MAMMOTH TRUMPET

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Center for the Study of the First Americans
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A Bull's-eye in Chile

Quebrada Santa Julia wasn't a lucky find. Archaeologists Donald Jackson and César Méndez of the University of Chile–Santiago studied paleo landforms and chose an ancient ravine that drains into the nearby Pacific Ocean as a likely site to find evidence of terminal-Pleistocene human occupation. After a dig more than 30 ft deep (the photo shows Dr. Jackson beside the impressive stratigraphic profile) they found an occupation floor that dates to the end of the Clovis culture in North America. Here Paleoamericans also chipped fluted points—but of quartz, not chert—and despite their proximity to the ocean chose a subsistence based largely on the horse instead of marine life. There are more surprises, too, in our story that starts on page 10.

CLAUDIA CONTRERAS AND GLORIA ROMÁN

The Center for the Study of the First Americans fosters research and public interest in the Peopling of the Americas. The **Center,** an integral part of the Department of Anthropology at **Texas A&M University,** promotes interdisciplinary scholarly dialogue among physical, geological, biological and social scientists. The **Mammoth Trumpet,** news magazine of the **Center,** seeks to involve you in the peopling of the Americas by reporting on developments in all pertinent areas of knowledge.

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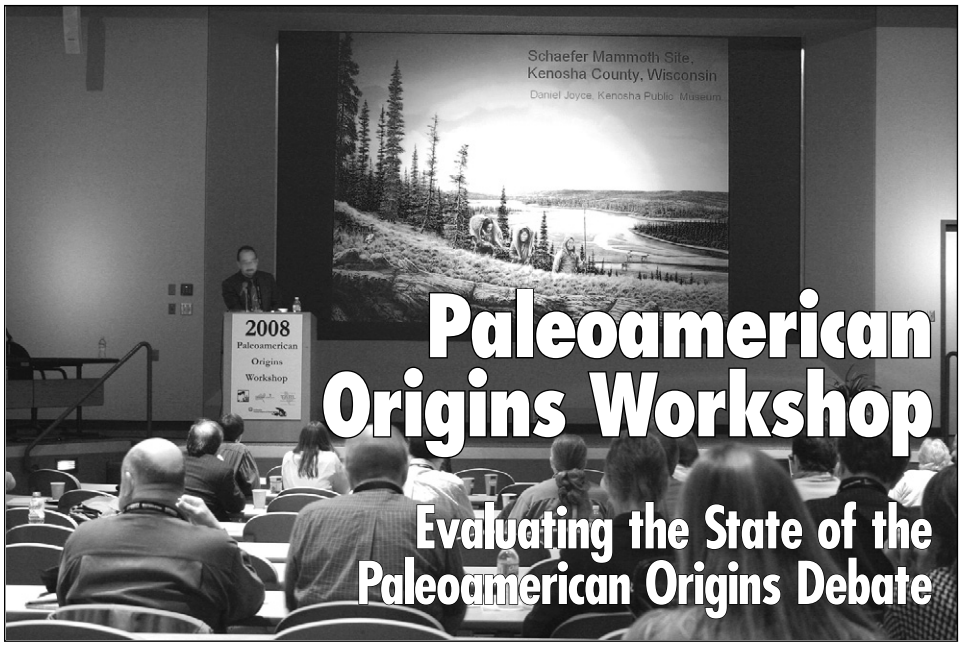

ALL PHOTOS: ASHLEY SMALLWOOD

Paleoamerican Origins Workshop

Evaluating the State of the Paleoamerican Origins Debate

by Ashley Smallwood

Dan Joyce of Kenosha Museum describes disarticulated mammoth bones and associated lithic tools from the Schaefer site, evidence of pre-Clovis human presence in Wisconsin.

THE TIMING AND NATURE of the peopling of the Americas remain contentious issues. With more and more evidence of potential pre-Clovis occupations in North America, archaeologists recognize the critical need to establish evidentiary and methodological criteria that will ensure a higher level of confidence in early sites. This was the primary goal of the Paleoamerican Origins Workshop, held last February 14–16 in Austin, Texas. Researchers from around the world, convened bearing a wide spectrum of views, open minds ready to evaluate the body of evidence, and a scholarly discourse to constructively address broad issues. Hosted by the Center for the Study of the First Americans, Texas Archeological Research Laboratory (TARL), Southeastern Paleo American Survey, and the Smithsonian Institution, the workshop reviewed specific early-occupation sites, models for the peopling of the Americas, and rules of evidence necessary to confidently verify human presence.

