episodes that occurred after the LGM through the late Holocene. People appear to have occupied these dunes since at least Clovis times. For example, several late-Holocene shell middens have been recorded in the dunes (Lowery 2005). Data from Elliott's Island

Darrin Lowery, Chesapeake Watershed Archaeological Research, 8949 High Banks Drive, Easton, MD 21601; email: darrinlowery@yahoo.com

John Wah, Matapeake Soil and Environmental Consultants, P.O. Box 186, Shippensburg, PA 17257; email: matapeake.soil@gmail.com

Torben Rick, Curator of North American Archaeology, Department of Anthropology, National Museum of Natural History, Smithsonian Institution Washington, DC 20013-7012; email: RickT@si.edu

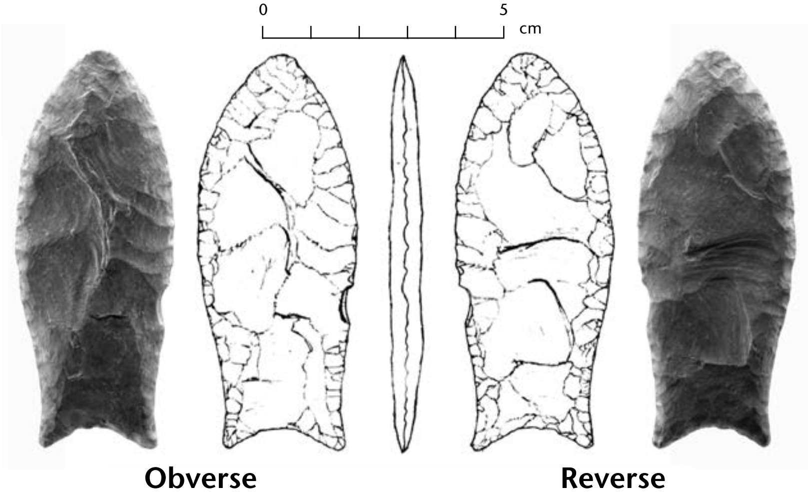


Figure 1. A "Fishtail" Clovis point from 18DO440 at Elliott's Island, Maryland.

and elsewhere in the region (Wah 2003) indicate landscape stability and vegetation cover during the LGM (Lowery 2009). Further research is needed to determine the composition of these vegetation communities and the timing and extent of dune formation on Chesapeake Bay.

References Cited

Alley, R. B. 2004 GISP2 Ice Core Temperature and Accumulation Data. *IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2004-013.* NOAA/NGDC Paleoclimatology Program, Boulder, Colorado.

Brown, L. 1979 Fluted Projectile Points in Maryland. Unpublished M.A. thesis, Department of Anthropology, The Catholic University, Washington, D.C.

Denny, C. S., J. P. Owens, L. Sirkin, and M. Rubin 1979 The Parsonburg Sand in the Central Delmarva Peninsula, Maryland and Delaware. *United States Geological Survey Professional Paper 1067-B.* USGS, Reston, Virginia.

Lowery, D. L. 2005 *Archaeological Survey of the Fishing Bay and the Fairmount Wildlife Management Areas within Dorchester and Somerset County, Maryland.* Monograph on file at the Maryland Historical Trust, Crownsville, Maryland.

——— 2009 Geoarchaeological Investigations at Selected Coastal Archaeological Sites along the Delmarva Peninsula. Unpublished Ph.D. dissertation, Department of Geology, University of Delaware, Newark.

Lowery, D. L., M. A. O'Neal, J. S. Wah, D. P. Wagner, and D. J. Stanford 2010 Late Pleistocene Upland Stratigraphy of the Western Delmarva Peninsula, USA. *Quaternary Science Reviews* 29:1472–80.

Markewich, H. W., R. J. Litwin, M. J. Pavich, and G. A. Brook 2009 Late Pleistocene Eolian Features in Southeastern Maryland and Chesapeake Bay Region Indicate Strong WNW–NW Winds Accompanied Growth of the Laurentide Ice Sheet. *Quaternary Research* 71(3):409–25.

Wah, J. S. 2003 The Origin and Pedogenic History of Quaternary Silts on the Delmarva Peninsula in Maryland. Unpublished Ph.D. dissertation, Department of Environmental Science and Technology, University of Maryland, College Park.

Deglaciation and the Archaeology of Trapper Creek, South-Central Alaska

Brian T. Wygal and Ted Goebel

➤ **Keywords**: Deglaciation, late Pleistocene, south-central Alaska

The Trapper Creek Overlook (TCO) site occupies an esker formed by ice stagnation in the middle Susitna River valley of south-central Alaska and has yielded two Holocene archaeological components, the earliest dated between 9500 and 7800 CALYBP (Wygal 2009). A significant unanswered question regarding the prehistory and paleoecology of the middle Susitna basin between Cook Inlet and Broad Pass surrounds the timing of glaciation during the late Pleistocene. Refined glacial histories are essential for understanding the paleoecology of early hunter-gatherers in the region, and for reconstructing the process of human colonization of deglaciated landscapes.

Ice flows from high mountain valleys mantled the Trapper Creek area sometime during the late Pleistocene (Hamilton and Thorson 1983:38); however, the timing of deglaciation is not well understood (Schmoll and Yehle 1986). The OSL-dated stratigraphic record from TCO may shed light on this problem. Figure 1 represents the 12 strata at TCO beginning with basal morainal gravel (Stratum 1) capped by 95 cm of sediments including four soil complexes and a series of tephras (Wygal 2009). Optically stimulated luminescence (OSL) dating at TCO suggests postglacial sediment deposition occurred during the last glacial maximum (LGM). Laboratory analyses included multiple aliquot regenerative dosing processes (for descriptions of method, see Jain et al. 2003; Murray and Wintle 2003) and employed infrared excitation on components dominated by feldspar and blue or green excitation on quartz particles. Because multiple methods produced statistically identical ages overlapping at 1σ, the feldspar and quartz components of these sediments appear to be consistent geochronometers (Forman 2007).

In 2006, two sediment samples were dated from Stratum 3a, a 25- to 35-cm-thick loess deposit grading from greenish gray loamy sand at its base (3a) into a yellowish brown sandy loam at its top (3b). While 3a lacks artifacts, overlying Stratum 3b contains the earliest component. The lowest OSL sample (UIC1865) produced three ages (32,540 ± 2480, 27,610 ± 2125, and 24,710 ± 1510 CALYBP). The second (UIC1935) yielded two aberrant dates (42,860 ± 3260 and 47,800 ± 3650 CALYBP) from 14 cm above basal gravel; and UIC1866 from Stratum 3b produced four ages (19,530 ± 1500, 17,685 ± 1360, 17,450 ± 1050, and 15,580 ± 980 CALYBP). Several unusually old estimates did not conform to stratigraphic superposition and were dismissed (Wygal 2009).

Brian T. Wygal, Adelphi University, Department of Anthropology, 102 Blodgett Hall, 1 South Ave, Garden City, NY 11530-0701; e-mail: bwygal@adelphi.edu

Ted Goebel, Center for the Study of the First Americans, 4352 Texas A&M University, College Station, TX 77843-4352; e-mail: goebel@tamu.edu

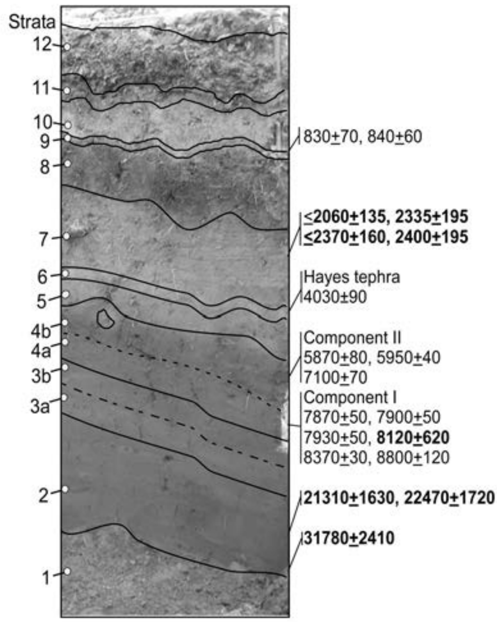


Figure 1. Stratigraphic Profile of the Trapper Creek Overlook site in south-central Alaska with OSL (bold) and radiocarbon ages (after Wygal 2009: Figure 3.2).

In 2007, six additional samples were collected from pure aeolian sediments with little sign of oxidation or pedogenesis. Blue excitation was employed with sample UIC2000 from the contact of Stratum 2 with 3a, yielding an age of 31,780 ± 2410 CALYBP, similar to the 2006 results. Additional dates from 10 cm above Stratum 2, clearly within Stratum 3a (UIC2002), again yielded estimates that fit the 2006 results (22,470 ± 1720 and 21,310 ± 1630 CALYBP). Furthermore, an OSL date (UIC2003) on an ash pocket from Stratum 4a (8120 ± 620 CALYBP) was consistent with five AMS dates ranging between 7870 ± 50 (AA67360) and 8800 ± 120 CALYBP (BETA208283), suggesting the 2007 OSL calibration methodology was accurate. Moreover, samples UIC2001 and UIC2004 from Stratum 7 yielded ages of 2400 ± 195, < 2370 ± 160, 2335 ± 195, and < 2060 ± 135 CALYBP, consistent with their position near the top of the profile, the known age of the Hayes tephra in lower-lying Stratum 6 (ca. 4000 CALYBP), and AMS dates on upper-lying tephras in stratum 9 (ca. 800–900 CALYBP).

Two interpretations for the ages of the basal sediments at TCO are possible. On the one hand, the results may be spurious, because they do not conform to the commonly held notion that southern Alaska was heavily glaciated until the end of the Pleistocene. On the other hand, the OSL ages from Stratum 3a suggest the lower loess deposits at TCO accumulated during or immediately after the LGM, implying deglaciation occurred much earlier than previously thought. We conclude that the latter interpretation is more probable given the conformance of OSL chronology with AMS ages on charcoal from the overlying stratum 4a, tephrochronological correlations, and AMS dating of strata 7 and 9. These results suggest a relatively early age for loess deposition at

TCO and support previous reports from 140 km north of the site suggesting final deglaciation by 17,200 CALYBP (Briner and Kaufman 2008; Dortch 2006). West of Bootlegger's Cove in northern Anchorage, the lower Susitna River debouches into upper Cook Inlet. Here, the Susitna valley was isostatically depressed and flooded with glacioestuarine waters extending upstream during the Elmendorf stadial at ca. 15,000 CALYBP (Reger et al. 2007:10); it therefore was not glaciated at that time. Because LGM glacial retreat occurred first from the valley floor moving toward alpine sources, it is probable that the middle Susitna was ice-free during or shortly after the LGM. Potentially correlative research from the neighboring upper Copper River basin suggests a catastrophic draining of Glacial Lake Ahtna because of ice-dam failure between 26,000 and 15,000 CALYBP (Wiedmer et al. 2010). Wood fragments recovered from Glacial Lake Ahtna bottom sediments yielded the uncalibrated date 17,600 ± 400 RCYBP (Williams 1989:82).

We thank Steve Forman at the Luminescence Dating Research Laboratory, University of Illinois, Chicago for conducting a thorough analysis of OSL ages for this project. Beta Analytic and University of Arizona laboratories provided radiocarbon assays. We also thank Randy Tedor and Kelly Graf for contributing to discussions on the sedimentology of the TCO site, and Gary Haynes, David Rhode, Scott Mensing, and Michael Bever for thoughtful comments on previous drafts of this research. This research was funded by the National Science Foundation (Arctic Social Sciences Program) and Department of Anthropology at the University of Nevada, Reno.

References Cited

Briner, J. P., and D. S. Kaufman 2008 Late Pleistocene Mountain Glaciation in Alaska: Key Chronologies. *Journal of Quaternary Science* 23(6-7):659–70.

Dortch, J. M. 2006 Defining the Timing of Glaciation in the Central Alaska Range. Unpublished M.A. thesis, University of Cincinnati, Cincinnati.

Forman, S. 2007 Optically Stimulated Luminescence (OSL) Ages and Associated Chronologic Data for Fine-Grained Sediments (4-11 µm) from near Talkeetna, Alaska. Unpublished Laboratory Report, Department of Earth and Environmental Sciences, University of Illinois, Chicago.

Hamilton, T. D., and R. M. Thorson 1983 The Cordilleran Ice Sheet in Alaska. In *Late-Quaternary Environments of the United States*, edited by S. C. Porter, pp. 38–52. University of Minnesota Press, Minneapolis.

Jain, M., L. Bøtter -Jensen, and A. K. Singhvi 2003 Dose Evaluation Using Multiple-Aliquot Quartz OSL: Test of Methods and a New Protocol for Improved Accuracy and Precision. *Radiation Measurements* 37(1):67–80.

Murray, A. S., and A. G. Wintle 2003 The Single Aliquot Regenerative Dose Protocol: Potential for Improvements in Reliability. *Radiation Measurements* 37(1):377–81.

Reger, R. D., A. G. Sturmann, E. E. Berg, and P. A. Burns 2007 *A Guide to the Late Quaternary History of Northern and Western Kenai Peninsula, Alaska.* Guidebook 8, State of Alaska, Department of National Resources, Division of Geological and Geophysical Surveys, Anchorage.

Schmoll, H. R., and L. A. Yehle 1986 Pleistocene Glaciation of the Upper Cook Inlet Basin. In *Glaciation in Alaska: The Geologic Record*, edited by T. D. Hamilton, K. M. Reed and R. M. Thorson, pp. 193–218. Alaska Geologic Society, Anchorage.

Wiedmer, M., D. R. Montgomery, A. R. Gillespie, and H. Greenberg 2010 Late Quaternary Megafloods from Glacial Lake Ahtna, Southcentral Alaska, U.S.A. *Quaternary Research* 73:413–24.

Williams, J. R. 1989 A Working Glacial Chronology for the Western Copper River Basin, Alaska. In *Late Cenozoic History of the Inerior Basins of Alaska and Yukon*, edited by L. D. Carter, T. D. Hamilton, and J. P. Galloway, pp. 81–84. U. S. Geological Survey Circular 1026.

Wygal, B. T. 2009 *The Prehistoric Colonization of Southcentral Alaska: Human Adaptations in a Post Glacial World.* Ph.D. dissertation, Department of Anthropology, University of Nevada, Reno

Paleobotany

Nonsiliceous Algae and Aquatic Pollen Spectra from the Portage River Channel, Northeast Minnesota

James K. Huber

➤ **Keywords**: Nonsiliceous algae, river channel, Minnesota

Nonsiliceous algae were extracted from the basal portion of a sediment core recovered from the Portage River Channel, Carlton County, Minnesota (92° 38′ 05″ N, 46° 27′ 50″ W). The site is located in the southwestern end of the Lake Superior basin and is in an old drainage channel of Glacial Lake Duluth (Bacig and Huber 1993).

At approximately 11,000 RCYBP during the Nickerson Phase of Wisconsin Glaciation, the southwest end of Lake Superior was last glaciated. A series of small glacial lakes formed between the retreating ice margin and the rim of the Superior basin as the ice of the Superior Lobe melted (Farrand 1960). These glacial lakes were named Nemadji, Ashland, Brule, and Ontonagon by Leverett (1929). These proglacial lakes combined to form Glacial Lake Duluth as the Superior Lobe ice retreated. The Portage River channel is interpreted to be the outlet for Glacial Lake Nemadji and the early stages of Glacial Lake Duluth. The Portage River channel was abandoned when the Lake Superior Lobe retreated further, dropping the level of Glacial Lake Duluth and opening an outlet at the Brule River (Wright et al. 1970).

The basal portion of the core (230–237.5 cm) is composed of medium- to fine-textured organic sands with small wood fragments and is overlain by a thin layer (228–230 cm) of organic-rich clay. The remainder of the core (0–228 cm) grades from amorphous to fibrous peat. A channel-fill sequence is interpreted based on the stratigraphy (Bacig and Huber 1993).

Three sediment samples for nonsiliceous algae and pollen were analyzed from the basal portion of the core. The pollen spectra are dominated by *Picea* (spruce) and *Pinus* (pine), mostly *Pinus banksiana/resinosa*-type (jack/red pine), and is interpreted as representing a transition from a boreal to mixed

James K. Huber, Department of Geoscience, University of Iowa, Iowa City, IS 52242 and James K. Huber Consulting, 2573 58th St., Vinton, IA 52349; e-mail: jhuber@fmtcs.com

conifer-hardwood forest. At various sites in northeast Minnesota has been dated between 10,700 and 9500 RCYBP (Bacig and Huber 1993).

Most of the algae taxa occur in all three samples and consist of *Botryococcus* (0.0–0.5%), *Pediastrum Boryanum* (0.4–0.9%), *P. duplex* var. *clathratum* (0.0–0.2%), *Scenedesmus* (1.1–2.7%), *Spirogyra*-type (0.5–0.9%), *Tetraedron* (0.0–1.4%), and *Zygnema*-type (1.8–2.0%), all green algae (Chlorophycophyta). *Gloeotrichia*-type (0.0–0.7%) is the only blue-green algae (Cyanochloronta) to occur in the sequence. Pollen from four aquatic plant taxa also occur in the Portage River Channel sequence: *Brasenia Schreberi* (watershield; 0.0–0.2%), *Potamogeton* sp. (pondweed; 0.0–0.2%), *Sparganium*-type (bur-reed; 0.0–0.5%), and *Typha latifolia* (cattail; 0.2-1.9%). Percentage values for nonsiliceous algae and aquatic pollen were calculated, respectively, by adding the pollen sum to the nonsiliceous algae sum and by adding the pollen sum to the aquatic pollen sum. A minimum of 400 pollen grains of trees, shrubs and herbs was identified for each sediment sample.

All the nonsiliceous algae taxa occurring in the basal portion of the Portage River Channel core are predominantly euplankton or tychoplankton. They are free-floating and commonly inhabit open water lakes and/or shallow open water lakes (Prescott 1962). The aquatic plants are all indicative of ponds or slow-moving streams (Fernald 1970). The aquatic pollen and algae are consistent with the early stages of a channel fill sequence.

References Cited

Bacig, E. J., and J. K. Huber 1993 A Late Glacial Sequence from the Portage River Channel, Northeast Minnesota. *Current Research in the Pleistocene* 10:87–89.

Farrand, W. R. 1960 *Former Shorelines in Western and Northern Lake Superior Basin.* Unpublished Ph.D. dissertation, University of Michigan, Ann Arbor.

Fernald, M. L. 1970 *Gray's Manual of Botany* (eighth edition). D. Van Nostrand Company, New York.

Leverett, F. 1929 Moraines and Shorelines of the Lake Superior Basin. *USGS Professional Paper* 154-A.

Prescott, G. W. 1962 *Algae of the Western Great Lakes Area.* W.C. Brown Company, Dubuque.

Wright, H. E., Jr., L. A. Mattson, and J. A. Thomas 1970 Geology of the Cloquet Quadrangle, Carlton County, Minnesota. *Minnesota Geological Survey, Geological Map Series* 3.

12,000 Years of Environmental Change Archived on Morainal Ridges in Central Alaska

William C. Johnson, Steven R. Bozarth, and Edmund P. Gaines

➤ **Keywords:** Environmental change, phytoliths, central Alaska

Biogenic silica (e.g., phytoliths) and charcoal data derived from loess samples and uppermost 10 cm of underlying till on morainal ridges within the Jarvis Creek valley of the Tanana River system provide a robust local signature for reconstructing postglacial climatic conditions from well-drained sites in this area of interior Alaska. The thin mantle of loess (<50 cm) capping the morainal ridges was likely derived from the Tanana River and its tributaries, with possible contributions from the Yukon and/or Nenana river systems (Muhs and Budahn 2006). The modern soil, imprinted on the loess and upper till, is a Eutrocryept with Oe, Bw/Ajj, and 2BC/CB (till) horizonation developed under a shrub and conifer cover. A prominent quasi-horizontal lamella, common within soils of the region (Dilley 1998), occurs within the Bw/Ajj horizon, in about the center of the loess mantle. Several pronounced changes in soil and sediment parameters occur from below to above the lamella, including an increase in frequency dependence of magnetic susceptibility (greater percent of very fine magnetic grains), a shift in L*a*b- and Munsell-derived colors, an increase in very fine silt, a C/N increase and a decrease in δ^{13}C and δ^{15}N values. These changes and lamella morphology suggest a pedo-petrogenic origin for the lamella (Rawling 2000), i.e., development at the contact between two loess units where surface stability, albeit perhaps short lived, likely occurred. Representative AMS ^{14}C ages are 10,870 ± 50 RCYBP (Beta 227161; *Betula* spp. charcoal; 12,700 CALYBP) within the middle of the lower loess and 5900 ± 50 RCYBP (Beta 227159; *Picea* spp. charcoal; 6700 CALYBP) immediately (0.5 cm) below the lamella.

Phytoliths, other biogenic silica, and particulate charcoal, extracted from the soil samples using a heavy-liquid extraction protocol (Bozarth 1997), were analyzed under ≥625x magnification. Microfossil data generated from profiles established in excavations at four archaeological sites (XMH-874, XMH-878, XMH-915, and XMH-917) depict similar vegetation histories for the past 13,000–12,000 years, with data from XMH-878 being presented herein. Phytolith data from the uppermost 10 cm of the till indicate prevalence of a C_3 grass (Pooideae subfamily) cover, interpreted as a cold, slightly mesic environment. No *Picea*- or *Betula*-type phytoliths were recovered. Fire occurrence was rare, given the lack of charcoal and charred phytoliths. Data from the lower loess (below the lamella, prior to 5900 ± 50 RCYBP) indicate persistence of

William C. Johnson and Steven R. Bozarth, Department of Geography, The University of Kansas, 1475 Jayhawk Blvd., Lawrence, KS 66045; emails: wcj@ku.edu sbozarth@ku.edu

Edmund P. Gaines, Arktikos Archaeology, PMB 193, 3875 Geist Road, Suite E, Fairbanks, AK 99709; email: epg74@yahoo.com

treeless, C_3-dominated grassland. Presence and near-pristine condition of sponge spicules suggests a loess source from the nearby Delta River, a tributary to the Tanana River. Phytolith concentration, a proxy for relative surface stability, increases upward from a low of ~1,400 phytoliths/gram and ~13,000 phytoliths/gram of sediment within the uppermost till and lowermost loess, respectively, to a lower loess maximum of ~120,000 immediately below the lamella. Low counts of particulate charcoal and charred phytoliths indicate a continued minor role for fire. High frequencies of algal statospores in the uppermost lower loess indicate also that this surface remained relatively moist for an extended period of time owing to rain, snowmelt, and perhaps changes in the local soil hydrology.

Phytoliths within the base of the upper loess drop in concentration from ~96,000 immediately above the lamella to a low of ~4000 in the middle of the upper loess; however, charcoal concentration increases to levels not observed below, especially in the >80 μm size (indicative of proximal or on-site fires). Within the upper ~22 cm of the profile, phytolith concentration increases dramatically to >1.5 million, and both small (10–80 μm) and large (>80 μm) charcoal increase to surface (upper 1 cm) maxima; conifer-type phytolith concentrations display a similar pattern of increase.

Scores of paleoecological studies have been reported for Alaska (Anderson et al. 2004), with the Tanana River valley the focus of some of the earliest research (see Ager 1975). While the thin mantle of loess on morainal ridges in the Tanana River Lowlands lacks the resolution and detail of the lake, muskeg, and other lowland records, it provides a relatively complete local environmental record from the late-Pleistocene/Holocene transition to the present. Given the AMS ^{14}C age of ~12,700 CALYBP above the loess-till contact and a presumed sedimentation rate, a basal-loess age estimate of ~13,500 years ago seems appropriate and agrees with ages of ~13,200 CALYBP obtained above the sand-silt contact on a loess-mantled sand dune at the Upward Sun River site (Potter et al. 2008, 2011).

The microfossil assemblage within the lower loess indicates that late-Pleistocene/early-Holocene human inhabitants of the region would have experienced an exposed treeless, grass environment on the morainal ridges. This environment would have supported large grazing herbivores such as elk and bison. Surrounding lowland areas, however, may have been occupied to varied extents by trees and shrubs at this time (Ager 1983, Anderson 2004).

References Cited

Ager, T. 1975 *Late Quaternary Environmental History of the Tanana Valley, Alaska.* Ohio State University Institute of Polar Studies Report 54.

——— 1983 Holocene Vegetation History of Alaska. In *Late-Quaternary Environments of the United States,* edited by H. E. Wright, Jr, pp. 128–41. University of Minnesota Press, Minneapolis.

Anderson, P. M., M. E. Edwards, and L. Brubaker 2004 Results and Paleoclimatic Implications of 35 Years of Paleoecological Research in Alaska. In *The Quaternary Period in the United States,* edited by A. R. Gillespie, S. C. Porter, and B. F. Atwater, pp. 427–40. Elsevier, Amsterdam.

Bozarth, S. R. 1997 Pollen and Phytolith Analyses. In *Vanishing River: Landscapes and Lives of the*

Lower Verde River (Volume 2), edited by J. H. Altschul and R. Ciolek-Torrello, pp. 179–204. SRI Press, Tucson.

Dilley, T. E. 1998 Late Quaternary Loess Stratigraphy, Soils, and Environments of the Shaw Creek Flats Paleoindian Sites, Tanana Valley, Alaska. Unpublished Ph.D. thesis, Department of Geosciences, University of Arizona, Tucson.

Muhs, D. R., and J. R. Budahn 2006 Geochemical Evidence for the Origin of Late Quaternary Loess in Central Alaska. *Canadian Journal of Earth Science* 43:323–37.

Potter, B. A., J. D. Irish, J. D., Reuther, C. Gelvin-Reymiller, and V. T. Holliday 2011 A Terminal Pleistocene Child Cremation and Residential Structure from Eastern Beringia. *Science* 331:1058–62.

Potter, B. A., J. D. Reuther, P. M. Bowers, and C. Gelvin-Reymiller 2008 Little Delta Dune Site: A Late-Pleistocene Multicomponent Site in Central Alaska. *Current Research in the Pleistocene* 25:132–35.

Rawling, J. E, 3rd 2000 A Review of Lamellae. *Geomorphology* 35:1–9.

Paleontology

A Geometric Morphometric Study of North American Late-Pleistocene Equid Upper Premolars and Its Potential Significance for Equid Systematics

Christian Raúl Barrón-Ortiz and Jessica Theodor

➤ **Keywords**: Geometric morphometrics, *Equus*, cheek teeth, late Pleistocene, North America

The systematics of North American late-Pleistocene equids continues to be problematic. More than 20 species have been named, but recent revisions recognize fewer species. Molecular analyses (Weinstock et al. 2005) indicate that only two are valid (a stilt- and a stout-legged species). Qualitative morphological studies suggest up to ten species (e.g., Azzaroli 1995), whereas quantitative revisions indicate at least three (e.g., Winans 1989).

Recent morphological revisions have concentrated on cranial and postcranial material, while study of the cheek teeth has been mostly limited to some observations (e.g., linguaflexid morphology) and measurements (e.g., tooth length and width). This is partly because of variability in the occlusal pattern and the difficulty of measuring its features. Methods for metrically studying cheek teeth concentrate primarily on overall dimensions (Eisenmann et al. 1988). This can be useful when comparing material from a particular region. However, when comparing across different regions, identifying taxonomic groups can become complicated because the main variation in the data is size-related, and size varies geographically.

Both these limitations can be overcome. The occlusal pattern can be taxonomically informative if teeth with an equivalent wear stage are compared (Barrón-Ortiz et al. 2008). Secondly, different methodologies such as geometric morphometrics exist for studying size separately from shape. In this report we describe the results of a geometric morphometric analysis of third and fourth upper premolars of North American late-Pleistocene equids.

The sample consisted of 78 specimens from 25 localities arranged into 6

Christian Raúl Barrón-Ortiz, Department of Biological Sciences, University of Calgary, 2500 University Drive N. W., T2N 1N4 Calgary, AB, Canada; e-mail: crbarron@ucalgary.ca

Jessica Theodor, Department of Biological Sciences, University of Calgary, 2500 University Drive N. W., T2N 1N4 Calgary, AB, Canada; e-mail: jtheodor@ucalgary.ca

geographic regions: Beringia (n = 4), northern Great Plains (n = 14), Southeastern U.S. (n = 13), American Southwest (n = 9), Southwest coast, U.S. (n = 4), and central Mexico (n = 34). Specimens of extant equids were also analyzed: *Equus caballus* (n = 21), *E. asinus* (n = 10), *E. zebra* (n = 4), *E. burchelli* (n = 4), and *E. hemionus* (n = 10). Teeth showing a crown height representing 30–40% of the estimated unworn height were studied. The specimens were obtained from collections and figures published in the literature.

For each tooth, 26 landmarks were located on a digital image of the occlusal enamel pattern using tpsDig 2.12 (Rohlf 2008). Centroid size was calculated in PAST 1.99 (Hammer et al. 2001). Subsequently, the landmark configurations were superimposed (Procrustes superimposition), and a relative warps analysis (alpha of -1) was performed. Differences in centroid size were tested using one-way ANOVA and Student's t-test; shape differences were tested using NP-MANOVA. To increase sample size, both tooth types were combined. A test on 14 teeth from a single species indicated no significant differences in centroid size and shape between these tooth types. Sexual dimorphism was tested on *E. caballus* with no significant differences found.

The teeth of the extant species, except zebras, separated in terms of shape. The fossil specimens showed overlap in size across the different geographic regions. However, within each region, there were between one and three different sizes represented; in accordance with other studies (e.g., Malgarejo-Damián and Montellano-Ballesteros 2008; Winans 1989). In terms of shape, two distinct morphotypes were identified. For every region, except the Southwest Coast, these two morphotypes correspond to the stout-legged and stilt-legged groups that have been recognized on morphological (e.g., Azzaroli 1995; Winans 1989) and molecular (Weinstock et al. 2005) grounds.

The results for each region can be summarized as follows. Only one size category (medium) was evident for the Beringian specimens, which in terms of shape clustered within the stout-legged morphotype. For the Great Plains there were two sizes (large and medium) that clustered within the stout-legged group. Two of four Southwest Coast specimens have been identified as *E. occidentalis* (Azzaroli 1998), and although this was a large stout-legged horse, the four specimens clustered within the stilt-legged morphotype group. Large, medium, and small specimens were found for the American Southwest sample that separated into stout-legged (large and medium) and stilt-legged (small) groups. Two size categories (large and medium) were present for the Southeastern U.S. specimens that clustered within the stout-legged group. Finally, for Mexico there were three different sizes (large, medium, and small) and two shape morphotypes: stout-legged (large and medium) and stilt-legged (small).

The results suggest four morphological groups ($F = 5.68$, $p<0.001$; $p<0.05$ for all pairwise comparisons) which might represent separate species. These are a small stilt-legged equid (including specimens previously identified as *E. tau* and *E. francisci*), a medium stout-legged equid (specimens previously identified as *E. conversidens*, *E. fraternus*, and *E. lambei*), a large stout-legged horse (specimens previously identified as *E. complicatus*, *E. niobrarensis*, and *E. mexicanus*) and *E. occidentalis*. Further analyses employing more specimens, other tooth positions, and outline-based morphometric methods are underway and will contribute to better understanding variation in cheek-tooth morphology.

We thank Joaquín Arroyo-Cabrales (Instituto Nacional de Antropología e Historia), Christopher Jass (Royal Alberta Museum), and Arthur Harris (University of Texas at El Paso) for access to specimens in their care.

References Cited

Azzaroli, A. 1995 A Synopsis of the Quaternary Species of *Equus* in North America. *Bollettino della Società Paleontologica Italiana* 34(2):205–21.

——— 1998 The Genus *Equus* in North America - The Pleistocene Species. *Paleontographia Italica* 85:1–60.

Barrón-Ortiz, C. R., G. de la Riva-Hernández, and R. Barrón-Corvera 2008 Morphometric Analysis of Equid Cheek Teeth Using a Digital Image Processor: A Case Study of the Pleistocene Cedazo Local Fauna Equids, Mexico. *Revista Mexicana de Ciencias Geológicas* 25(3):334–45.

Eisenmann, V., M. T. Alberdi, C. De Giuli, and U. Staesche 1988 Studying Fossil Horses. In *Collected Papers After the New York International Hipparion Conference, 1981*, edited by M. Woodburne and P. Sondaar, pp. 1–71. E. J. Brill, Leiden.

Hammer, Ø., D. A. T. Harper, and P. D. Ryan 2001 PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1):1–9.

Malgarejo-Damián, M. P., and M. Montellano-Ballesteros 2008 Quantitative Differentiation of Mexican Pleistocene Horses. *Current Research in the Pleistocene* 25:184–86.

Rohlf, F. J. 2008 tpsDig, Digitize Landmarks and Outlines, Version 2.12. Department of Ecology and Evolution, State University of New York at Stony Brook.

Weinstock, J., E. Willerslev, A. Sher, W. Tong, S. Y. W. Ho, D. Rubenstein, J. Storer, J. Burns, L. Martin, C. Bravi, A. Prieto, D. Froese, E. Scott, and L. Xulong 2005 Evolution, Systematics, and Phylogeography of Pleistocene Horses in the New World: A Molecular Perspective. *PLoS Biology* 3(8):e241.

Winans, M. C. 1989 A Quantitative Study of North American Fossil Species of the Genus *Equus*. In *The Evolution of Perissodactyls*, edited by D. R. Prothero and R. M. Schoch, pp. 262–97. Oxford University Press, New York.

Reexamining the Geological Context and Age of the Walhalla, North Dakota, Mammoth

Ashley Breiland and Kenneth Lepper

➤ **Keywords:** Lake Agassiz, mammoth, OSL dating

During the recession of Glacial Lake Agassiz a series of beach ridges formed in the Dakotas, Minnesota, and several Canadian provinces. Within these ridges

Ashley Breiland, Department of Geosciences, North Dakota State University, P.O. Box 6050 / Dept. 2745, Fargo, ND 58102-6050; e-mail: ashley.breiland@ndsu.edu

Kenneth Lepper, Optical Dating and Dosimetry LaboratoryDepartment of Geosciences, North Dakota State University, P.O. Box 6050 / Dept. 2745 Fargo, ND 58102-6050; e-mail: ken.lepper@ndsu.edu

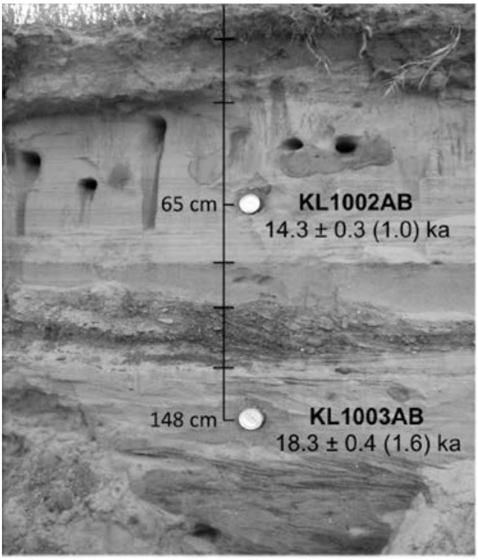
a variety of mammal fossils have been discovered, including the remains of mammoths (Hoganson 2006; Ashworth and Cvancara 1983). The Herman is the earliest of the well-developed ridges, and at least four mammoth specimens have been reported in association with beach deposits of the Herman stage within North Dakota and Minnesota. However, no mammoth remains have been linked to younger beaches or stages of Lake Agassiz.

One of the scientifically reported Herman beach mammoth specimens was found near Walhalla, North Dakota. It is identified in two published reports as catalog #5388 of the University of North Dakota Paleontology Collection (UND-PC 5388; Ashworth and Cvancara 1983; Harington and Ashworth 1986). Both these reports indicate clearly that the specimen was associated with Herman level beach-ridge deposits of Lake Agassiz, but they disagree with the UND-PC catalog entry on the specific location where the specimen was collected. The objective of our project was to investigate the location where the Walhalla mammoth specimen was found and, if possible, determine a geologic age for the mammoth remains using optically stimulated luminescence (OSL) dating.

The specimen, a single tooth, was described by Harrington and Ashworth (1986) as a heavily worn upper molar from a woolly mammoth (*Mammuthus primigenius*). Ashworth and Cvancara (1983) documented the collection location of the tooth as "NE1/4, NE1/4, Sec 29, T163N, R56W near the USGS gauge at Walhalla." This subsection is underlain by floodplain deposits of the Pembina River and does not include the gauging station or Herman beach ridge deposits. If recovered from floodplain deposits the specimen would most likely be reworked and its geologic age undeterminable. The UND-PC catalog card for specimen #5388 also indicated that the tooth had been found near the USGS gauge, but the section number had been typed over with the section number changed from "26" to "25" (pers. comm., Joseph Hartman, 2010). Neither of these sections corresponds to the gauge location but instead to sections within the Lake Agassiz basin. We proposed an additional interpretation of the site location: NE1/4, NE1/4, Sec 26, T163N, R57W (the McDonald site). This location is the site of a sand and gravel borrow pit that lies within Lake Agassiz beach deposits and has been active since at least 1979, based on USGS mapping (Walhalla, ND, 7.5' quadrangle).

In the summer of 2010 two sediment samples (Figure 1) were collected for OSL dating from the McDonald site (48° 55′ 08.39″ N; 97° 58′ 18.40″ W; surface elevation 356 m). Clean quartz sand in the grain-size range of 150–250 μm was isolated from each field sample (supplement to Lepper et al. 2007). OSL data were collected using single-aliquot regeneration experimental procedures (SAR: adapted from Murray and Wintle 2000; 2006), and the data were analyzed using the approach described in the supplement to Lepper et al. (2007). The equivalent dose distributions for both samples were symmetric; therefore, their mean and standard error were used for age calculations (Table 1).

The OSL age obtained for the upper portion of the section, 14,300 ± 300 CALYBP, is consistent with OSL ages that have previously been reported for the Herman strandline of Lake Agassiz (Lepper et al. 2007; Lepper et al., in review). Below a transitional layer of crossbedded gravels (Figure 1), an age of 18,300 ± 400 CALYBP was obtained. This age from lower in the profile could



A 0–16 cm; very dark brown (7.5YR2.5/2), very coarse sandy loam.

Bw 16–30 cm; dark brown (7.5YR3/2), planar bedded, medium to coarse sand.

C1 30–91 cm; pinkish gray (7.5YR6/2), planar bedded to laminated very fine to fine sand.

C2 91–~105 cm; light brown (7.5YR6/3), structureless, medium sand.

C3 ~105–119 cm; crossbedded coarse sandy gravel lens; most of the gravel clasts were rounded tablets of gray shale.

C4 119–200 cm; crossbedded and ripple crossbedded fine sand with coarse sand stringers; varied colors including tans, light browns, and grays.

Figure 1. Photograph and brief stratigraphic description of the exposed profile at the McDonald sampling site. OSL dating results are given in the format of "age ± error (uncertainty)."

potentially represent deposition of sediments in the Pembina deltaic complex prior to beach ridge formation.

Previously published reports regarding the Walhalla mammoth definitively state its connection to the Herman beach ridge. Therefore, if our interpreted location (NE1/4, NE1/4, Sec 26, T163N, R57W) is correct and the specimen was recovered from the upper portion of the profile, then and only then could it be assigned an age of 14,300 ± 300 CALYBP, which would be consistent with the Herman stage of Lake Agassiz. Unfortunately, however, no stratigraphic context is recorded for this specimen and the possibility that it was recovered from the floodplain site cannot be ruled out. Its heavily worn condition also supports reworking prior to burial. Consequently, we conclude that the Walhalla mammoth should not be considered among the group of "Lake Agassiz beach mammoths."

Table 1. OSL data and results.

Sample ID	N■	Dose rate (Gy/ka)	Equivalent dose (Gy)	Age (ka)	Age uncertainty (ka)
KL1002AB	94/95	1.334 ± 0.108	19.117 ± 0.427	14.3 ± 0.3	1.0
KL1003KB	91/94	1.322 ± 0.114	24.225 ± 0.475	18.3 ± 0.4	1.6

■Number of aliquots suitable for analysis/number of aliquots from which data were collected.

References Cited

Ashworth, A. C., and A. M. Cvancara 1983 Paleoecology of the Southern Part of the Lake Agassiz Basin. In *Glacial Lake Agassiz*, edited by J. T. Teller and L. Clayton. Geological Association of Canada Special Paper 26:133–56.

Harington, C. R., and A. C. Ashworth 1986 A Mammoth Tooth from Late Wisconsin Deposits near Embden, North Dakota, and Comments on the Distribution of Woolly Mammoths South of the Wisconsin Ice Sheets. *Canadian Journal of Earth Science* 23:909–18.