The workshop was organized by **Tom Pertierra,** a co-organizer of the Southeastern Paleo American Survey (SEPAS) and founder of SEPAS.Inc., a citizens support organization that conducts archaeological conferences and workshops. SEPAS.Inc. also provides logistical support to archaeological projects

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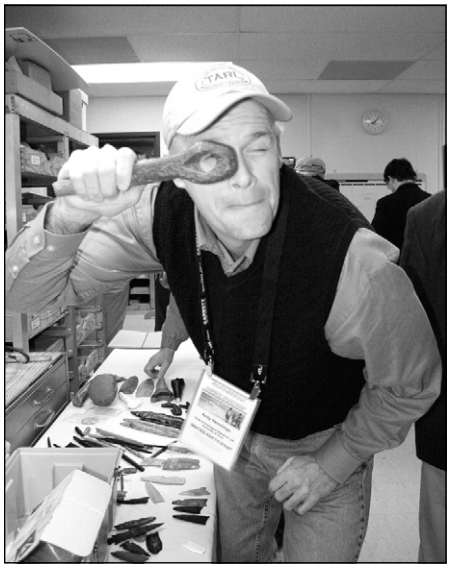
that promote public education and cooperation between professional, avocational, and amateur archaeologists. Pertierra had high hopes for the conference. "Our goal for the conference," he remarks, "was to bring together key researchers directly involved with the Peopling of the Americas to collectively share and consider their evidence in a collegial atmosphere and to establish acceptable evidentiary criteria for evaluation of proposed early sites." It's high time scholars take stock of the current base of knowledge. "Frankly," says Pertierra, "it was time for proponents and critics to openly discuss the early-entry issue face-to-face."

The 3-day workshop was an intense evaluation of the state of the Paleoamerican origins debate. On days 1 and 2, researchers gave 40-minute presentations, each followed by a 40-minute discussion period, giving scholars the unique opportunity to present and discuss face-to-face archaeological evidence from specific sites that elude the traditional Clovis-first model.



Andy Hemmings of TARL has an interesting use for a Clovis shaft wrench.

Day 1: Plotting the course and taking stock

A brief introduction by **Michael Collins,** TARL, welcomed speakers and guests to the exciting event. Then it was straight to the facts. **Michael Waters,** Director of the Center for the Study of the First Americans (CSFA), encouraged researchers to thoroughly evaluate and discuss each site based on the rules of evidence: the artifact assemblages, geologic context, and the reliability of their dates.

Ted Goebel, Associate Director of CSFA, presented recent evidence from molecular genetics that southern Siberia is the ancient homeland of the First Americans. Their dispersal from Siberia into Beringia was a single major founding migration. Furthermore, dispersal into America from Beringia, the leg of the trip that largely appeals to the Paleoamerican debate, appears to have taken place after the last glacial maximum by subhaplogroups genetically distinct from Siberian groups. In sum, the genetic signature of the First Americans didn't evolve until after humans spread out of Siberia.

Tom Stafford (Stafford Research Laboratories) called for a "moratorium on complaining" and urged that every site be excavated as if it had the archaeological potential for occupation earlier than Clovis.

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Mammoth Trumpet, Statement of Our Policy

Many years may pass between the time an important discovery is made and the acceptance of research results by the scientific community. To facilitate communication among all parties interested in staying abreast of breaking news in First Americans studies, the **Mammoth Trumpet,** a science news magazine, provides a forum for reporting and discussing new and potentially controversial information important to understanding the peopling of the Americas. We encourage submission of articles to the Managing Editor and letters to the Editor. Views published in the **Mammoth Trumpet** are the views of contributors, and do not reflect the views of the editor or **Center** personnel.