Hoganson, J. W. 2006 Late Pleistocene (Rancholabrean) Mammals of North Dakota. In *Quaternary Geology of the Missouri River Valley and Adjacent Areas of Northwest-central North Dakota*, edited by L. A. Manz, pp. 79–83. Geologic Investigations #24, North Dakota Geological Survey.

Lepper, K., K. Gorz, T. Fisher, and T. Lowell (in review) Age Determinations for Lake Agassiz Shorelines West of Fargo, North Dakota, U.S.A. *Canadian Journal of Earth Sciences.*

Lepper, K., T. Fisher, I. Hajdas, and T. Lowell 2007 Supplement to: Ages for the Big Stone Moraine and the Oldest Beaches of Glacial Lake Agassiz: Implications for Deglaciation Chronology. *Geology* 35(7):667–70.

Murray, A., and A. G. Wintle 2000 Luminescence Dating of Quartz Using an Improved Single-Aliquot Regenerative Protocol. *Radiation Measurements* 32:571–77.

——— 2006 A Review of Quartz Optically Stimulated Luminescence Characteristics and their Relevance in Single-Aliquot Regeneration Dating Protocols. *Radiation Measurements* 41:369–91.

Mammal Extinction at the Pleistocene-Holocene Boundary in South America

Alberto L. Cione, Eduardo P. Tonni, and Leopoldo Soibelzon

➤ **Keywords:** South America, mammals, extinction, pseudo-extinction

Extinctions throughout the Neogene in South America at species, genus, and even family levels were mostly related to climate and environmental changes. They affected different components of the biota. However, by the late Pleistocene and early Holocene there was an extinction event of extraordinary features, when 100% of the remarkably abundant megamammal species (37 species with body mass over 1,000 kg) and about 80% of the large mammal species (those over 44 kg) became extinct. With the exception of some small mammals, no other animals or plants disappeared. Consequently, the extinction event was distinct from "normal" mass extinctions (see comments in Cione et al. 2003). This extinction has been attributed to climate change, epidemics, or human action, and Cione et al. (2009) proposed an alternative, which they called the "Broken Zig Zag" theory. According to these authors, the distribution and abundance of mammals alternated from wider to narrower ranges, following the cycles of spread and reduction of open-vegetation zones responding to climate changes in the middle and late Pleistocene (see Vivo and Carmignotto 2004). During the cold events, megamammals had a wider distribution. During the warm periods, open environments shrank owing to the expansion of forests. These climatic and faunal changes can be modeled as zig zags. Twenty pairs of changes in temperature from hot to cold and back

Alberto L. Cione, Eduardo P. Tonni, and Leopoldo Soibelzon División Paleontología de Vertebrados, Museo de La Plata, 1900 La Plata, Argentina; e-mails: acione@museo.fcnym.unlp.edu.ar eptonni@museo.fcnym.unlp.edu.ar lsoibelzon@museo.fcnym.unlp.edu.ar

occurred during the middle and late Pleistocene (see Petit et al. 1999), but no extinctions occurred. At the beginning of the current interglacial, when temperatures were rising, moisture increased, and forests expanded; megamammals and many large mammals that had survived for hundreds of thousands of years became extinct, and the "zig zag" was broken. The arrival of humans in South America was the sole new biological or geological event that occurred in the present interglacial period. Consequently, the entrance of humans and their pressure on numerically reduced mammal populations must have been the factor that led to local extinction (extirpation) or total (global) extinction. The different extinction of related species (e.g., between Cervidae and Camelidae, cited by Cione et al. 2009), may correspond to subtle differences in ecological plasticity.

The process of extinction appears to have taken several thousands of years in South America. Politis and Messineo (2008) published six AMS ^{14}C ages from *Megatherium americanum* bone collagen from the site Campo Laborde (37° 00′ 36″ S and 60° 23′ 05″ W), ranging from ca 9700 to 6700 RCYBP. The evidence obtained from Campo Laborde as well as from the La Moderna site (Politis et al. 2003) indicates that some Pleistocene species such as giant ground sloth and some glyptodonts (*Doedicurus clavicaudatus* and *Neosclerocaliyptus sp.*) survived in the Pampas until the early Holocene. Recently, Cajal et al. (2010) proposed that the extinction of a camelid, *Lama gracilis*, can be attributed also to the anthropic action that not only includes the hunt burden but also other factors (i.e., environmental change and ethological changes caused by human presence).

References Cited

Cajal, J., E. P. Tonni, and V. Tartarini 2010 The Extinction of Some South American Camelids: The Case of *Lama (Vicugna) gracilis. Mastozoología Neotropical* 17:129–34.

Cione, A. L., E. P. Tonni, and L. H. Soibelzon 2003 The Broken Zig-Zag: Late Cenozoic Large Mammal and Turtle Extinction in South America. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"* 5:1–19.

——— 2009 Did Humans Cause Large Mammal Late Pleistocene-Holocene Extinction in South America in a Context of Shrinking Open Areas? In *American Megafaunal Extinctions at the End of the Pleistocene*, edited by G. Haynes, pp. 125–44. Springer Publishers, Vertebrate Paleobiology and Paleontology Series.

Petit, J. R., J. Jouzel, D. Raynaud, N. I. Barkov, J.-M. Barnola, I. Basile, M. Bender, J. Chappellaz, M. Davis, G. Delaygue, M. Delmotte, V. M. Kotlyakov, M. Legrand, V. Y. Lipenkov, C. Lorius, L. Pépin, C. Ritz, E. Saltzman and M. Stievenard 1999 Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica. *Nature* 399: 429–36.

Politis, G. G., E. Johnson, M. A. Gutierrez, and W. T. Hartwell 2003 Survival of the Pleistocene Fauna: New Radiocarbon Dates on Organic Sediments from La Moderna (Pampean Region, Argentina). In *Where the South Winds Blow: Ancient Evidence for Paleo South Americans*, edited by L. Miotti, M. Salemme, and N. Flegenheimer, pp.45–50. Center for the Studies of the First Americans (CSFA) and Texas A&M University Press, College Station, TX.

Politis, G. G., and Messineo, P. 2008 The Campo Laborde Site: New Evidence for the Holocene Survival of Pleistocene Megafauna in the Argentine Pampas. *Quaternary International* 191(1): 98–114.

Vivo, M., and A. P. Carmignotto 2004 Holocene Vegetation Change and the Mammal Faunas of South America and Africa. *Journal of Biogeography* 31:943–57.

Environmental Stability During the Pleistocene-Holocene Transition in Northwestern Patagonia? The Small Mammals of Cueva Huenul 1 as Evidence

Fernando J. Fernández, Ulyses F. J. Pardiñas, Pablo Teta, and Ramiro Barberena

➤ **Keywords:** Micromammals, taphonomy, paleoenvironments, Argentina

Paleoenvironmental studies in northwestern Patagonia are mostly focused on forest and ecotone forest-steppe areas (e.g., Whitlock et al. 2006 and references therein). The obtained data indicate dry and cold conditions for the late-Pleistocene/Holocene transition (see also Markgraf et al. 2009). For the steppic and hilly ranges east of the Andes in northern Neuquén province there are no studied paleoclimatic records, despite the potential interest of this region, because it has the highest elevations in Patagonia (Domuyo system) and is situated near the western limit of the South American Arid Diagonal. Recent excavations at Cueva Huenul 1 (CH1; 36° 56′ 45″ S, 69° 47′ 32″ W, 1008 m, Neuquén province, Argentina, Figure 1) yielded a rich sequence spanning the late-Pleistocene/early-Holocene (Barberena et al. 2010), and reaching the late Holocene. In this note we briefly address the taphonomy and paleoenvironmental significance of the micromammal remains obtained in CH1.

Bones and teeth of rodents and marsupials (NISP = 1418, MNI = 81) were recovered from late-Pleistocene/early-Holocene layers [units VIII-VII = 13,844 ± 75 RCYBP (AA-85722); units VI-IV = 11,841 ± 56 RCYBP (AA-85720); 9531 ± 39 RCYBP (AA-85718)]; and late-Holocene layers [units III-I = 1416 ± 37 RCYBP (AA-85721)]. We also analyzed samples of fresh pellets from *Tyto alba* (Strigiformes, Tytonidae) obtained from the surroundings of CH1, to compare them with the fossil samples (Figure 1).

The finding of pellets preserved in stratigraphy, together with light digestive traces on some teeth and postcranial bones, and relative abundance of skeletal elements, suggests that the main accumulator agent was an owl, probably *T.*

Fernando J. Fernández, Cátedra de Anatomía Comparada, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Calle 64 s/n entre diag. 113 y calle 120, (CP1900) La Plata, Argentina; e-mail: fernandezf77@yahoo.com.ar

Ulyses F. J. Pardiñas, Unidad de Investigación Diversidad, Sistemática y Evolución, Centro Nacional Patagónico, Casilla de Correo 128, Puerto Madryn, Chubut, Argentina; e-mail: ulyses@cenpat.edu.ar

Pablo Teta, Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Avenida Ángel Gallardo 470, (C1405DJR) Buenos Aires, Argentina; e-mail: antheca@yahoo.com.ar

Ramiro Barberena: CONICET-IMHICIHU, Saavedra 15, 5th (1083), Buenos Aires, Argentina: e-mail: ramidus28@gmail.com

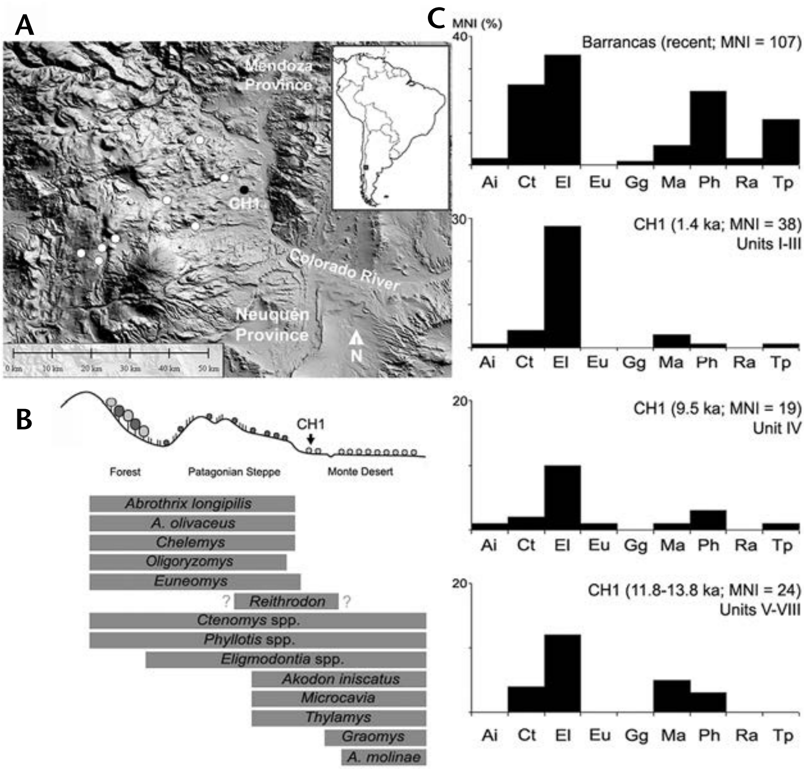


Figure 1. **A,** Northeastern portion of Neuquén Province, Argentina, showing the location of Cueva Huenul 1 (black circle) and modern owl pellet samples (white circles) used for comparisons; **B**, distribution of small mammal species in a west-east gradient in northeastern Neuquén Province (at the level of CH1 in the Fig. 1A); **C**, histograms showing the changes in small-mammal abundance (expressed as percentage of the minimum number of individuals [MNI] per period) through time. Abbreviations: *Akodon iniscatus* (Ai); *Ctenomys* spp. (Ct); *Eligmodontia* spp. (El); *Euneomys* spp. (Eu); *Graomys griseoflavus* (Gg); *Microcavia australis* (Ma); *Phyllotis* spp. (Ph); *Reithrodon auritus* (Ra); *Thylamys pallidior* (Tp); ka = RCYBP.

alba (see Andrews 1990). Moreover, no evidence of weathering and other post-depositional processes, such as hydraulic transport, root action, and diagenesis, were found. However, the high breakage of cranial elements and long bones, taken with the good preservation of smaller elements such as vertebrae, calcaneus, astralagus, metapodials, and phalanges, may indicate some trampling action (Andrews 1990).

Species richness was related to sample sizes ($r = 0.74$), a situation that, coupled with the small NISP studied, hampers the scope of our conclusions. Fossil samples are dominated by silky desert mouse *(Eligmodontia* spp.), leaf-eared mouse *(Phyllotis* spp.), cavy *(Microcavia australis)* and tuco-tuco *(Ctenomys* spp.). Early-Holocene and late-Holocene assemblages are richer than those of the late Pleistocene and include species typically associated with the Monte

Desert, such as the sigmodontine *Akodon iniscatus* and the mouse opossum *(Thylamys pallidior)*, and the Patagonian rat *(Euneomys* spp.*)* (early Holocene). This situation, with the risk of a biased interpretation due to the small Pleistocene sample sizes, appears to be indicative of a smooth change toward a more heterogeneous environment after ca. 9500 RCYBP and up to the late Holocene, including a mosaic of shrubby steppes, open bare areas, and large rocky outcrops. However, the basic signature (i.e., the codominance of *Ctenomys* spp., *Eligmodontia* spp., *M. australis*, and *Phyllotis* spp.) of the small-mammal assemblages of CH1 remained almost without changes during the Pleistocene-Holocene transition, even up to the late Holocene. A few kilometers west of this cave a recent owl pellet sample shows the occurrence of several abrotrichines (*Abrothrix longipilis*, *A. olivaceus*) and high proportions of *Euneomys* and *Reithrodon auritus* under cooler and wetter conditions. This faunal assemblage never reached CH1 vicinities according to the preserved record, an expectable situation if cooling events had occurred (Pardiñas and Teta 2008), suggesting instead a remarkable ecological resilience to climate change. The general faunal stability of CH1 agrees with the environmental stability inferred on the basis of pollen data from the segment 14,800-8,900 RCYBP of Mallín Vaca Lauquen (Markgraf et al. 2009). Additionally, small mammals of CH1 do not reflect the occurrence of the Huelmo/Mascardi Cold Reversal (HMCR; Hajdas et al. 2003). However, the HMCR is broadly coincident with an erosive unconformity recorded at CH1 that is bracketed between the ages of 11,841 ± 56 and 9531 ± 39 RCYBP (Barberena et al. 2010).

We thank Gustavo Neme and Adela Bernardis for providing a part of the recent pellet samples of *Tyto alba*; the effort of Anahí Formoso and A. Bernardis in sorting and confirming the taxonomy of those samples is greatly appreciated. We also thank CONICET and Agencia (PICT 2008-0547 to UFJP) for economic support.

References Cited

Andrews, P. 1990 *Owls, Caves and Fossils*. University of Chicago Press, Chicago.

Barberena, R., M. P. Pompei, C. Otaola, A. Gil, G. Neme, K. Borrazzo, V. Durán, and R. Hoguin 2010 Pleistocene-Holocene Transition in Northern Patagonia: Evidences from Huenul Cave (Neuquén, Argentina). *Current Research in the Pleistocene* 27:5–8.

Hajdas, I., G. Bonani, P. I. Moreno, and D. Ariztegui 2003 Precise Radiocarbon Dating of Late-Glacial Cooling in Mid-Latitude South America. *Quaternary Research* 59:70–78.

Markgraf, V., C. Whitlock, R. S. Anderson, and A. García 2009 Late Quaternary Vegetation and Fire History in the Northernmost *Nothofagus* Forest Region: Mallín Vaca Lauquen, Neuquén Province, Argentina. *Journal of Quaternary Science* 24:248–58.

Pardiñas, U. F. J., and P. Teta 2008 Small Mammals and Paleoenvironments around the Pleistocene-Holocene Boundary in Patagonia. *Current Research in the Pleistocene* 25:30–32.

Whitlock, C., M. M. Bianchi, P. J. Bartlein, V. Markgraf, J. Marlon, M. Walsh, and N. McCoy 2006 Postglacial Vegetation, Climate, and Fire History along the East Side of the Andes (lat 41–42.5° S), Argentina. *Quaternary Research* 66:187–201.

The "Living Fossil" Peccary, *Catagonus wagneri* (Tayassuidae), and Its Climatic Significance during the Pleistocene and Holocene

Germán M. Gasparini, Esteban Soibelzon, Eduardo P. Tonni, and Martín Ubilla

➤ **Keywords**: *Catagonus*, Tayassuidae, paleonvironments, Pleistocene, South America

The Tayassuidae first expanded their range into North America from Eurasia and then extended into South America during the "Great American Biotic Interchange," becoming one of the first North American mammalian immigrants. Three genera are recognized in South America: *Platygonus* Le Conte (middle Pliocene to early Pleistocene), *Catagonus* Ameghino (late Pliocene? early Pleistocene to Recent), and *Tayassu* Fischer (middle Pleistocene to Recent; see Gasparini et al. 2009, 2010).

Catagonus wagneri was assigned to the genus *Catagonus* Ameghino by Wetzel et al. (1975); it is commonly known as Chacoan peccary, *taguá* or *chancho quimilero*. It has the most restricted geographical distribution among extant Tayassuidae and inhabits semiarid thorny forests of Dry Chaco in western Paraguay, southeastern Bolivia and northern Argentina (Mayer and Wetzel 1986; Gasparini et al. 2006; see Figure 1). The genus *Catagonus* was known from early- to middle-Pleistocene deposits in Buenos Aires City, Argentina (the extinct species *C. metropolitanus*). The species *C. wagneri* was reported by Rusconi (1930) in archaeological sites from Santiago del Estero Province, Argentina (ca. 1000 RCYBP; see Tonni 2006); it was believed to be extinct until it was described by Wetzel et al. (1975). Recently a partial skull from late Pleistocene of Uruguay (Cuareim River, Artigas Department) was assigned to *C. wagneri* (Gasparini et al. 2009, 2010). This material comes from the Sopas Formation (>45,000 RCYBP; 43,500 ± 3600 and 58,300 ± 7400 CALYBP [TL dates]; see Ubilla 2004). This is the oldest fossil record of this species and shows that the species ranged out of its present distribution during late Pleistocene.

Chacoan peccary is more like the extinct *Platygonus* than the other living peccaries. Certain anatomical features of *C. wagneri* are linked with a cursorial life in open and arid or semiarid environments (e.g., elongated limbs, a reduction of the lateral digits, and a great development of the sinuses and nasal chambers; see Wetzel 1977).

Germán M. Gasparini, Esteban Soibelzon, and Eduardo P. Tonni, División Paleontología Vertebrados, Museo de La Plata, Facultad de Ciencias Naturales y Museo, UNLP, Paseo del Bosque s/n, B1900FWA La Plata, Argentina; emails: germanmgasparini@gmail.com esoibelzon@fcnym.unlp.edu.ar eptonni@fcnym.unlp.edu.ar

Martín Ubilla, Facultad de Ciencias, Iguá 4225, 11400, Montevideo, Uruguay; email: ubilla@fcien.edu.uy

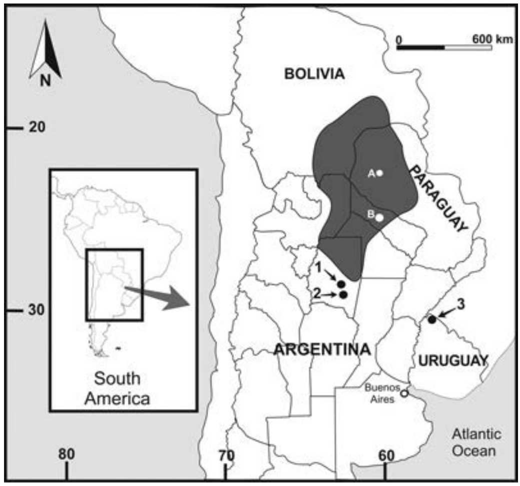


Figure 1. Archaeological and paleontological sites where fossil remains of *C. wagneri* were found, and current range: **1,** Llajta Maüca archaeological site, 15 km northwest of Melero, Santiago del Estero Province; **2,** Tulip-Loman archaeological site, near Icano, Santiago del Estero Province, 45km south of Llajta Maüca; **3,** paleontological site rio Cuareim, Artigas Department, Uruguay; **A,** Mariscal Estigarribia, Boquerón Department, Paraguay; **B,** Las Lomitas, Formosa Province, Argentina. Gray area indicates current range of *C. wagneri.*

At present, *C. wagneri* inhabits areas of rainfall between 800 mm (Mariscal Estigarribia, Paraguay) and 80 mm (Las Lomitas, Argentina)—concentrated in summer months—and high temperatures (mean annual temperature over 24°C). During the late Pleistocene (Uruguay) and the late Holocene (Argentina), *C. wagneri* is recorded in association with mammals that also indicate arid or semiarid conditions (e.g., *Lama guanicoe, Myrmecophaga tridactyla*) linked to chacoan vegetation.