–Michael R. Waters, Director

The rest of day 1 was devoted to presentations describing the empirical or archaeological evidence on review. The first group of sites presented included sites once positioned along the glacier ice margin. **Dan Joyce** (Kenosha Public Museum) described his reevaluation of the mammoth remains from Schaefer site, Wisconsin. He suggests that the disarticulated mammoth and associated lithic remains were found in a low-energy pond deposit that dates to 12,300–12,500 RCYBP. (A study by **Waters** and **Stafford** published in *Science* in 2007 defines the span of the Clovis culture from about 11,100 to 10,765 RCYBP, or about 13,125 to 12,925 CALYBP.) **Eileen Johnson** (Director of Lubbock Lake Landmark, Texas) discussed the Mud Lake and Hebior sites, two other sites along the ice margin in Wisconsin dated between 12,500 and 13,500 RCYBP. Based on plotted bone distributions and detailed analysis of cutmarks, she proposes that both sites have animals disarticulated by humans. Finally, **Mike Waters** updated the group on the Manis Mastodon site in Washington; he notes that CT scans confirm that the object lodged in the animal is a penetrating bone projectile point that had split at the tip.

Michael Collins (*left*) of TARL confers with Mike Waters of CSFA.

Most authorities agree that the scratches on this mammoth leg bone from the Mud Lake site in Wisconsin are man-made cutmarks. Purified collagen from the bone dates to 13,530 RCYBP.

After a constructive discussion on sites along the ice margin, the focus turned to the preliminary report of **Dennis Jenkins** (Museum of Anthropology, University of Oregon) on the archaeology and geoarchaeology of Paisley Cave 5. Three human coprolites dating older than 12,000 RCYBP offer strong evidence for an early human occupation in Oregon. Geneticist **Eske Willerslev** (Department of Evolutionary Biology, University of Copenhagen) was eager to present his analysis of the Paisley Cave coprolites. The team plans to conduct more DNA testing and obtain additional dates on component materials from the human coprolites.

Dennis Jenkins, discoverer of pre-Clovis human coprolites in Paisley Cave in Oregon (*left*), and Steve Holen of the Denver Museum of Nature & Science examine a specimen on display.

Shifting the focus from North America, **Ruth Gruhn** (emerita Anthropology professor, University of Alberta), a longtime proponent of South America's role in the peopling of the Americas, had the challenging task of presenting decades of research on early South American sites. With **Alan Bryan** (emeritus Anthropology professor, University of Alberta) ready to field questions, Gruhn emphasized the need to take into account early sites in the Southern Hemisphere. The occupation at Taima-taima in Venezuela, for example, has been dated to approximately 13,000 RCYBP.

The final presentation of the day was perhaps the most stirring. **Allen West** (GeoScience Consulting) and **Jim Kennet** (Department of Geological Sciences, University of California–Santa Barbara) presented evidence of spikes in the incidence of extraterrestrial particles that suggest a comet impact with North America at about 11,000 RCYBP. The fiery airburst, they argue, halted ocean circulation in the North Atlantic, led to widespread megafauna extinctions, and triggered the collapse of the Clovis culture.

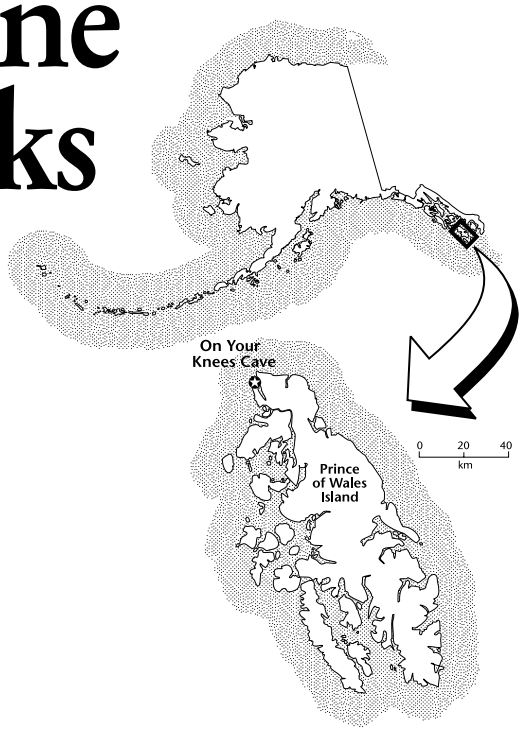
Day 2: Pre-Clovis evidence show-and-tell

Day 2 began with an evaluation of the early record from eastern North America. **Jim Dunbar** (Bureau of Archaeological Research for the State of Florida) reported evidence for human occupation at the Page-Ladson site in the Aucilla and Wacissa river basins of western Florida. According to Dunbar, an older, intact component (Unit 3) contains disarticulated mastodon remains with potential cutmarks and an associated lithic assemblage. Page-Ladson and Suwanee points, among the artifacts displaced from Unit 3, are thought to be potentially associated with the megafauna. **Mike Johnson** (Fairfax County Park Authority) reviewed archaeological evidence dated to about 16,000 RCYBP from Cactus Hill, Virginia, then introduced a predictive model for locating early human occupations in the Nottoway River Valley. He plans to use his model to systematically locate summer occupations for Clovis and potentially earlier groups.