During the arid phases of the Pleistocene and Holocene, *C. wagneri* extended its geographic range; during the mainly humid phases—similar to the present ones—it has survived in a scrub-thorn refugium.

The authors thank the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Universidad Nacional de La Plata, ANPCyT, and CIC-PBA, for financial support.

References Cited

Gasparini, G. M., E, Ortiz Jaureguizar, and A. A. Carlini 2006 Familia Tayassuidae. In *Los Mamíferos de Argentina: Sistemática y distribución,* edited by R. M. Bárquez, M. M. Díaz, and R. A. Ojeda, pp. 114–15. Publicación Especial de la Sociedad Argentina para el Estudio de los Mamíferos (SAREM).

Gasparini, G. M., M. Ubilla, and E. P. Tonni 2009 Tres especies de tayasuidos (*Catagonus wagneri, C. stenocephalus* y *Tayassu pecari*) en el Pleistoceno tardío del norte de Uruguay (Fm. Sopas). *Reunión Anual de Comunicaciones de la Asociación Paleontológica Argentina*:47.

Gasparini, G.M., M. Ubilla, and E. P. Tonni 2010 The Chacoan Peccary, *Catagonus wagneri* (Mammalia, Artiodactyla) in the Late Pleistocene of Northern Uruguay (South America). *The Third International Palaeontological Congress, IPC3*:123.

Mayer, J. J., and R. M. Wetzel 1986 *Catagonus wagneri. Mammalian Species* 259:1–5.

Rusconi, C. 1930 Las especies fósiles argentinas de pecaríes y sus relaciones con las del Brasil y Norteamérica. *Anales del Museo Nacional de Historia Natural "Bernardino Rivadavia"*, 36:121–241.

Tonni, E. P. 2006 Cambio climático en el Holoceno tardío de la Argentina. Una síntesis con énfasis en los últimos 1000 años. *Folia Histórica del Nordeste* 16:187–95.

Ubilla, M. 2004 Mammalian Biostratigraphy of Pleistocene Fluvial Deposits in Northern Uruguay, South America. *Proceedings of the Geologists Association* 115:347–57.

Wetzel, R. M. 1977 The Chacoan Peccary, *Catagonus wagneri* (Rusconi). *Bulletin of the Carnegie Museum of Natural History* 3:1–36.

Wetzel, R. M., R. E. Dubois, R. L. Martin, and P. Myers 1975 *Catagonus* an "Extinct" Peccary, Alive in Paraguay. *Science* 189:379–81.

Using Morphometrics to Identify Shape Differences on Isolated Teeth in Pleistocene Tapir Species

Matthew Lewis Gibson and Steven C. Wallace

➤ **Keywords:** Morphometrics, tapir dentition, taxonomic identification

Tapirs are considered relatively conservative Perissodactyls, sometimes referred to as living fossils (Janis 1984), and possess generalized dentitions (Simpson 1945), which can make identifying species and running statistical analyses using isolated teeth problematic (Graham 2003). Unfortunately, tapir material is frequently recovered from cave deposits as only fragmentary dental remains, so several taxa have been described based on isolated teeth alone, primarily based on size (Ray and Sanders 1984). Naming species based on size differences can create problems, however. Rather than being two species, they may simply be different-sized individuals of the same species. Additionally, defining one species as two also fractionalizes the true historical range for the species. Consequently, different methods for identifying isolated teeth to species are needed to ensure proper paleoenvironmental interpretations of such cave faunas. With this in mind, morphometrics could prove to be a useful alternative to identifications based on size .

Identifying shape differences among the various tapir taxa is difficult considering the similar dentitions seen throughout the group. Moreover, it is often difficult to identify with certainty tooth location for isolated teeth, let alone to assign them to a species. However, using geometric morphometrics, it may be possible to recognize even minor shape change, which could be used to differentiate isolated teeth, thereby allowing direct comparison to "known" specimens. Fortunately, the unique shape of the P1 and M3 means that only P2–M2 are problematic and therefore are the focus of this study. Therefore, using a landmark-based scheme applied to P2 through M2, we identified

Matthew Lewis Gibson, Department of Biological Sciences. PO Box 70267, Johnson City, TN 37614; e-mail: gibsonml@goldmail.etsu.edu

Steven C. Wallace, Department of Geosciences and Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN 37614; e-mail: wallaces@mail.etsu.edu

shape differences among the cheek teeth of two Pleistocene tapirs (*Tapirus veroensis* and *T. haysii*) as a test case and sought to identify an unidentified premolar from a cave deposit in eastern Tennessee. *Tapirus veroensis* and *T. haysii* were used for this analysis because they are the most likely candidates for the Tennessee specimen based on overall morphology and previously reported taxa from Tennessee. However, there are some potential problems which would need to be addressed in future applications of this method. First, the sample sizes are fairly small (*T. haysii*, n = 4; *T. veroensis*, n = 8; and the unknown), so true natural variation is not likely well represented. Secondly, discriminant analysis works best when an unknown belongs to one of two groups; therefore we assume that these are the only two possible taxa (an as yet recognized species of large tapir could have coexisted).

Initial discriminant analysis of the buccal teeth had difficulty grouping the unknown with either *T. veroensis* or *T. haysii* likely due to the unknown being a juvenile with several deciduous teeth. Step-wise discriminant analysis removed landmarks that provided the least discriminating power (likely noise) (Figure 1). Focusing on those characters that best distinguished the two taxa, both separate well, with the unknown grouping with *T. veroensis*. It is likely that the initial discriminant analysis was picking up on the differences between deciduous and adult teeth, or that the results suggest a species of *Tapirus* not considered in this study. Further study is needed to test the utility of this method, but results seem promising.

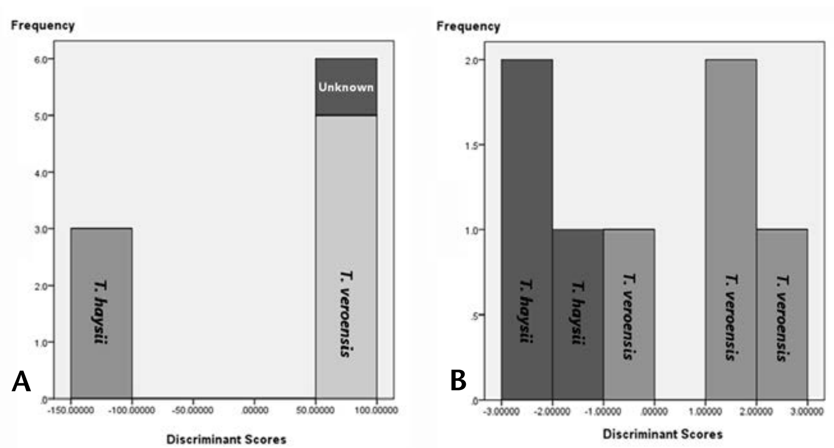


Figure 1. A, Step-wise Discriminant analysis of premolars. Note that the analysis groups the unknown with *T. veroensis*; **B,** Step-wise Discriminant analysis of molars**.** The unknown specimen lacked M2 so it was not included.

References Cited

Graham R. W. 2003 Pleistocene Tapir from Hill Top Cave, Trigg County, Kentucky, and a Review of Plio-Pleistocene Tapirs of North America and Their Paleoecology. In *Ice Age Cave Faunas of North America,* edited by B. W. Schubert, J. I. Mead, and R. W. Graham, pp 87–118. Indiana University Press, Bloomington and Indianapolis.

Janis C. 1984 Tapirs as living fossils. In *Living Fossils*, edited by N. Eldredge and S. V. Stanley, pp. 80–86. Springer-Verlag, New York.

Ray, C. E., and A. E. Sanders 1984 Pleistocene tapirs in the eastern United States. Contributions in Quaternary Vertebrate Paleontology: A volume in memorial to John E. Guilday, edited by H. H. Genoways and M. R. Dawson, pp. 283–315. Special Publication of Carnegie Museum of Natural History, Pittsburgh.

Simpson G. G. 1945 Notes on Pleistocene and recent tapirs. *Bulletin of the American Museum of Natural History* 86(**2**):37–81.

A Review of the Nye Site, Wisconsin

Marlin F. Hawley, Matthew G. Hill, Christopher C. Widga, and Darrell W. Kittleson

➤ **Keywords**: Bison, Holocene, Early Man

The Nye site (47PK206) was reported in 1935 by zoologist S. Eddy and anthropologist A. E. Jenks at the University of Minnesota (UM). According to their *Science* article (Eddy and Jenks 1935), on 28 October 1934 a farmer in the St. Croix River valley (between Minnesota and Wisconsin) brought to them several large animal bones, which Eddy identified as an extinct species of bison (*Bison oliverhayi*) (Eddy and Jenks 1935). Over the next several months Eddy collected an estimated 1,500 bones from the undisclosed source, said to be marl pits. Rosendahl (1948:290) reported a personal communication from Eddy indicating that fully 90% of the bones were bison. Elk and caribou bones were also reportedly present. Eddy and Jenks (1935) offered an MNI of 40 bison ranging in age from calves to 3 years; at least 6 adults were supposed to be represented. McDonald (1981) examined bison crania from Nye at the Bell Museum of Natural History at UM, and identified *B. antiquus antiquus* and *B. a. occidentalis.* More recently, preliminary analysis of the Nye bison crania indicates that their morphology could be accommodated within the variability of other regional bison assemblages from the early to mid Holocene (Hill et al. 2011).

By 1934–1935 Jenks, a prominent UM anthropologist, was already deeply involved in investigating putative Early Man sites in the upper Midwest, including the Arvilla Culture and Minnesota Woman (Jenks 1932a, 1932b, 1933, 1934, 1935). Not surprisingly, Eddy and Jenks (1935) framed the discovery as yet another in a growing list of Early Man sites in the region. Bone preserva-

Marlin F. Hawley, Museum Archaeology Program, Wisconsin Historical Society, Madison , WI; e-mail: marlin.hawley@wisconsinhistory.org

Matthew G. Hill, Department of Anthropology, Iowa State University, Ames, IA; e-mail: mghill@iastate.edu

Christopher C. Widga, Illinois State Museum, Springfield, IL; e-mail: cwidga@museum.state.il.us

Darrell W. Kittleson, Polk County Historical Society, Balsam Lake, WI.

tion was excellent; thus "many of the bones show that they were food refuse. Cuts and scratches made as by flint implements are present on some 20 per cent or more of the bones" (Eddy and Jenks 1935:535). Other bones appeared burned. Importantly, "[a] small number of artifacts . . . have been recovered. These include . . . artifacts made of elk and bison bones, one . . . of oak wood and a few of stone." Although "the age of this kitchen-middens [sic]" was unknown, they emphasized that "the artifacts are quite unlike those associated with modern North American Indians in the area." A full report on the site was never prepared.

In 1948, UM paleobotanist C. O. Rosendahl (1948:290) revealed that the site was located "near the village of Nye in Polk County, Wisconsin." The specific location was finally established 29 June 2010 through the assistance of the Polk County Historical Society, Balsam Lake, Wisconsin, and an informant, Mr. Eldred Anderson, of Dresser, Wisconsin. Mr. Anderson's grandfather, Martin Anderson, managed work at the marl pits, and young Eldred (then ca. 10 years old) was dispatched daily to deliver lunches to the 5–6 workmen. (Hans Anderson, Eldred's uncle, may have been the farmer who visited Eddy at UM.) Mr. Anderson recalled that marl was dug with a drag line and backhoe from a sheltered spring-fed marsh east of Round Lake. (Excavated marl was dried and applied to cut-over land to deacidify the soil.) Thus the bone was exhumed in a non-systematic manner. With the location of the site in hand, an aerial photograph of the area (U.S. Department of Agriculture 1938) confirms the presence of two long curvilinear trenches, as well as the haul road into the site described by Mr. Anderson. A long overlooked contemporary article in *The Amery* (Wis.) *Free Press* (Anonymous 1935) indicates that the project was supported with Federal Emergency Relief Administration dollars.

Rosendahl (1948:290), based on recovered woody plant remains, reasoned that the site dated to the late Pleistocene. This estimate suggests that the site is older than the nearby Interstate Park Bison site (excavated in 1936–1937 by the CCC), which dates to the early Holocene (ca. 7500 CALYBP) (Hawley et al. 2007; Hill et al. 2011). As bone and floral remains at Nye were apparently recovered from different depths—the former from 10–18 ft and the flora from 6–10 ft—their association is far from certain. Moreover, the floral assemblage, especially in the absence of spruce, closely mirrors the early- and mid-Holocene regional vegetational record. Now perennially inundated, the site has been exhaustively quarried, rendering the 1934–1935 collection (the extant portion recently has been transferred to the University of Wisconsin Zoology Museum) that much more important. The next logical phase of research would be to date one or more samples of bone from the site and analyze the whole assemblage. Data from Nye, together with that from the Interstate Park Bison site, would add immeasurably to knowledge of regional paleoecology in the early and mid Holocene.

The Nye site was relocated, after 75 years, through the efforts of Darrell Kittleson, Dan Mosay, Greg Marsten, and most critically, Eldred Anderson. We are especially grateful also to Bill and Jean Dehning for permitting access to the site. The timely assistance of the staff of the Arthur H. Robinson Map Library, UW Madison is also acknowledged.

References Cited

Anonymous 1935 Marl Pits Give Up Buffalo Bones, Daggers. *The Amery Free Press*, February 14, 1935, p. 1. Amery, Wisconsin.

Eddy, S., and A. E. Jenks 1935 A Kitchen Middens with Bones of Extinct Animals in the Upper Lakes Area. *Science* 8(2109):535.

Hawley, M. F., M. G. Hill, and C. C. Widga 2007 Recent Research on the Interstate Park Bison Site, Polk County, Northwestern Wisconsin. *Current Research in the Pleistocene* 24:93–95.

Hill, M. G., M. F. Hawley, and C. C. Widga 2011 Interstate Park Bison Site: New Deal Archaeology, Early Man in America, and Postglacial Foragers in the Upper Midwest. Unpublished manuscript in possession of authors.

Jenks, A. E. 1932a The Problem of the Culture from the Arvilla Gravel Pit. *American Anthropologist* 34(3):455–66.

——— 1932b Pleistocene Man in Minnesota. *Science* 75(1954):607–08.

——— 1933 Minnesota Pleistocene Homo, An Interim Communication. *Proceedings of the National Academy of Science* 19(1):1–6.

——— 1934 The Discovery of an Ancient Minnesota Maker of Yuma and Folsom Flints. *Science* 80(2070):205.

——— 1935 Recent Discoveries in Minnesota Prehistory. *Minnesota History* 16(1):1–21.

McDonald, J. N. 1981 *North American Bison: Their Classification and Evolution*. University of California Press, Berkeley.

Rosendahl, C. E. 1948 A Contribution to the Knowledge of the Pleistocene Flora of Minnesota. *Ecology* 29(3):284–315.

U.S. Department of Agriculture, Agriculture Adjustment Administration 1938 Series 1938 Aerial Photograph, Polk County, Wisconsin, Abrams Aerial Survey Corporation, Ann Arbor, Michigan. Arthur H. Robinson Map Library, University of Wisconsin, Madison.

Weevil (*Strangaliodes* sp., Curculionidae) Records for the Early Holocene in the Semiarid North of Chile

Douglas Jackson

➤ **Keywords:** Coleoptera, Curculionidae, early Holocene, northern Chile

Studies of fossil insects in Chile are circumscribed to records of the south part of the country (40–45° S), and essentially include coleoptera and cephalic capsules of *diptera chironomidae* (Ashworth and Hoganson 1987; Ashworth and Marckgraf 1989; Ashworth et al., 1991; Borrero et al. 1991; Massaferro and Brooks 2002; Saxon 1979). On the other hand, the only archaeological site in the south of America with well-documented records of insects is Monte Verde, which includes predominantly coleoptera, among which weevils stand out (Curculionidae) (Ashworth et al. 1989).

In this context, the reevaluation of samples from an early archaeological site

Douglas Jackson, Sociedad Chilena de Entomología, Casilla 21132, Santiago (21), Chile, e-mail: sillitus@hotmail.com

known as (Curculionidae), an early-Holocene hunter-gatherer-fisher habitation site located along the coast of Los Vilos (31°) in the semiarid north of Chile, has recovered one elytron of a weevil (Figure 1A) of the genus *Strangaliodes.*

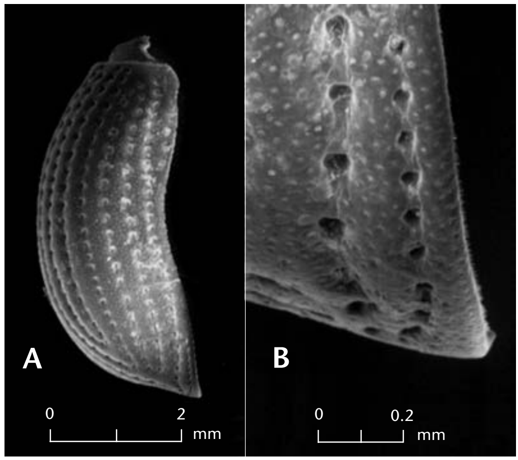


Figure 1. Scanning electron microphotograph of elytron *Strangaliodes* sp. (Cu rculionidae): **A,** showing the longitudinal striae and interstriae; **B,** elytron apex, showing the absence of scales on puncture.

The remains of this insect were recovered along with other organic remains in a soil sample (3 liters) processed by flotation (light fraction), which was obtained from the lower levels (105–110 cm) of the archaeological deposit, formed by a sand matrix of a paleo-sand dune with mollusk remains and other cultural signs dated to Beta 106802: 10,200 ± 70 RCYBP [11,895 CALYBP])/Beta 94101: 9320 ± 60 RCYBP (10,439 CALYBP) (Jackson and Méndez 2005). The remains of the insect were probably deposited at some point in the abandonment of the settlement, which was repeatedly occupied.

The specimen consists of a right elytron that is morphologically assignable to the genus *Strangaliodes,* by displaying a soft and constant convexity in the elytral declivity and a back of longitudinal convexity, which are typical features of this genus of weevil (Elgueta 1985). The elytron is 8.10 mm long and dull black in color; the striae puncture is deep without scales (Figure 1B). The darkening of the structural color (Elias 1994), the detachment of the scales from the striae, and the stratigraphic position and radiocarbon dating of the layer where this elytron was recorded confirm that it was deposited during the early Holocene.

However, taphonomic samplings from present-day dune systems in the same locality have led to recovery of 128 remains of this weevil. This record confirms that the elytra are the best preserved parts (23.44%), being considerably unaffected by meteorization processes owing to their rigid and highly sclerotized structure.

The genus *Strangaliodes* is endemic (or native) to Chile and at present consists of nine species (Elgueta and Marvaldi 2006), four of which live in the hyperarid north extreme of the country (15°–25°), while *S. niger, S. sticticus,* and *S. sulcatulus* live in the central valley (35° S), and *S. albosquamosus* and *S. mutuarius* are found in the Andean foothills of the south-center of Chile

(35° S). Although the elytron reported here belongs to the genus *Strangaliodes*, it is not assignable to any of the above-mentioned species, and instead corresponds to a new species not yet described. The study of its ecology shows that it is nowadays restricted to dunes, where it is associated with *Baccharis* sp. (Asteraceae), where it develops its larval state.

The record of this species of *Strangaliodes* in early-Holocene archaeological deposits is concurrent with Asteraceae predominance (*Baccharis* sp.) for this period (Maldonado et al. 2010; Maldonado and Villagrán 2006a, 2006b), when environmental conditions were relatively dry. This suggests that this species of weevil once enjoyed a wider dispersion, owing to the predominance of Asteraceae in this period and to the strict development of this weevil in this kind of plant (monophagous).

This type of record could yield relevant insights into the environment of archaeological sites, because one of the most important features of insects is their sensitivity to environmental change (Elias 1994). At the same time, the record of old insects contributes to the paleogeographical knowledge of the biological diversity of the environments occupied by the first human populations that inhabited the continent.