Pushing the human occupation record back even further in time, **Steve Holen** (Denver Museum of Nature & Science) presented evidence of human bone processing and quarrying at the La Sena, Nebraska, and Lovewell, Kansas, sites. Bone beds contain concentrations of highly fragmented bones, spiral-fractured mammoth femurs, and displaced rib bones, some specimens dating

continued on page 16

Early-Holocene Caveman Sinks His Teeth into Genetics



ANCIENT REMAINS of a young man found in 1996 in On Your Knees Cave on Prince of Wales Island in southern Alaska were radiocarbon-dated to 10,300 yr B.P., making this one of the oldest widely accepted archaeological sites with human remains in North America.

It turns out this Early American has secrets to share with us, for molecular analysis of two molars from the remains reveals an additional founding lineage for the Americas, implying greater genetic diversity than we thought. This led Brian Kemp, a Washington State University molecular anthropologist, to postulate that dates previously derived from genetic evidence were likely too old. Previous molecular studies place the peopling of the Americas earlier than 30,000 yr B.P., a date far older than any physical evidence supports. Those studies, however, used a calibration rate for the first hypervariable region (HVRI) of the mitochondrial DNA (mtDNA) that Dr. Kemp has discovered is two to four times too slow. His findings are supported by evidence from the fields of archaeology, linguistics, mathematics, and statistics, and by subsequent studies of other molecular anthropologists.

Individuals bearing the haplotype of the Early American found in On Your Knees Cave are found all the way from the far north to the southernmost tip of the Americas. All samples are living Native Americans except for the Klunk Mound sample (1300 yr B.P.) and the Tierra Del Fuego sample (400 yr B.P.). The population at Tierra del Fuego is extinct. The sample size at each location is 1 unless otherwise noted.

About haplogroups and haplotypes

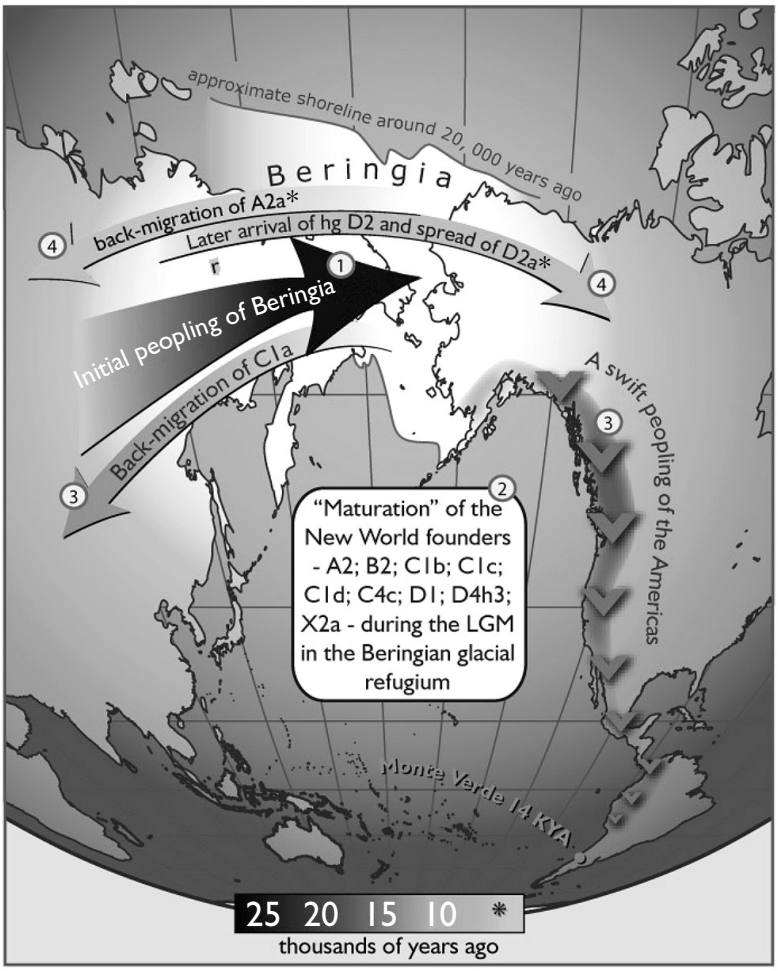
The terms *haplogroup* and *haplotype* can be confusing. In terms of mitochondrial DNA, a haplotype is a unique mitochondrial lineage, different from all other lineages by at least one mutation. A haplogroup is a group of closely related haplotypes. The terminology, however, is relative, which means that a haplotype can be referred to as a haplogroup in that it contains all the descendant haplotypes.