Research was funded by Fondecyt grant 1090044.

References Cited

Ashworth A. C., and J. W. Hoganson 1987 Coleoptera Bioassociations along an Elevational Gradient in the Lake Region of Southern Chile, and Comments on the Postglacial Development of the Fauna. *Annals of the Entomological Society of America* 80:865–95.

Ashworth A. C., and V. Markgraf 1989 Climate of the Chilean Channels between 11,000 and 10,000 yr B.P. Based on Fossil Beetle and Pollen Analysis. *Revista Chilena de Historia Natural* 62:61–74.

Ashworth A. C., J. Hoganson, and M. Gunderson 1989 Fossil Beetle Analysis. In *Monte Verde: A Late Pleistocene Settlement in Chile, Volume 1: Palaeoenvironment and Context*, edited by T. D. Dillehay, pp. 211–26. Smithsonian Institution Press, Washington, D. C.

Ashworth A. C., V. Markgraf, and C. Villagran 1991 Late Quaternary Climatic History of the Chilean Channels Based on Fossil Pollen and Beetle Analyses, with an Analysis of the Modern Vegetation and Pollen Rain. *Journal of Quaternary Science* 6:279–91.

Borrero L., J. Lanata, and P. Cardenas 1991 Reestudiando cuevas: nuevas excavaciones en Ultima Esperanza, Magallanes. Anales . Instituto Patagonia, Serie. Ciencias. Sociales., Punta Arenas (Chile) Vol. 20: 101–10.

Elgueta, M. 1985 Comentarios sobre algunas especies chilenas de *Leptopiinae* descritas por Charles Emile Blanchard (Coleoptera: Curculionidae). *Revista Chilena de Entomología* 12:141–43.

Elgueta, M., and A. Marvaldi 2006 Lista sistemática de las especies de Curculionoidea (Insecta: Coleoptera) presentes en Chile, y sus sinonimias. *Boletín del Museo Nacional de Historia Natural* (Santiago, Chile), 55-113–53.

Elias, S. 1994 *Quaternary Insects and Their Environments*. Ed. Smithsonian Institution Press, Washington and London.

Jackson, D., and C. Méndez 2005 Primeras ocupaciones humanas en la costa del semiárido de Chile: Patrones de asentamiento y subsistencia. *Actas del XVI Congreso Nacional de Arqueología Chilena, Ediciones, Museo de Historia Natural de Concepción, Sociedad Chilena de Arqueología*, ediciones Escaparate Pp.493–502.

Maldonado, A., and C. Villagrán 2006a Climate Variability over the Last 9900 cal yr BP from a Swamp Forest Pollen Record along the Semiarid Coast of Chile. *Quaternary Research* 66:246–58.

——— 2006b Variability of the Northern Limit of Southern Westerlies over the Last 9500 cal yr BP from a Swamp-Forest Pollen Record along the Semiarid Coast of Chile (32° 04¢ S). *Quaternary Research* 66:246–58.

Maldonado, A., C. Méndez, P. Ugalde, D. Jackson, R. Seguel, and C. Latorre 2010 Early Holocene Climate Change and Human Occupation along the Semiárid Coast of North-Central Chile. *Journal of Quaternary Science* 25:1–4.

Massaferro, J., and S. J. Brooks 2002 The Response of Chironomids to Late Quaternary Environmental Change in the Taitao Penninsula, Southern Chile. *Journal of Quaternary Science* 17(2):101–11.

Saxon, E. C. 1979 Natural Prehistory: The Archaeology of Fuego-Patagonia Ecology. *Quaternaria* 12:329–56.

Additional Records of Late Pleistocene Sciurids from the Hand Hills, Alberta

Christopher N. Jass, David (Tim) Schowalter, Lisa Bohach, and Emily Frampton

➤ **Key Words:** *Cynomys, Spermophilus,* Sciuridae

Localities characterized by Pleistocene burrow casts and associated fossils of an extinct form of white-tailed prairie dog (*Cynomys niobrarius churcherii*) were previously reported from the Hand Hills and Wintering Hills regions of Alberta (Young et al. 1999). Those remains, and fossils of other taxa preserved in the burrow casts, were collected primarily from outcrops associated with aggregate operations; therefore, both burrow casts and associated skeletal remains represent nonrenewable resources that will disappear as aggregate excavations continue. Given that vulnerability, and the potential for additional fossils to be used to address new research questions (e.g., morphological variation in extinct populations), we initiated new field efforts in the Hand Hills and Wintering Hills. Here we present early results of those efforts.

In 2010, we visited localities that included reported sites in the Hand Hills (Winter Site I and II of Young et al. 1999) and Wintering Hills (Schowalter Site; Burns 1996), and potential new sites in the Hand Hills. Previously reported sites were in an advanced stage of development, and no specimens were exposed where outcrops remained visible. However, we recovered Pleistocene fossils from three new sites, all of which occur in close proximity to previously reported localities (Burns 1996). The depositional framework of new sites was consistent with that previously reported

Christopher N. Jass, Royal Alberta Museum, 12845 – 102 Ave., Edmonton, AB, T5N 0M6, Canada; e-mail: chris.jass@gov.ab.ca

David (Tim) Schowalter, Box 202, Delia, AB, T0J 0W0, Canada; e-mail: tim.schowalter@gmail.com

Lisa Bohach and Emily Frampton, FMA Heritage Inc., 200, 1719 – 10th Ave. SW, Calgary, AB, T3C 0K1, Canada; e-mails: Lisa.Bohach@stantec.com Emily.Frampton@stantec.com

for Pleistocene burrow casts and associated skeletal elements (i.e., Young et al. 1999).

Vertebrate fossils were identified based on comparisons with paleontological and modern specimens housed at the Royal Alberta Museum (RAM), and descriptions from the literature. Fossils are housed at the RAM. Reported measurements taken with an ocular micrometer follow Goodwin (1995) for orientation and position of measurement.

Records of Pleistocene sciurids from new sites include *Cynomys* (P10.7.1–P10.7.2; P10.9.1–P10.9.9; P10.11.2) and *Spermophilus* (P10.7.3–P10.7.13, P10.7.15). On specimens of *Cynomys* (P10.7.1, P10.9.1) with a complete lower cheek tooth series (p4–m3), qualitative characters of the p4 and m3 permit referral to the subgenus *Leucocrossuromys* (see Semken 1966, Burns and McGillivray 1989), and the specimens exhibit overall similarity to *C. n. churcherii*. Measurements of individual teeth of P10.7.1 and P10.9.1 are provided in Table 1. Other elements identified as *Cynomys* are morphologically indistinguishable from similar elements preserved in the holotype of *C. n. churcherii*. Recovered specimens of *Spermophilus* consist of isolated teeth and are similar to *S. richardsonii* in size and structure.

Table 1. Measurements of individual teeth of P10.7.1 and P10.9.1 in mm.

Specimen	Tooth	Length	Width
P10.7.1	p4	2.8	4.0
	m1	2.7	4.5
	m2	2.9	4.5
	m3	5.0	4.4
P10.9.1	p4	2.9	3.9
	m1	3.1	4.3
	m2	3.2	4.3
	m3	4.9	4.3

Given previous identifications of fossils from adjacent localities, it seems likely that the fossils reported here represent *C. n. churcherii* and *S. richardsonii*. However, we conservatively refer the records to *Cynomys* (*Leucocrossuromys*) sp. and *Spermophilus* sp. For specimens of *Cynomys*, this reflects the fact that *C. n. churcherii* was originally diagnosed (in part) on the basis of cranial morphometrics (Burns and McGillivray 1989), and we do not currently have a sample size from new sites that would allow us to reasonably evaluate such characteristics. For specimens of *Spermophilus*, the identification reflects uncertainty with respect to our ability to separate isolated teeth of *S. richardsonii* from all other *Spermophilus* in western North America. Because any white-tailed prairie dog (subgenus *Leucocrossuromys*) in Alberta is outside of the modern range (Young et al. 1999), it seems appropriate to minimize any assumption that fossil *Spermophilus* represents a locally-extant taxon. Future, periodic inspection of new localities will continue to increase sample sizes, leading to the possibility of further taxonomic refinement.

We thank the landowners and gravel pit operators who provided access to sites. The editor and two anonymous reviewers provided constructive comments on the manuscript.

References Cited

Burns, J. A. 1996 Review of Pleistocene Zoogeography of Prairie Dogs (Genus *Cynomys*) in Western Canada with Notes on Their Burrow Architecture. In *Palaeoecology and Palaeoenvironments of Late Cenozoic Mammals: Tributes to the Career of C.S. (Rufus) Churcher*, edited by K. M. Stewart and K. L. Seymour, pp. 34–53. University of Toronto Press, Toronto.

Burns, J. A., and W. B. McGillivray 1989 A New Prairie Dog, *Cynomys churcherii*, from the Late Pleistocene of Southern Alberta. *Canadian Journal of Zoology* 67:2633–39.

Goodwin, H. T. 1995 Systematic Revision of Fossil Prairie Dogs with Descriptions of Two New Species. *The University of Kansas Natural History Museum Miscellaneous Publication* 86:1–38.

Semken, H. A., Jr. 1966 Stratigraphy and Paleontology of the McPherson *Equus* Peds (Sandahl Local Fauna), McPherson County, Kansas. *University of Michigan Museum of Paleontology Contributions* 20:121–78.

Young, R. R., J. A. Burns, R. B. Rains, and D. B. Schowalter 1999 Late Pleistocene Glacial Geomorphology and Environment of the Hand Hills Region and Southern Alberta, Related to Middle Wisconsin Fossil Prairie Dog Sites. *Canadian Journal of Earth Sciences* 36:1567–81.

Sexual Dimorphism in the Black-Footed Ferret (*Mustela nigripes*) Revealed by Geometric Morphometrics

Leigha M. King and Steven C. Wallace

➤ **Keywords:** Geometric morphometrics, *Mustela nigripes*, sexual dimorphism

Mustelids exhibit sexual dimorphism (Fairbairn 1997; Gliwicz 1988; Moors 1980) that strongly correlates with body size (Fairbairn 1997). *Mustela nigripes*, black-footed ferret, exemplifies this characteristic, with males consistently being larger (Moors 1980; Vargasj and Anderson 1996). Females are approximately 10% smaller than males in linear skeletal measurements (Hall 1981) and have skulls approximately 93% the size of males (Anderson et al. 1986; and see summaries provided by Hillman and Clark 1980; Nowak 2005). Although previous authors found clear separation between the sexes, none characterize in detail the morphology of the differences. Therefore, we aimed to describe such change in the cranium using geometric morphometrics.

Specimens analyzed, housed in the collections at East Tennessee State University, include eight females and nine males. Following Anderson et al. (1986), all individuals were classified as adults based on full fusion of cranial and epiphyseal sutures, and full eruption of permanent dentition. Each skull was photographed and analyzed in dorsal, ventral, and left lateral views. A total of 66 landmarks were placed on the skulls. Once digitized, a consensus skull was created for each sex

Leigha King and Steven C. Wallace, Department of Geosciences and Don Sundquist Center of Excellence in Paleontology, East Tennessee State University, Johnson City, TN 37614; e-mails: kingl1@goldmail.etsu.edu wallaces@etsu.edu

and directly compared with that of the other using thin plate spline analysis (essentially a grid is placed over the consensus skulls and then deformed during comparison to visualize what happens between landmarks).

Splines created of the dorsal view showed little shape change within the grid as the consensus female was warped to the consensus male; however, several regions exhibited an expansion and/or overall elongation: 1) widening of the inter-ridge space located between the postorbital and lacrimal processes; 2) sagittal crest lengthening; and 3) expansion of the braincase associated with further thinning of the postorbital constriction. The ventral spline highlighted: 1) braincase expansion; 2) thinning in the postorbital constriction; 3) secondary palate expansion at the carnassials; 4) lengthening between the occipital condyles and palatal opening; and 5) posterior squamosal lengthening. Such lengthening may in turn allow for a more anterior attachment of the temporalis, which typically results in a greater bite force (Greaves 1982). The lateral spline (Figure 1) showed the clearest changes, including: 1) sagittal crest lengthening; 2) carnassial lengthening; and 3) dorsal rotation of the rostrum. Overall, changes in cranial morphology between the two sexes reflected an enlargement of the skull as well as dorsal rotation of the rostrum.

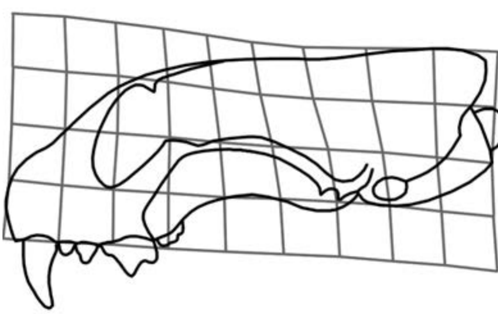


Figure 1. Thin plate spline showing the change in shape occurring between females and males. In this case the consensus female is transformed to that of the consensus male in lateral view. As noted in text, the ventral rotation of the rostrum causes a shortening in the distance between the sagittal crest and postorbital process. Lengthening can also be seen in the sagittal crest and carnassial.

Better understanding of the sexual differences within black-footed ferrets will be beneficial in identifying this species in the fossil record by helping avoid oversplitting of species simply due to morphological differences (i.e., not recognizing sexual dimorphism). More accurate identification of species will in turn improve our interpretations of past environments (e.g., Mead and Mead 1989). Moreover, because the furs of this animal were commonly used by various Native American tribes (U.S. Fish and Wildlife Service 1998), identifying sexes of ferrets collected from archaeological sites may prove insightful as to how the tribes affected the populations of this species. Continuation of this work, among other outcomes, will likely lead to a better understanding of genetic bottleneck effects; specifically, how loss of genetic diversity affects morphology. Lastly, future comparisons between *M. nigripes* and other closely related taxa (e.g., *M. eversmanii*) could also reveal range shifts not previously recognized.

References Cited

Anderson, E., S. C. Forrest, T. W. Clark, and L. Richardson 1986 Paleobiology, Biogeography, and Systematics of the Black-footed Ferret, *Mustela nigripes* (Audubon and Bachman), 1851. *Great Basin Naturalist Memoirs* 8:11–62.

Fairbairn, D. J. 1997 Allometry for Sexual Size Dimorphism: Pattern and Process in the Coevolution of Body Size in Males and Females. *Annual Review of Ecology and Systematics* 28:659–87.

Gliwicz, J. 1988 Sexual Dimorphism in Small Mustelids: Body Diameter Limitation. *Oikos* 53:411–14.

Greaves, W. S. 1982 A Mechanical Limitation on the Position of Jaw Muscles of Mammals: The One Third Rule. *Journal of Mammology* 63:261–66.

Hall, E. R. 1981 *The Mammals of North America.* 2nd ed. John Wiley and Sons, Inc., New York.

Hillman, C. N., and T. W. Clark 1980 *Mustela nigripes. Mammalian Species* 126:1–3.

Mead, E. M., and J. I. Mead 1989 Snake Creek Burial Cave and a Review of the Quaternary Mustelids of the Great Basin. *The Great Basin Naturalist* 49:143–54.

Moors, P. J. 1980 Sexual Dimorphism in the Body Size of Mustelids (Carnivora): The Roles of Food Habits and Breeding Systems. *Oikos* 34:147–58.

Nowak, R. M. 2005 *Carnivores of the World.* The Johns Hopkins University Press, Baltimore.

U.S. Fish and Wildlife Service 1998 *Black-footed Ferret: Return of a Native.*

Vargasj, A., and S. H. Anderson 1996 Growth and Physical Development of Captive-raised Black-footed Ferrets (*Mustela nigripes*). *The American Midland Naturalist* 135:43–52.

Extinct Fauna from the Calama-Chiuchiu Basin, (North Arid, Chile): Taphonomic and Archaeological Relevance in the Late Pleistocene

Patricio López M. and Osvaldo Rojas M.

➤ **Keywords:** Calama Basin, late Pleistocene, northern Chile

In recent years, the discovery of paleontological sites with the remains of extinct fauna in the Calama-Chiuchiu basin (Second Region, Chile) has multiplied (Alberdi et al. 2007; Cartajena et al. 2010; López et al. 2010). This goes hand in hand with the chronological reevaluation of the litho-stratigraphic units containing fossil remains that have been dated to the late Pleistocene. This basin was divided by Marinovic and Lahsen (1984) into three discordant units called the "Calama Formation" (middle-late Miocene), "El Loa Formation" (late Miocene–early Pliocene) and "Chiuchiu Formation"

Patricio López M., Instituto de Investigaciones Arqueológicas y Museo, Universidad Católica del Norte, Calle Gustavo Le Paige 380, San Pedro de Atacama 141-0000, Chile; email: patriciolopezmend@yahoo.es

Osvaldo Rojas M., Museo de Historia y Cultural del Desierto de Atacama, Av. Bernardo O'Higgins s/n, Interior del Parque del Loa, Calama, Chile; email: museocalama@vtr.net

(late Pliocene–Pleistocene). Their antiquity was confirmed by May et al. (2005) using $^{40}Ar/^{39}Ar$ dating.

Recently, Blanco and Tomlinson (2009) state in the "Chiuchiu Geological Letter" that four main sequences on top of the Paleozoic-Triassic base that make up the sedimentary filling of the Cenozoic basin in Calama from the Chiuchiu Formation (Pleistocene). Characteristically, this was a fluvial fan system fed by the former Loa and Salado rivers that formed ephemeral lagoon marshes in the middle and distal sectors (Blanco and Tomlinson 2009). The Chiuchiu Formation toward the east and southeast is joined with alluvial beach facies attributed to the Pleistocene–middle Holocene (Blanco and Tomlinson 2009). Of all the sites registered in the Calama-Chiuchiu basin and the nearby mountain range with remains of extinct fauna (Table 1), only two have been ^{14}C dated.

Table 1. Sites of the Calama-Chiuchiu Basin with extinct faunal remains (data from Nuñez et al. 2002 and López et al. 2010).

Equidae	**A**				**P**			
Equus (Amerhippus) sp.			**P**					
Hippidion saldiasi				**P**		**P**	**P**	
cf. Gomphotheriidae								**P**
cf. *Lama gracilis*				**P**		**P**		
Rheidae						**P**		
Macrauchenia cf.*patachonica*						**P**		
Xenarhra				**P**		**P**		
Megatherium medinae		**P**						
Megatherium sp								**P**
Canidae				**P**				
Total		**1**	**1**	**4**	**1**	**5**	**1**	**2**

A Archaeological site **P** Paleontological site

Two samples of a *Hippidion saldiasi* skeleton from the Betecsa-1 paleontological site have been dated using AMS ^{14}C to 21,070 ± 100 (GrA-29389) and 21,380 ± 100 RCYBP (GrA-29388) (Alberdi et al. 2007); organic remains associated with an Equidae sacrum from the "Tuina-5" archaeological site (in the mountain range) have been dated between 10,000 and 9800 RCYBP (Núñez et al. 2002). Nevertheless, the fact that alluvial sediments from the Calama-Chiuchiu basin have been assigned to the Pleistocene–middle Holocene by Blanco and Tomlinson (2009) implies that deposits from the Jalquincha-1, La Vega, Ojo Opache, Opache-2, Kamac Mayu and Río Salado-1 sites should also be assigned to this temporal range. Cultural remains have not been observed in the aforementioned sites. The mortality events of diverse fauna ensembles are associated with fluvial courses over exokarst formations, which functioned as natural traps in the case of the Ojo Opache and Kamac Mayu sites. In the latter site, the remains of *Macrauchenia* cf. *patachonica* and cf. *Lama gracilis* include individuals from every age range, suggesting mortality events of flocks that fell into these exokarst canals, covered by water and sand and gravel sediments (Cartajena et al. 2010). In the other sites, mortality events are associated with former fluvial beaches, such as La Vega, Jalquincha-1, Betecsa-1 and Río Salado-1 (López et al. 2010).

In summary, recent studies of sites from the Calama-Chiuchiu basin with remains of extinct fauna have redefined their temporality and enhanced our understanding of the diverse fauna that existed at the end of the Pleistocene and associated formation processes. Further archaeological study of these remains must focus on the former fluvial basins that encouraged cinegetic activity owing to entrapment zones and faunal concentration.

The research presented here was funded by the Museo de Historia Natural y Cultural del Desierto de Atacama.

References Cited

Alberdi, M. T., J. L. Prado, P. López, R. Labarca, and I. Martínez 2007 *Hippidion saldiasi* Roth, 1899 (Mammalia, Perissodactyla) en el Pleistoceno Tardío de Calama, Chile. *Revista Chilena de Historia Natural* 80:157–71.

Blanco, N., and A. Tomlinson 2009 *Carta Chiu-Chiu, Región de Antofagasta.* Escala 1:50.000. Servicio Nacional de Geología y Minería, Carta Geológica de Chile, Serie Geológica Básica 117.

Cartajena, I., P. López, and I. Martínez 2010 New Camelid (Artiodactyla: Camelidae) Record from the Late Pleistocene of Calama (Second Region, Chile): a Morphological and Morphometric Discussion. *Revista Mexicana de Ciencias Geológicas* 27(2):197–212.

López, P., O. Rojas, P. Mansilla, L. Olivares, and I. Martínez 2010 Mamíferos extintos del Pleistoceno de la Cuenca de Calama (Segunda Región, Chile). Viejas colecciones y nuevos hallazgos. *Treballs del Museu de Geologia de Barcelona* 17:1–15.

Núñez, L., M. Grosjean, and I. Cartajena 2002 Human Occupations and Climate Change in the Puna de Atacama, Chile. *Science* 298:821–24.

Marinovic, N., and A. Lahsen 1984 *Geología de la Hoja Calama.* Escala 1:250.000. Servicio Nacional de Geología y Minería, Carta Geológica de Chile, 140 p.

May, G., A. J. Harttley, G. Chong, F. Stuart, P. Turner, and S. Kape 2005 Eocene to Pleistocene Lithostratigraphy, Chronostratigraphy and Tectono-sedimentary Evolution of the Calama Basin, Northern Chile. *Revista Geológica de Chile* 32(1):33–58.

Taxonomy and Evolution of the Plio-Pleistocene Proboscidean *Stegomastodon* in North America

Spencer G. Lucas, Gary S. Morgan, Justin A. Spielmann, Michael R. Pasenko, and Ricardo Hernán Aguilar

➤ **Keywords:** Proboscidea, *Stegomastodon*, taxonomy

One of the last North American gomphotheriid proboscideans, *Stegomastodon* Pohlig, has a Plio-Pleistocene temporal range of early Blancan (~4 Ma) to early Irvingtonian (~1.2 Ma). Although some have argued that *Stegomastodon* descended directly from an Old World ancestor (Prado and Alberdi 2008), most regard it as a descendant of New World *Gomphotherium* (e.g., Lambert and Shoshani 1998; Savage 1955; Tobien 1973). All agree that *Stegomastodon* is closely related to the derived Plio-Pleistocene New World gomphotheres *Cuvieronius* and *Rhynchotherium*. Identification of *Stegomastodon* in South America has been controversial, and we accept arguments that the genus is confined to North America (e. g., Ferretti 2008; Lucas and Alvarado 2010). In North America, the extinction of *Stegomastodon* approximately coincided with the arrival of *Mammuthus*, and this eliminated *Stegomastodon* as a potential food source for Early Americans. Its absence from the Pleistocene of South America also precluded its utilization as a food item by Early Americans.

Stegomastodon is distinguished from other gomphotheres by a combination of cranio-dental features that include a high-domed, elephantid-like cranium, slightly curved upper tusks that lack enamel bands, no lower tusks in a short (brevirostrine) lower jaw, and third molars with five or more lophs/lophids. There are three different views of the species-level taxonomy of North American *Stegomastodon*, which recognize one, two, or as many as seven valid species (e.g., Kurtén and Anderson 1980; Lambert and Shoshani 1998; Osborn 1936). The extremes are Kurtén and Anderson (1980), who identified the genotypic species *S. mirificus* Leidy as the only valid species, and Osborn (1936:727), who recognized seven species (*S. primitivus*, *S. successor*, *S. mirificus*, *S. chapmani*, *S. texanus*, *S. arizonae* and *S. aftoniae*) as a series of "ascending mutations." Most workers, however, have argued that there are two valid species of the genus—a primitive and generally older species, called *S. primitivus* or *S. rexroadensis,* and a more derived species, usually called *S. mirificus* (e.g., Lambert and Shoshani 1998; Lucas and Morgan 2005; Lucas and Oakes 1986; Savage 1955).

We recently revised and redescribed many North American *Stegomastodon* (Lucas et al. 2011; Morgan and Lucas 2011; Pasenko and Lucas 2011) to

Spencer G. Lucas, Gary S. Morgan, and Justin A. Spielmann, New Mexico Museum of Natural History and Science, 1801 Mountain Road N.W., Albuquerque, NM 87104; emails: spencer.lucas@state.nm.us gary.morgan@state.nm.us justin.spielmann1@state.nm.us

Michael R. Pasenko, Environmental Planning Group, 4141 North 32nd Street, Suite 102, Phoenix, AZ 85018; email: mpasenko@epgaz.com

Ricardo Hernán Aguilar, Museo Paleontología de Guadalajara, Guadalajara, Jalisco, Mexico; email: zooevolution@hotmail.com

conclude that although there is extensive morphological overlap and polymorphism in the entire sample of North American *Stegomastodon*, it is possible to construct a chronomorphocline that recognizes three successive species that temporally and morphologically overlap. This is similar to the taxonomy of North American *Mammuthus* in which the chronomorphocline *M. meridionalis* (or *M. hayi*) → *M. imperator* → *M. columbi* recognizes three distinct morphotypes that nonetheless grade into each other and temporally overlap (e.g., Agenbroad 1994; Lucas 1996). *Cuvieronius* is a similarly long-lived proboscidean genus, but a chronomorphocline of its variation apparently cannot be constructed (Lucas 2008).

The most primitive species of *Stegomastodon, S. primitivus* Osborn (= *S. rexroadensis* Woodburne) is characterized by cheek teeth with simple trefoils, second molars with three lophs/lophids, and third molars with 5–6 lophs/lophids. The morphologically intermediate species encompasses most known *Stegmomastodon* specimens, and is *S. mirificus* (= *S. successor* Cope, = *S. texanus* Osborn, = *S. arizonae* Gidley). This species has cheek teeth that wear to double trefoils, second molars with rudimentary fourth lophs/lophids, and third molars with 6–7 lophs/lophids. The derived species, *S. aftoniae*, has very complex trefoils, a fourth loph/lophid on the second molar, and seven lophs/lophids on the third molars. There is also an increase in the amount of cement and the choerodonty (number of tubercles) on the molars from *S. primitivus* to *S. mirificus* to *S. aftoniae*.

Stegomastodon primitivus is early Blancan in age, including the type of *S. primitivus* from the *Stegomastodon* Quarry in Nebraska, part of the Sand Draw fauna (Osborn 1936; Skinner and Hibbard 1972), the type of *S. rexroadensis* from Rexroad in Kansas (Woodburne 1961), and referred specimens from Elephant Butte Lake and Cuchillo Negro Creek in New Mexico and Duncan in Arizona (Morgan and Lucas 2000, 2011). The type of *S. mirificus* is from a site of unknown age in Nebraska; however, most specimens of this species are late Blancan, including Blanco and Cita Canyon in Texas and possibly Curtis Ranch in Arizona, the type locality of *S. arizonae* (Gidley 1926; Savage 1955). The type of *S. aftoniae* is from the early Irvingtonian of Iowa (Osborn 1924). *S. aftoniae* is also known from the early Irvingtonian Tortugas Mountain gravel pit in New Mexico (Lucas et al. 2000).

We view the evolution of *Stegomastodon* as the development of a derived, grazing gomphothere. The tall, elephantid skull directly above the short, robust lower jaw suggests a powerful vertical bite of the relatively broad and increasingly complex grinding cheek teeth. Thus, *Stegomastodon* was likely a grazer, and it is no coincidence that its disappearance during the early Irvingtonian is almost coeval with the appearance of a more effective grazer, *Mammuthus*.

References Cited

Agenbroad, L. D. 1994 Taxonomy of North American *Mammuthus* and Biometrics of the Hot Springs Mammoths. In *The Hot Springs Mammoth Site*, edited by L. D. Agenbroad and J. I. Mead, pp. 158–207. Fenske Printing, Rapid City.

Ferretti, M. P. 2008 A Review of South American Proboscideans. *New Mexico Museum of Natural History and Science Bulletin* 44:381–91.

Gidley, J. W. 1926 Fossil Proboscidea and Edentata of the San Pedro Valley, Arizona. *U.S. Geological Survey, Professional Paper* 140-B:83–95.

Kurtén, B., and E. Anderson 1980 *The Pleistocene Mammals of North America.* Columbia University Press, New York.

Lambert, W. D., and J. Shoshani 1998 Proboscidea. In *Evolution of Tertiary Mammals of North America, Volume I: Terrestrial Carnivores, Ungulates, and Ungulatelike Mammals*, edited by C. M. Janis, K. M. Scott, and L. L. Jacobs, pp. 606–21. Cambridge University Press, New York.

Lucas, S. G. 1996 The Thornton Beach Mammoth: Consistency of Numerical Age and Morphology. *Quarternary Research* 45:332–33.

——— 2008 *Cuvieronius* (Mammalia, Proboscidea) from the Neogene of Florida. *New Mexico Museum of Natural History and Science Bulletin* 44:31–38.

Lucas, S. G., and G. E. Alvarado 2010 Fossil Proboscidea from the Upper Cenozoic of Central America: Taxonomy, Evolutionary and Paleobiogeographic Significance. *Revista Geológica de América Central* 42:9–42.

Lucas, S. G., and G. S. Morgan 2005 Ice Age Proboscideans of New Mexico. *New Mexico Museum of Natural History and Science Bulletin* 28:255–61.

Lucas, S. G., and W. Oakes 1986 Pliocene (Blancan) Vertebrates from the Palomas Formation, South-Central New Mexico. *New Mexico Geological Society,* Guidebook 37:249–55.

Lucas, S. G., R. H. Aguilar, and J. A. Spielmann 2011 *Stegomastodon* from the Pliocene of Jalisco, Mexico. *New Mexico Museum of Natural History and Science Bulletin*, 53: 517–53.

Lucas, S. G., G. S. Morgan, and J. W. Estep 2000 Biochronological Significance of the Co-Occurrence of the Proboscideans *Cuvieronius*, *Stegomastodon*, and *Mammuthus* in the Lower Pleistocene of Southern New Mexico. *New Mexico Museum of Natural History and Science Bulletin* 16:209–16.

Morgan, G. S., and S. G. Lucas 2000 Biostratigraphic Significance of Late Neogene Vertebrate Fossils from the Gila Group, Pearson Mesa, Southwestern New Mexico and Southeastern Arizona. *New Mexico Geological Society Guidebook* 51:211–20.

——— 2011 *Stegomastodon* (Mammalia: Proboscidea: Gomphotheriidae) from the Blancan and Irvingtonian (Pliocene and early Pleistocene) of New Mexico. *New Mexico Museum of Natural History and Science Bulletin*, 53:570–82.

Osborn, H. F. 1924 Additional Generic and Specific Stages in the Evolution of Proboscidea. *American Museum Novitates* 154:1–5.

——— 1936 *Proboscidea, Vol. 1.* American Museum Press, New York.

Pasenko, M. R., and S. G. Lucas 2011 A Review of Gomphotheriid (Proboscidea, Mammalia) Remains from the Pliocene Benson and Curtis Ranch Local Faunas, Southern Arizona, with a Discussion of Gomphotheriids in Arizona. *New Mexico Museum of Natural History and Science Bulletin*, 53:592–601.

Prado, J. L., and M. T. Alberdi 2008 A Cladistic Analysis among Trilophodont Gomphotheres (Mammalia, Proboscidea) with Special Attention to the South American Genera. *Palaeontology* 51:903–15.

Savage, D. E. 1955 A Survey of Various Late Cenozoic Vertebrate Faunas of the Panhandle of Texas. Part II. Proboscidea. *University of California Publications in Geological Sciences* 31:51–72.

Skinner, M. F., and C. W. Hibbard 1972 Early Pleistocene Pre-glacial and Glacial Rocks and Faunas of North-central Nebraska. *Bulletin of the American Museum of Natural History* 148:1–148.

Tobien, H. 1973 On the Evolution of Mastodonts (Proboscidea, Mammalia), Part 1: The Bunodont Trilophodont Groups. *Notizblatt des Hessischen Landesamtes fur Bodenforschung zu Wiesbaden* 101:202–76.

Woodburne, M. O. 1961 Upper Pliocene Geology and Vertebrate Paleontology of Part of the Meade Basin, Kansas. *Papers of the Michigan Academy of Science, Arts, and Letters* 46:61–101.

Explorations in the Early Pleistocene of West Texas

John Moretti and Eileen Johnson

➤ **Keywords**: Faunal Diversity, Early Pleistocene, Southern Plains

Ongoing excavations at Roland Springs Ranch Locality 1 (RSR-1) have produced a unique, varied, and diverse terminal-Blancan fauna with over 50 taxa identified to at least the family level. The locality is situated on the Southern Plains within the western Rolling Plains, on a tributary of the Clear Fork of the Brazos River. The fauna is contained in a gleyed deposit, exhibiting swirls and cross-bedding indicating a fluvial environment, with the gleyed deposit itself set into an extinct ancient drainage. The surface of this ancient drainage reveals a micro-topography that provides an opportunity to study the dynamics and deposition patterns of a terminal-Blancan stream.

The fauna contains members of all vertebrate classes. Represented are taxa of a wide range of sizes. Abundant microfaunal remains comprise a variety of fish, amphibian, reptile, avian, and small mammals. Multiple rabbit taxa are identified in the fauna, with *Aztlanolagus agilis* and cf. *Lepus* spp. present.

The fauna is dominated by Testudines, primarily *Chrysemys picta* (pond turtle) and extinct land tortoises of the genus *Hesperotestudo* (= *Geochelone*). *Geochelone* taxonomy currently is in flux, but the generic elevation of the subgenus *Hesperotestudo* is recognized here (Holman and Fitz 2005; Le et al. 2006; Meylan and Sterrer 2000).

Among the ungulates, *Platygonus* (peccary) and a small camelid are tentatively identified, as are at least two antilocaprids, including *Capromeryx* spp. *Equus simplicidens* (American zebra) and *Nannippus peninsulatus* (three-toed horse) are present. *Equus* remains are rare, and *Nannippus* material is common.

The Blancan carnivores *Buisnictus breviramus* (pygmy skunk) and *Canis lepophagus* (ancestral coyote) are present, but *Borophagus* (bone-eating dog) is absent. The cheetah-like felid *Miracinonyx* cf. *trumani* could be the earliest record of this species and the first occurrence in pre-Rancholabrean deposits (Bell et al. 2004; Van Valkenburgh et al. 1990). The specimen, a right ramus, is significantly smaller in all measurements than *M. inexpectatus* but agrees with published metrics for *M. trumani* (Orr 1969; Van Valkenburgh et al. 1990). In view of the relative paucity of *Miracinonyx* discoveries, however, it is possible that this specimen falls outside the currently recognized size range of *M. inexpectatus*, or perhaps is a transitional form between the two species.

The presence of several cursorial forms (e.g., equids, antilocaprids, and *Miracinonyx trumani*) indicates a grassland ecosystem, as does *Hesperotestudo*, an open-land grazer/browser (Gibson and Hamilton 1983; Heller 1903). Supporting this view are other grassland-adapted taxa that inhabit the region today. The abundance of *Hesperotestudo* indicates a climate that was warmer, more equable, and perhaps wetter than today's continental climate (Hibbard

---

John Moretti and Eileen Johnson, Museum of Texas Tech University, Box 43191, Lubbock, TX 79409-3191; e-mails: j.moretti01@yahoo.com eileen.johnson@ttu.edu

1960). Fish, frogs, pond and mud turtles, and an ardeid (heron/bittern) indicate a rich stream and riparian environment, with water present at least regularly in the drainage. Hackberry (*Celtis* spp.) bordered the drainage and perhaps existed throughout the bottomlands, providing habitat and roosts for wild turkey (*Meleagris*) and raptors (Accipitridae).

Since absolute dates are not available yet for RSR-1, the age estimate is based on faunal composition. The primitive vole *Ogmodontomys poaphagus* indicates a Blancan age later than the earliest faunas of the period (Bell et al. 2004; Repenning 1987; Zakrzewski 1967). A small form of the cotton rat *Sigmodon minor* (*medius* chronomorph), within the range of variation (although at the larger end of the range) of *S. minor* from the latest Blancan Borchers fauna (Pelaez-Campomanes and Martin 2005), suggests a late-Blancan age (Martin et al. 2003; Martin et al. 2008). *Canis lepophagus*, *Nannippus peninsulatus*, *Geomys* (*Nerterogeomys*) *minor* (pocket gopher), *Prodipodomys centralis* (kangaroo rat), and *Scalopus* (*Hesperoscalops*) cf. *rexroadi* (mole) indicate a middle- to late-Blancan age, while cf. *Lepus* suggests a late-Blancan age (Bell et al. 2004; Martin et al. 2003; White 1991). *Miracinonyx trumani* occurs rarely in the Rancholabrean, while *M. inexpectatus* ranges from the late Blancan to late Irvingtonian (Bell et al. 2004; Van Valkenburgh et al. 1990). To date, no South American immigrants have been recorded at RSR-1.

The Pleistocene, its beginning recently revised to 2.58 Ma, incorporates the terminal Blancan (Gibbard et al. 2010). The youngest recognized occurrence of *Nannippus* is at 2.1 Ma in the Macasphalt Shell Pit fauna of Florida (Bell et al. 2004; Jones et al. 1991); the oldest recognized record of *Lepus* is in the Borchers fauna of Kansas dated to 2.0–2.1 Ma (Gansecki et al. 1998; Hibbard 1941; Honey et al. 1998). Taken as a whole, these indicators place the estimated age for the RSR-1 fauna at early Pleistocene (perhaps 1.8–2.1+ Ma) and latest Blancan Land Mammal age.

Research at RSR-1 is funded by the Museum of Texas Tech University, two foundations that wish to remain anonymous, and the landowners. We are indebted to the landowners for access, donation of the generated collections to the Museum, their financial support, and continuing great interest in the research and dissemination of knowledge gained. This manuscript is part of the ongoing Lubbock Lake Landmark regional research into Quaternary climatic, ecological, and biogeographic change on the Southern Plains.

References Cited

Bell, C. J., E. L. Lundelius Jr., A. D. Barnosky, R. W. Graham, E. H. Lindsay, D. R. Ruez Jr., H. A. Semken Jr., S. D. Webb, and R. J. Zakrzewski 2004 The Blancan, Irvingtonian, and Rancholabrean Mammal Ages. In *Late Cretaceous and Cenozoic Mammals of North America*, edited by M. O. Woodburne, pp. 232–314. Columbia University Press, New York.

Gansecki, C. A., G. A. Mahood, and M. McWilliams 1998 New Ages for the Climatic Eruptions at Yellowstone: Single-Crystal Ar/Ar Dating Identifies Contamination. *Geology* 26:343–46.

Gerlach, J. 2001 Tortoise Phylogeny and the "*Geochelone*" Problem. *Phelsuma* 9(A):1–24.

Gibbard, P. L., M. J. Head, M.J.C. Walker, and the Subcommission on Quaternary Stratigraphy 2010 Formal Ratification of the Quaternary System/ Period and the Pleistocene Series/ Epoch with a Base at 2.58 Ma. *Journal of Quaternary Science* 25(2):96–102.

Gibson, C. W. D., and J. Hamilton 1983 Feeding Ecology and Seasonal Movements of Giant Tortoises on Aldabra Atoll. *Oecologia* 56(1):84–92.

Heller, E. 1903 Papers from the Hopkins Stanford Galapagos Expeditions, 1898–1899. XIV, Reptilia. *Proceedings of the Washington Academy of Sciences* 5:39–98.

Hibbard, C. W. 1941 New Mammals from the Rexroad Fauna, Upper Pliocene of Kansas. *American Midland Naturalist* 26(2):337–68.

——— 1960 An Interpretation of Pliocene and Pleistocene Climates in North America. *Michigan Academy of Sciences, Arts, and Letters* 62:5–30.

Holman, A. J., and U. Fritz 2005 The Box Turtle Genus Terrapene (Testudines: Emydidae) in the Miocene of the USA. *Herpetological Journal* 15:81–90.

Honey, J. G., M. R. Hudson, and J. D. Obradovich 1998 The Occurrence of the Reunion II Subchron in Lacustrine Beds in the Beaver Basin, Utah. In *Advances in Vertebrate Paleontology and Geochronology*, edited by Y. Tomida, L. J. Flynn, and L. L. Jacobs, pp. 17–38. *National Science Museum Monographs* 14:17–38.

Jones, D. S., B. J. MacFadden, S. D. Webb, P. A. Mueller, D. A. Hodell and T. M. Cronin 1991 Integrated Geochronology of a Classic Pliocene Fossil Site in Florida: Linking Marine and Terrestrial Biochronologies. *Journal of Geology* 99(5):637–48.

Le, M., C. J. Raxworthy, W. P. McCord and L. Mertz 2006 A Molecular Phylogeny of Tortoises (Testudines: Testudinidae) Based on mitochondrial and Nuclear Genes. *Molecular Phylogenetics and Evolution* 40:517–31.

Martin, R. A., R. T. Hurt, J. G. Honey and P. Pelaez-Campomanes 2003 Late Pliocene and Early Pleistocene Rodents from the Northern Borchers Badlands (Meade County, Kansas), with Comments on the Blancan-Irvingtonian Boundary in the Meade Basin. *Journal of Paleontology* 77(5):985–1001.

Martin, R. A., P. Pelaez-Campomanes, J. G. Honey, D. L. Fox, R. J. Zakrzewski, L. B. Albright, E. H. Lindsay, N. D. Opdyke, and H. T. Goodwin 2008 Rodent Community Change at the Pliocene-Pleistocene Transition in Southwestern Kansas and Identification of the *Microtus* Immigration Event on the Central Great Plains. *Palaeogeography, Palaeoclimatology, Palaeoecology* 267:196–207.

Meylan, P. A., and W. Sterrer 2000 *Hesperotestudo* from the Pleistocene of Bermuda, with Comments on the Phylogenetic Position of the Genus. *Zoological Journal of the Linnean Society* 128:51–76.

Orr, P. C. 1969 *Felis trumani*, A New Radiocarbon Dated Cat Skull from Crypt Cave, Nevada. *Santa Barbara Museum of Natural History Bulletin* 2:1–8.

Pelaez-Campomanes, P., and R. A. Martin 2005 The Pliocene and Pleistocene History of Cotton Rats in the Meade Basin of Southwestern Kansas. *Journal of Mammalogy* 86(3):475–94.

Repenning, C. A. 1987 Biochronology of the Microtine Rodents of the United States. In *Cenozoic Mammals of North America: Geochronology and Biostratigraphy*, edited by M. O. Woodburne, pp. 236–68. University of California Press, Berkeley.

Van Valkenburgh, B., F. Grady, and B. Kurten 1990 The Plio-Pleistocene Cheetah-like Cat *Miracinonyx inexpectatus* of North America. *Journal of Vertebrate Paleontology* 10(4):434–54.

White, J. A. 1991 North American Leporinae from the Late Miocene to Latest Pliocene. *Journal of Vertebrate Paleontology* 11(1):67–89.

Zakrzewski, R. J. 1967 The Primitive Vole, *Ogmodontomys*, from the Late Cenozoic of Kansas and Nebraska. *Papers of the Michigan Academy of Science, Arts, and Letters* 53:133–50.

Species Response to the Theorized Clovis Comet Impact at Sheriden Cave, Ohio

Brian G. Redmond and Kenneth B. Tankersley

➤ **Keywords:** Younger Dryas, climate change, comet impact

Sheriden is a deeply stratified cave site situated in the glaciated Silurian karst plain of northwest Ohio. The sinkhole entrance formed and exposed the cave after glacial ice covering the site retreated during the late Pleistocene. The cave rapidly filled with sediments, and the entrance was completely buried by the early Holocene. During the Allerød, plants, animals, and Clovis people entered the sinkhole and cave (Tankersley 1999).

Clovis artifacts and contemporary faunal remains include two complete bone projectile points made from dense cortical megamammal long bones, a Clovis fluted point, a scraper-knife made on a large flake, two biface fragments, a graver, a portion of an endscraper, 28 pieces of microdebitage, a cervical vertebra of *Chelydra serpentine* (snapping turtle) with cut and chop marks, and burned and disarticulated elements of *Platygonus compressus* (flat-headed peccary) and *Castoroides ohioensis* (giant beaver) (Redmond and Tankersley 2005). The age of the Clovis assemblage was determined by direct AMS radiocarbon dating of purified collagen extracted from one of the two bone points. The calibrated ^{14}C age was 13,000 to 12,900 RCYBP at two standard deviations (Waters et al. 2009). This date overlaps the current, revised age range of Clovis and makes Sheriden Cave the twelfth firmly dated Clovis site in North America (Waters and Stafford 2007). The age from the bone point also overlaps the AMS radiocarbon dates obtained from two extinct taxa, flat-headed peccary and giant beaver, and a distinctive charcoal layer (Tankersley 1999). Comparable organic layers have been identified at other Clovis sites across North America (Haynes 2008).

The charcoal layer contains above-background levels of carbon spherules, 148/kg by weight and 100 microns to 1 mm in size, as well as magnetic grains, 2.5 g/kg by weight and up to 300 microns in size, magnetic microspherules, more than 100/kg by weight and 20 to 100 microns in size, nanometer-sized diamonds, 400 ppb by weight 0.5 microns to 0.5 mm in size, and Lonsdaleite, a hexagonal nanodiamond polymorph found at other postulated Clovis comet impact sites across North America (Kennett et al. 2009). Lonsdaleite, nanodiamonds, magnetic microspherules, magnetic grains, and carbon spherules were absent in layers above and below the Clovis assemblage (Figure 1).

Of the 63 floral and faunal taxa recovered in direct stratigraphic association from the Clovis layer, 52 species of amphibians, arboreal plants, fish, mammals,

Brian G. Redmond, Cleveland Museum of Natural History, 1 Wade Oval Drive Cleveland, OH 44106-1701; e-mail: bredmond@cmnh.org

Kenneth B. Tankersley, Department of Anthropology, Department of Geology, University of Cincinnati, Cincinnati, OH 45221; e-mail:tankerkh@uc.edu

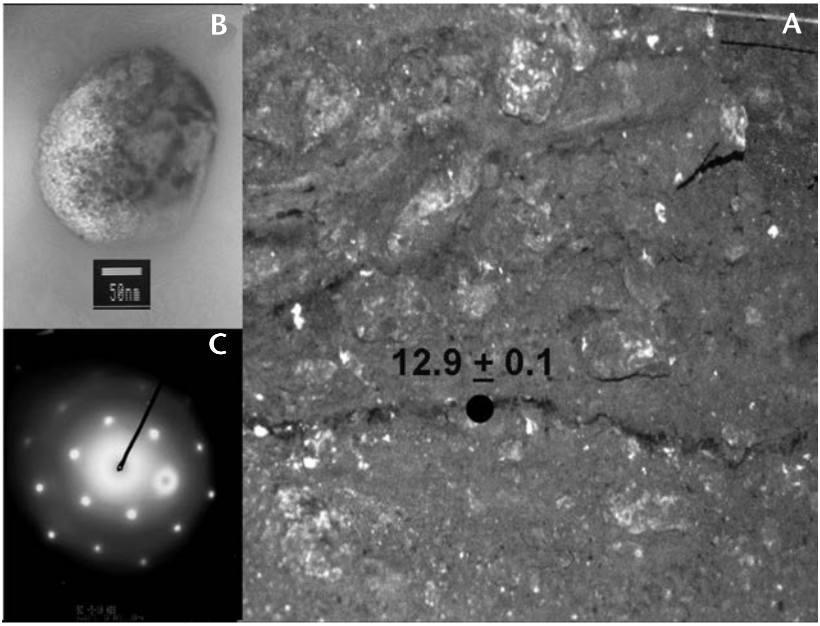


Figure 1. **A,** Stratigraphic profile of Sheriden Cave illustrating the charcoal layer and mean RCYBP; **B,** TEM photomicrograph of Lonsdaleite; **C,** selected area electron diffraction pattern typical of a hexagonal nonodiamond.

and reptiles were unaffected by the theoretical Clovis comet impact event and are still living in the immediate vicinity of the cave today. Only two species of megamammals in the assemblage went extinct, flat-headed peccary and giant beaver, while five microtines (*Microtis xanthognathus,* yellow-checked vole; *Phenacomys intermedius,* heather vole; *Sorex cinereus,* masked shrew; *Sorex hoyi,* pygmy shrew; and *Synaptomys borealis,* northern bog lemming), three small carnivores (*Martes americana,* pine martin; *Martes pennanti,* fisher; and *Mustela erminea,* ermine), and an artiodactyl (*Rangifer tarandus,* caribou) migrated northward to their present ranges in boreal and tundra environments. Although the disappearance of two species of megamammals at Sheriden Cave coincides with the proposed Clovis comet impact event, the survival of more than 50 taxa of diverse plants and animals suggests that factors such as climate change during the subsequent Younger Dryas were more likely a contributing cause of their extinction instead of the theorized comet impact (Graham 1996).

This study was made possible with support from the National Science Foundation and the Court Family Foundation. The assistance and support of Keith Hendricks and the Cleveland Museum of Natural History is greatly appreciated. Allen West provided sediment analyses and Greg McDonald and the late Fran King identified the faunal and floral species.

References Cited

Graham, R. W. (FAUNMAP Working Group) 1996 Spatial Response of Mammals to Late Quaternary Environmental Fluctuations. *Science* 272:5268:601–1606.

Haynes, C. V. 2008 Younger Dryas "Black Mats" and the Rancholabrean Termination in North America. *Proceedings of the National Academy of Science* 105:6520–25.

Kennett, D. J., J. P. Kennett, A. West, C. Mercer, S. S. Que Hee, L. Bement, T. E. Bunch, M. Sellers, and W. S. Wolbach 2009 Nanodiamonds in the Younger Dryas Boundary Sediment Layer. *Science* 323:5910:94.

Redmond, B. G., and K. B. Tankersley 2005 Evidence of Early Paleoindian Bone Modification and Use at the Sheriden Cave Site (33WY252), Wyandot County, Ohio. *American Antiquity* 70(3):503–26.

Tankersley, K. B. 1999 Sheriden: A Stratified Pleistocene-Holocene Cave Site in the Great Lakes Region of North America. *BAR International Series* 800:67–75.

Waters, M. R., and T. W. Stafford, Jr. 2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315:5815:1122–26.

Waters, M. R., T. W. Stafford, Jr., B. G. Redmond, and K. B. Tankersley 2009 The Age of the Paleoindian Assemblage at Sheriden Cave, Ohio. *American Antiquity* 74:107–11.

A New Occurrence of Toxodonts in the Pleistocene of México

Rubén A. Rodríguez-de la Rosa, José Rubén Guzmán-Gutiérrez, and Carlos Ortega-Hurtado de Mendoza

➤ **Keywords:** Toxodonts, Pleistocene, Veracruz, México

Toxodonts were South American rhinoceros-like mammals, belonging to the extinct group Notoungulata. Prior to 2004, the northernmost record of toxodonts was from Guatemala, in Central America (Woodburne, 1969); however, Polaco and coworkers reported the occurrence of toxodonts in two different localities from Mexico (Polaco et al. 2004). A right mandibular ramus was collected from Hihuitlán, Michoacán, western Mexico, and partial molars and an incomplete upper incisor were collected from la Estribera, Veracruz, eastern Mexico (Polaco et al. 2004).

One of the authors (C.O.H.M.) collected fossil material from a Pleistocene locality in the Municipio of Pánuco, northern Veracruz (587592.48 m E, 2442482.10 m N). This material included at least four isolated toxodont molars, the subject of this report (Figure 1). However, the authors were recently informed about the existence of at least four other partial molars collected at the same locality.

Two of the molars presented here are a right M_1 and a left M_2; the other two specimens are a right P^4 and a left M^1 (Figure 1). These specimens are slightly

Rubén A. Rodríguez-de la Rosa, Unidad Académica de Ciencias Biológicas, Universidad Autónoma de Zacatecas, Campus 2, Zacatecas, México; e-mail: ruben_raptor@yahoo.com

José Rubén Guzmán-Gutiérrez, Secretaria del Medio Ambiente, Gobierno del Estado de Aguascalientes, Aguascalientes; e-mail: paleovert@yahoo.com

Carlos Ortega-Hurtado de Mendoza, Protenek, Ciudad Victoria, Tamaulipas; e-mail: protenek@hotmail.com

larger than the specimens reported by Polaco et al. (2004), suggesting a rather mature individual. The right M_1 is 54 mm long (as preserved), 110 mm tall, and 17.5 mm broad (at the level of the entonconid; the left M_2 is 52 mm long, 108 mm tall, and 23 mm broad (at the protoconid-paraconid level); the right P^4 is 131 mm tall, 39 mm at its widest portion of the crown, and 28 mm in anteroposterior breadth; the left M^1 is 114 mm tall (as preserved), 63 mm at its widest portion, and 29 mm in anteroposterior breadth.

As noticed by Polaco et al. (2004), all Central American toxodont fossils

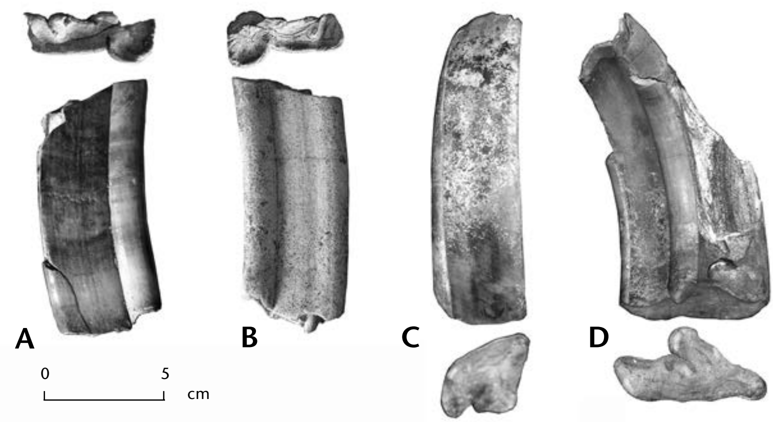


Figure 1. Occlusal and labial views of Toxodont molars from Pánuco, northern Veracruz, México: **A,** right M_1; **B,** left M_2; **C,** right P^4; **D,** left M^1 shown in lingual and occlusal views. **A–C** shown in labial view.

have been assigned to *Mixotoxodon larensis* Van Frank (1957), a toxodont first reported from northern Venezuela (Laurito 1993; Lucas et al. 1997; Polaco et al. 2004; Webb and Perrigo 1984).

The Mexican fossils show dental features similar to those present in *Mixotoxodon larensis*; however, there exist some subtle morphological differences, such as the meta-entoconid folds in both right M1 and left M2. However, more material is still needed to know if these features represent only morphological variation within a single species or if the Mexican toxodont really represents a new taxon.

Hulbert (2001) suggested the occurrence of toxodonts in Mexico; Polaco et al. (2004) confirmed their presence. The occurrence of toxodonts in western and eastern México strongly suggests the possibility of finding more toxodont remains in other Pleistocene deposits present in coastal states of the Country, thus favoring the idea of toxodont migration to northern areas of North America.

Authors want to thank Dr. Enrique Ortega Lozano, who initiated the fossil collection at the locality.

References Cited

Hulbert, R. C., Jr. 2001 Florida's Fossil Vertebrates: An Overview. In *The Fossil Vertebrates of Florida,* edited by R. C. Hulbert Jr., pp. 25–33. University Press of Florida, Gainesville.

Laurito, C. A. 1993 Análisis Topológico y Sistemático del Toxodonte de Bajo de los Barrantes, Provincia de Alajuela, Costa Rica. *Revista Geológica de América Central* 16:61–8.

Lucas, S. G., G. E. Alvarado, and E. Vega 1997 The Pleistocene Mammals of Costa Rica. *Journal of Vertebrate Paleontology* 17(2):413–27.

Polaco, O. J., A. F. Guzmán, and G. Tapia-Ramírez 2004 Occurrence of Toxodonts in the Pleistocene of México. *Current Reseacrh in the Pleistocene* 21:113–14.

Van Frank, R. 1957 A Fossil Collection from Northern Venezuela 1. Toxodontidae (Mammalia, Notoungulata). *American Museum Novitates* 1850:1–38.

Webb, D. S., and S. C. Perrigo 1984 Late Cenozoic Vertebrates from Honduras and El Salvador. *Journal of Vertebrate Paleontology* 4(2):237–54.

Woodburne, M. O. 1969 A Late Pleistocene Occurrence of the Collared Peccary, *Dicotyles tajacu*, in Guatemala. *Journal of Mammalogy* 50(1):121–25.

Dental Variation in Pleistocene Marsh Rabbits from Ichetucknee River, Florida

Dennis R. Ruez, Jr.

➤ **Keywords:** *Sylvilagus*, Pleistocene, Florida

The Ichetucknee River flows through north-central Florida and intersects several sinkhole deposits that contain a diverse assemblage of Rancholabrean (late-Pleistocene) fossil vertebrates from both forest and open-terrain ecosystems (Lambert and Holling 1998; Webb 1974). This assemblage, housed at the Florida Museum of Natural History (UF), contains two species of lagomorphs: *Sylvilagus palustris* (marsh rabbit) and *Sylvilagus palustrellus* (Ruez 2003). Although the extant marsh rabbit, *S. palustris*, is abundant in many fossil and modern faunas of Florida, the Ichetucknee River sample of 22 lower third premolars (p3), the most diagnostic element of fossil rabbits, is the largest known fossil collection of the species.

The crenulate enamel on the PER of the p3 (Figure 1) differentiates *S. palustris* from other species of *Sylvilagus* except for *S. hibbardi*, *S. webbi*, and *S. aquaticus*. In the two extinct species, *S. hibbardi* and *S. webbi*, the PER does not reach the lingual border of the p3. *Sylvilagus aquaticus* (swamp rabbit) is larger than *S. palustris* and exhibits more extreme complexity of the ARs.

The length of the teeth ranges from 2.83 mm to 3.72 mm, with an average of 3.31 mm. Width ranges from 2.30 mm to 2.97 mm, with an average of 2.70 mm. The number of ARs varies from 1 to 6 (average = 2.9), but there is no correlation between the number of reentrants and the size of the tooth. Additionally, there is no correlation between ARs and the depth of the AER or the length/width ratio.

Dennis R. Ruez, Jr., Department of Environmental Studies, University of Illinois at Springfield, One University Plaza, MS PAC 308, Springfield, IL 62703-5407; email: druez2@uis.edu

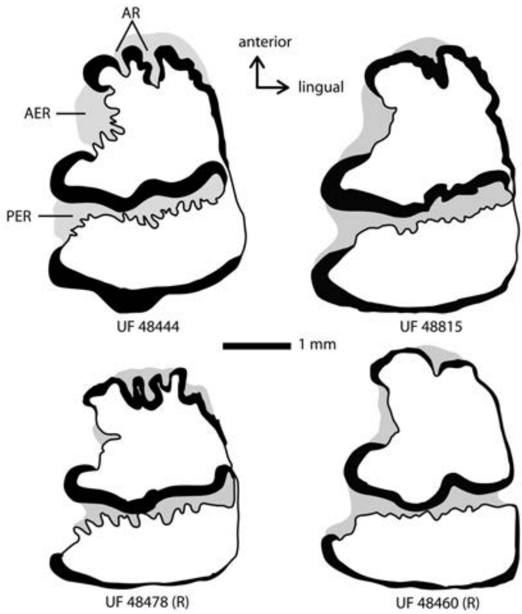


Figure 1. Camera lucida drawings of the occlusal view of four p3s of *Sylvilagus palustris* from the Ichetucknee River fauna. Terminology and measurements follow White (1987, 1991); measurements were made with a optical micrometer attached to a Wilde monocular microscope. On each illustration, enamel is shown in black, dentine is white, and cementum is gray. The bottom two illustrations are reversed to facilitate comparisons. **AR** = anterior reentrant; **AER** = anteroexternal reentrant; **PER** = posteroexternal reentrant.

On all teeth, the PER has thick enamel anteriorly, and thin enamel posteriorly. The PER becomes constricted about a third to half across the tooth. Labially, the thick enamel exhibits either one or two anterior curves, which widen the PER. In one tooth (UF 48460) the PER extends completely through the lingual edge; no enamel closes the PER. Although this pattern occurs in ontogenetically young rabbits, this tooth is parallel sided and larger (length = 3.38 mm; width = 2.72 mm) than the averages for this sample of *S. palustris.* Additionally, this tooth only has one well-developed AR; *S. palulstris* individuals typically show an increased number of ARs as they mature. I am not aware of other published records of a neotenic fossil lagomorph tooth. This specimen coupled with many others from other localities is yielding insight into the evolutionary patterns with *Sylvilagus.*

References Cited

Lambert, W. D., and C. S. Holling 1998 Causes of Ecosystem Transformation at the End of the Pleistocene: Evidence from Mammal Body-mass Distribution. *Ecosystems* 1:157–75.

Ruez, D. R., Jr. 2003 A New Record of *Sylvilagus palustrellus* from the Rancholabrean (Late Pleistocene) of Florida. *Current Research in the Pleistocene* 20:112–13.

Webb, S. D. 1974 Chronology of Florida Pleistocene Mammals. In *Pleistocene Mammals of Florida,* edited by S. D. Webb, pp. 5–31. University of Florida Press, Gainesville.

White, J. A. 1987 The Archaeolaginae (Mammalia, Lagomorpha) of North America, Excluding *Archaeolagus* and *Panolax. Journal of Vertebrate Paleontology* 7:425–50.

——— 1991 North American Leporinae (Mammalia: Lagomorpha) from Late Miocene (Clarendonian) to Latest Pliocene (Blancan). *Journal of Vertebrate Paleontology* 11:67–89.

Evaluating the Co-occurrence of *Platygonus compressus* and *Mylohyus nasutus* at Sheriden Cave, Wyandot County, Ohio

Kenneth B. Tankersley

➤ **Keywords**: Peccary, radiocarbon dates, stable carbon isotopes

The biogeographic distribution of *Platygonus compressus* (flat-headed peccary) and *Mylohyus nasutus* (long-nosed peccary) suggests that they were sympatric omnivores with foraging specificity and niche partitioning during the late Pleistocene. This hypothesis is based on the fact that their skeletal remains are widely known from late-Wisconsin cave deposits across North America. However, specific details concerning their temporal and paleoenvironmental association remain poorly understood.

Although dentition suggests that both species of peccaries were omnivorous, some vertebrate paleontologists believe that significant differences in their feeding strategies made forage partitioning necessary. It has been assumed that *Mylohyus nasutus* was more of a solitary browser because they occur as isolated individuals in the fossil record (Munson 1984). The gregarious nature of *Platygonus compressus* was inferred from large fossil bone assemblages in various stages of growth and development in caves, rockshelters, and sand-dune deposits (Graham and Lundelius 1994). With the exception of Sheriden Cave, Ohio, only *Platygonus compressus* was recovered from sites located north of the Wisconsin glacial maximum and late glacial margins (Faunmap Working Group 1996).

Over the past two decades, cranial and postcranial elements of more than 40 *Platygonus compressus* and a single *Mylohyus nasutus* were excavated from the late-Pleistocene strata of Sheriden Cave (Tankersley 1999). Bones of *Platygonus compressus* were recovered in direct association with Clovis artifacts (Redmond and Tankersley 2005; Waters et al. 2009). *Mylohyus nasutus* remains were recovered from gray silt and in contact with the Clovis-age stratum, but 10 cm below the deepest artifacts.

To determine if *Platygonus compressus* and *Mylohyus nasutus* coexisted at Sheriden Cave, samples of bone collagen were submitted for AMS ^{14}C dating, and cortical bone was subjected to fluoride dating. Chemical preparation of the bone collagen for AMS ^{14}C dating followed procedures described by Waters and Stafford (2007), and cortical bone was chemically prepared for fluoride dating following the procedures described by Tankersley et al. (1998). Two AMS radiocarbon dates were obtained on collagen from a single *Platygonus compressus* bone, 11,060 ± 60 (CAMS-10349) and 11,130 ± 60 RCYBP (CAMS-33970). A single AMS radiocarbon date, 11,860 ± 40 RCYBP (Beta-

Kenneth B. Tankersley, Department of Anthropology and Department of Geology, University of Cincinnati, Cincinnati, OH 45221; e-mail: tankerkh@uc.edu

139687), was obtained on *Mylohyus nasutus* bone collagen. Despite their close vertical and horizontal proximity, these ages differ by more than 600 ^{14}C years. Similar results were found in the fluoride content of the cortical bone. *Platygonus compressus* cortical bone contained 1.0 ± 0.2 % fluoride and *Mylohyus nasutus* cortical bone contained 2.0 ± 0.2 % fluoride. The disparate chronometric and relative age ranges on the Sheriden Cave peccary specimens demonstrate that only *Platygonus compressus* is contemporary with the Clovis occupation of the site and that their sympatric biogeographic distribution with *Mylohyus nasutus* at the cave is temporally biased.

To determine if significant differences occurred in the feeding strategies of *Platygonus compressus* and *Mylohyus nasutus,* stable carbon isotope values were obtained from their bone collagen. A $\delta^{13}C$ value of -20.9 was obtained on *Mylohyus nasutus* bone collagen, and a $\delta^{13}C$ value of -21.4 was obtained on *Platygonus compressus* bone collagen. These values for stable carbon isotopes are essentially the same, which suggests an absence of forage specificity. Because these two species of peccaries did not temporally overlap at Sheriden Cave, their co-occurrence does not need to be explained in terms of foraging partitioning. Indeed, these stable carbon isotope values are comparable to those obtained on peccary bone collagen from other cave sites (Tankersley et al. 2009).

To better infer the vegetation communities around Sheriden Cave at the time remains of *Platygonus compressus* and *Mylohyus nasutus* were deposited, stable carbon isotope values were obtained on twelve samples of bulk soil organic matter (SOM) from a vertical profile of the peccary-bearing late-Pleistocene strata. Ten $\delta^{13}C$ values were obtained from the *Platygonus compressus*-bearing strata: -24.1, -24.3, -25.9, -24.1, -25.5, -25.6, -25.5, -23.3, -24.9, and -24.5. Two identical $\delta^{13}C$ values of -25.7 were obtained from the stratum containing *Mylohyus nasutus.* The mean $\delta^{13}C$ value for the 12 samples was -24.9, with σ of 0.8. These $\delta^{13}C$ values are consistent with the carbonized remains of C3 plants such as *Abies balsamea* (balsam fir), *Juniperus virginiana* (eastern red cedar), *Larix laricina* (larch), *Picea sp.* (spruce), *Pinus sp.* (pine), *Populus sp.* (poplar), *Salix sp.* (willow), *Thuja occidentalis* (white cedar), and *Tsuga canadensis* (eastern hemlock) recovered from the peccary-bearing strata (Tankersley 1999). A single $\delta^{13}C$ value of -17.9 was obtained on SOM from a 13,000 RCYBP stratum underlying the fossil-bearing deposits. While this value suggests that the surface vegetation around Sheriden Cave was more open at the period 13,000 RCYBP, C3 plant remains dominate the strata associated with *Platygonus compressus* and *Mylohyus nasutus.*

This study was made possible with support from the National Science Foundation and the Court Family Foundation. The author wishes to thank Greg McDonald and the late Fran King for the faunal and floral species identifications.

References Cited

Graham, R. W. (FAUNMAP Working Group) 1996 Spatial Response of Mammals to Late Quaternary Environmental Fluctuations. *Science* 272:5268:601–1606.

Graham, R. W., and E. L. Lundelius 1994 *FAUNMAP: A Database Documenting Late Quaternary Distributions of Mammal Species of the United States.* Illinois State Museum, Springfield.

Munson, P. J. 1984 A Long-Nosed Peccary *(Mylohyus nasutus)* From Knob Rock Cave, Indiana. *National Speleological Society Bulletin* 46:1.

Redmond, B. G., and K. B. Tankersley 2005 Evidence of Early Paleoindian Bone Modification and Use at the Sheriden Cave Site (33WY252), Wyandot County, Ohio. *American Antiquity* 70:503–26.

Tankersley, K. B. 1999 Sheriden: A Stratified Pleistocene-Holocene Cave Site in the Great Lakes Region of North America. *BAR International Series* 800:67–75.

Tankersley, K. B., K.D. Schlecht, and R. S. Laub 1998 Fluoride Dating of Mastodon Bone from an Early Paleoindian Spring Site. *Journal of Archaeological Science* 25:805–11.

Tankersley, K. B., B. Lane, D. J. Wells, C. Hamburg, and A. Nagy 2009 Last Glacial Maximum Fauna from Great Saltpeter Cave, Kentucky. *Current Research in the Pleistocene* 26:48–50.

Waters, M. R., and T. W. Stafford, Jr. 2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315: 1122–26.

Waters, M. R., T. W. Stafford, Jr., B. G. Redmond, and K. B. Tankersley 2009 The Age of the Paleoindian Assemblage at Sheriden Cave, Ohio. *American Antiquity* 74:107–11.

Compression Fractures in Dwarf Elephants from Malta Give an Insight into Their Small Size

George E. Theodorou, Bruce M. Rothschild, and Larry D. Martin

➤ **Keywords**: Proboscidea, compression fracture, dwarfism

Agenbroad (2002a,b) has characterized proboscidean dwarfism in islands off the California coast, suggesting an evolutionary disadvantage to the species. Examination of pathology in dwarf elephants exposes one of the factors that contributes to dwarfism and its implication for organismal health.

Compression fractures are quite rare in the fossil record. They include impaction or pilon (from the Latin *pilum,* or pounder) fractures (wherein one bone penetrates the distal joint or portion of the same bone (Hastings and Carroll, 1988; Stern et al., 1991) and the subject of the current report, fractures of vertebral centra. The latter may take several forms, related to direct trauma and a form of disruption referred to as a burst fracture (Bensch et al., 2006; 2009), endplate shattering cracks, and compression or wedge fractures. Wedge or compression fractures suggest an underlying process, osteoporosis (Jacobs-Kosmin et al., 2010).

In a sample of 58 cervical vertebrae of the pygmy elephant, *Elephas tiliensis,* from the late Pleistocene of Tilos Island, Dodecanese Greece, an "impact" fracture was noted in Athens University Museum of Palaeontology and Geol-

George E. Theodorou, Director of Museum of Palaeontology and Geology, Athens University and Department of Historical Geology and Palaeontology, Athens 15784, Greece; e-mail: gtheodor@gol.uoa.gr

Bruce M. Rothschild and Larry D. Martin; Biodiversity Institute, University of Kansas, Lawrence, KS 66006; e-mails: bmr@ku.edu ldmartin@ku.edu

ogy #2312. Examination of lumbar vertebrae revealed compression fractures in #6453 and # 2286 (Figure 1). This is a relatively high rate of occurrence and suggests some underlying cause.

Causes of wedge fractures include infections such as tuberculosis, but those are associated with external signs of vertebral erosion or holes and reactive new bone formation. These were not found in our study. Osteoporosis can also be caused by estrogen deficiency, inflammatory bowel disease, and liver failure. Metastatic disease and infection can mimic it (Jacobs-Kosmin et al., 2010). Other causes of vertebral wedging include hyperparathyroidism, kidney disease, infection, and metastatic cancer. There was no evidence of

Figure 1. Lateral view of pygmy elephant lumbar vertebra #2286 with 2.5 cm coin. Note significant reduction of ventral vertebral centra height (compared with posterior centra height) from compression fracture.

subperiosteal resorption characteristic of hyperparathyroidism (Resnick, 2002) or periosteal reaction characteristic of kidney disease (Rothschild and Martin, 2006; Rothschild et al. 2002). There was no change in limb morphology to suggest rickets. Vitamin D is necessary to utilize calcium; osteomalacia, the result of vitamin D deficiency in mature animals, could be considered. But what would cause deficiency that was limited to mature animals? It seems probable that we are observing a dietary deficiency, but there is no evidence of hyperparathyroidism, excess phosphate intake, or magnesium deficiency. There might have been excess phytates in their diet that bound the dietary calcium, preventing absorption. As an island population, their dietary opportunities were more limited than for elephants on the mainland. It is not clear that the animals with compression fractures were disadvantaged. In humans disease is often asymptomatic (except for loss of height) until a fracture occurs in the peripheral skeleton.

Foster's Rule (1964) states that large mainland animals get smaller on islands, with the converse noted for small mainland animals. Sondaar (1977) suggested that size-reduction stresses include increased mobility and reduced food and range requirements. Agenbroad (2002a,b) suggested that smaller, more agile animals with a lower center of gravity, would have selective advantage in rugged island areas, such as those on Santa Rosa Island.

The energy needed for growth competes with that required to put on body fat. In mammals a certain amount of body fat is required for reproductive activity in the females, and malnourishment can delay puberty. When food availability is limited by competitors on an overpopulated island or in a large herd, inability to obtain surplus energy for body fat may result in delayed sexual maturity . This could be compensated for by ceasing growth at a smaller size, resulting in a higher reproductive potential for significantly smaller individuals. The reported compression fractures are consistent with nutrition stress on the population of dwarf mammoths on Malta and suggest that this was a contributing factor to their small size. Roth (1992) also suggests that compensation for population density might explain dwarfism in insular dwarf elephants. The pathology findings in European dwarf elephants suggests the possibility that nutritional limitations may have been a factor in the demise of the California dwarf proboscidea.

References Cited

Agenbroad, L. D. 2002a California's Channel Islands: A One Way Trip in the Tunnel of Doom. In *Proceedings of the Fifth California Islands Symposium*, edited by D. Browne, K. Mitchell, and H. Chaney, pp. 1–6. Santa Barbara Museum of Natural History, Santa Barbara, California.

Agenbroad, L. D. 2002b New Localities, Chronology, and Comparisons for the Pygmy Mammoth *(Mammuthus exilis)*: 1994–1998. In *Proceedings of the Fifth California Islands Symposium*, edited by D. Browne, K. Mitchell, and H. Chaney, pp. 518–24. Santa Barbara Museum of Natural History, Santa Barbara, California.

Bensch, F. V., M. P. Koivikko, M. J. Kiuru, and S. K. Koskinen 2006 The Incidence and Distribution of Burst Fractures. *Emergency Radiology* 12:124–29.

——— 2009 Measurement of Spinal Canal Narrowing, Interpedicular Widening, and Vertebral Compression in Spinal Burst Fractures: Plain Radiographs Versus Multidetector Computed Tomography. *Skeletal Radiology* 38:887–93.

Foster, J. B. 1964 Evolution of Mammals on Islands. *Nature* 202:234–35.

Hastings, H., and C. Carroll 1988 Treatment of Closed Articular Fractures of the Metacarpophalanageal and Proximal Interphalangeal Joints. *Hand Clinics* 4:503–27.

Jacobs-Kosmin, D., C. Hobar, and S. Shanmugam 2010 Osteoporosis. Website http://emedicine.medscape.com/article/330598-overview, accessed12/20/10

Resnick, D. 2002 *Radiology of Bone and Joint Disease*. Saunders, Philadelphia.

Roth, V. L. 1992 Inferences from Allometry and Fossils: Dwarfing of Elephants on Islands. In *Oxford Studies in Evolutionary Biology*, edited by D. Futuyma and J. Antonovics, volume 8, pp. 259–88. Oxford University Press, New York.

Rothschild, B. M., and L. D. Martin 2006 *Skeletal Impact of Disease*. New Mexico Museum of Natural History, Albuquerque, New Mexico.

Rothschild, C., B. Rothschild, and I. Hershkovitz 2002 Clues to Recognition of Kidney Disease in Archeologic Record: Characteristics and Occurrence of Leontiasis Ossea. *Rheumatismo* 54:133–43.

Sondaar, P. 1977 Insularity and its effects on mammal evolution. In *Major Patterns in Vertebrate Evolution,* edited by M. K. Hecht, P. C. Goody, and M. B. Hecht, pp. 671–707. Plenum Press, New York.

Stern, P. J., R. J. Roman, T. R. Kiefhaber, and J. J. McDonough 1991 Pilon Fractures of the Proximal Interphalangeal Joint. *Journal of Hand Surgery* 16A:844–50.

THE CENTER FOR THE STUDY OF THE FIRST AMERICANS

The Center for the Study of the First Americans (CSFA) is a unit of the Department of Anthropology, College of Liberal Arts, Texas A&M University, College Station, TX. The CSFA was established in July 1981 by a seed grant from Mr. William Bingham's Trust for Charity (renamed Bingham Trust). The mission of the Center is the promotion of interdisciplinary scholarly dialogue and the stimulation of public interest on the subject of the peopling of the Americas through research, education, and outreach. Toward these goals:

- CSFA designs and implements programs of study and research involving the physical, biological, and cultural sciences;
- CSFA provides leadership and coordination to scholars world wide on the subject of the First Americans;
- CSFA promotes an open dialogue between government, business, avocation archaeologists, and the Native American community on the preservation of cultural and biological resources, and other issues relating to the study of the First Americans.
- CSFA disseminates the product of this synergism through education programs reaching a broad range of groups, including school children, the general public, and international scholars.

The mission of the Center's staff and Advisory Board is to further the goals and programs of the CSFA, which has a membership of over 1400 individuals. The Center's office and research laboratories are located in the Anthropology Building on the TAMU campus. The Center's faculty and associates include:

Michael R. Waters	Director and General Editor e-mail: mwaters@tamu.edu
Ted Goebel	Editor, *CRP* e-mail: goebel@tamu.edu
Laurie Lind	Office Manager e-mail: csfa@tamu.edu
James M. Chandler	Editor, Mammoth Trumpet e-mail: wordsmiths@touchnc.net
Ruth Gruhn	Series Editor of CSFA books

The Center's Peopling of the Americas publication program focuses on the earliest Americans and their environments. The Center solicits high-quality original manuscripts in English. For information write to: Michael R. Waters, Center for the Study of the First Americans, Department of Anthropology, Texas A&M University, 4352 TAMU, College Station, TX 77843-4352. *Current Research in the Pleistocene* presents note-length articles about current research in the interdisciplinary field of Quaternary studies as it relates to the peopling of the Americas. The submission deadline is February 15 of each calendar year. In addition, the Center publishes a quarterly newsmagazine, the *Mammoth Trumpet,* written for both general and professional audiences. Subscription to the *Mammoth Trumpet* is by membership in the Center. Contact Laurie Lind, CSFA, Department of Anthropology, Texas A&M University, 4352 TAMU, College Station, TX 77843-4352; phone (979) 845-4046, fax (979) 845-4070 for more information about the CSFA, its programs, and membership in the Center. The CSFA is a non-profit organization that depends on gifts and grants for its support. To learn about America's earliest cultural and biological heritage, join the Center today.

Author Index

General Index

Order back issues of *Current Research in the Pleistocene*

If you are missing issues to complete your set of *Current Research in the Pleistocene* or if you want to find out what you have been missing, back issues of some volumes of *Current Research in the Pleistocene* are available. Quantities are limited.

To purchase, fill out the order form below and mail it with a check or money order to:

CSFA
Department of Anthropology
Texas A&M University
4352 TAMU
College Station, TX 77843-4352

To order by credit card, go to the secure order form on our web site (www.centerfirstamericans.com) and use your credit card to purchase current and back issues of *CRP*.

Order back issues of *Current Research in the Pleistocene*

- ☐ Vol. 4 (1987)
- ☐ Vol. 5 (1988)
- ☐ Vol. 6 (1989)
- ☐ Vol. 7 (1990)
- ☐ Vol. 8 (1991)
- ☐ Vol. 9 (1992)
- ☐ Vol. 10 (1993)
- ☐ Vol. 11 (1994)
- ☐ Vol. 12 (1995)
- ☐ Vol. 13 (1996)
- ☐ Vol. 14 (1997)
- ☐ Vol. 15 (1998)
- ☐ Vol. 16 (1999)
- ☐ Vol. 16 (1999)
- ☐ Vol. 17 (2000)
- ☐ Vol. 18 (2001)
- ☐ Vol. 19 (2002)
- ☐ Vol. 20 (2003)
- ☐ Vol. 21 (2004)
- ☐ Vol. 22 (2005)
- ☐ Vol. 23 (2006)
- ☐ Vol. 24 (2007)
- ☐ Vol. 25 (2008)
- ☐ Vol. 26 (2009)
- ☐ Vol. 27 (2010)
- ☐ Vol. 28 (2011)

	unit price	*Qty.*
Vol. 4–16	$10.00	______
Vol. 17–21	$20.00	______
Vol. 22–28	$25.00	______

Subtotal: $ __________

U.S., $5 + $1 each additional volume
Foreign, $10 + $2 each additional volume → S&H: __________

Total __________

Make check or money order payable to TAMU–CSFA.

Ship to (please print clearly):

Name ______________________________

Address ______________________________

City ____________________ State ______ Zip ________

____

____
e-mail address (in case we have a question about your order)