By studying mitochondrial variation in contemporary and prehistoric Native Americans and sorting out haplogroups, haplotypes, subhaplotypes and sub-subhaplotypes, scientists collect important clues about the origin of the First Americans, when they first arrived in the New World, and even the route they may have taken.

To understand genetic science, think printers

If the concepts of alleles and hypervariable regions are foreign to you, look at the whole thing with a detective's eye. Let's say a memo was issued at the company where you work, but no one signed it and no one knows its origin.

Your company has three different printers. (For our analogy, a printer corresponds to a haplogroup.) One is a color printer, one is a black-and-white laser printer, and one is an old dot-matrix printer that uses continuous-feed paper. By examining the memo, you can ascertain which printer produced it, or if it matches none of the three known printers you can deduce that an additional, previously unknown printer is in the building. In addition, if copies of the memo have been made, there will likely be artifacts and degradation noticeable in the later copies. Examine a second-, or third-, or twelfth-generation photocopy of a document and you may find the copy eventually so altered that characters are reduced to a series of dots, with an occasional word totally annihilated by a rogue glob of toner.



AFTER TAMM ET AL.

This marvelous illustration shows maternal gene flows in and out of Beringia. Gray shades of the arrows correspond to approximate timing of the events shown on the time bar at the bottom. The initial peopling of Beringia was followed by a standstill, after which the ancestors of Native Americans spread swiftly all over the New World while some of the Beringian maternal lineages (C1a) spread westward. More recent genetic exchange (*) is manifested by back-migration of A2a into Siberia and the spread of D2a into northeastern America, which postdated the initial peopling of the New World.

Those omissions and additions on a photocopy correspond to mutations that result in alleles.

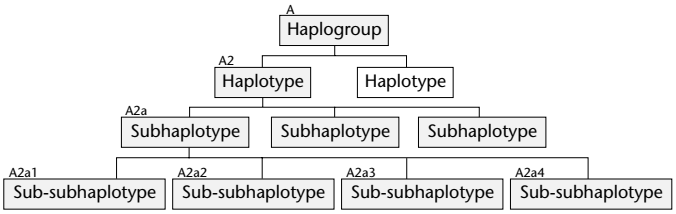
If you determine that photocopy integrity degrades by 10 percent with each successive copy you can estimate, from the cumulative amount the copy varies from its original, how many successive copies have been made. Suppose you reason, by examining a number of factors, that the memo must have been originally produced between January 3 and February 10. Since you know approximately how many times it has been copied, you can therefore estimate the average rate of how often the memo was copied. This copy rate corresponds to the mutation rate, the rate of molecular evolution.

If, however, you know the memo's *exact* original date of issue, you can *calculate* the copy rate to a high degree of accuracy instead of estimating it. Kemp realized that knowing the "date of issue" for the On Your Knees Cave remains (10,300 RCYBP) and the variations between those alleles (the "original memo") and the descendants' alleles (the 47 individuals that fit into haplogroup D4H3) gave him a unique opportunity to recalibrate the molecular clock as it relates to the HVRI of the mtDNA. By plugging in a known value and calculating the average rate of mutation, the accepted standard mutation rate can be tested. That's exactly what Kemp did.

(We hope our analogy of printers and blurred type helps you understand the principles of genetics. Our analogy is an imprecise fit in one important respect, though, because it supposes that all mutations degrade genetic information. In fact, mutations are random occurrences that may benefit the organism, have a negative effect, or produce no noticeable effect at all. Any mutation is passed on to future generations unless it impairs the organism's ability to produce offspring; then the mutation is lost forever when the individual dies. In the HVRI region of the genome discussed below, a special instance, mutations are believed to be uniformly neutral in their consequences.)

The tick-tock of mutation

"The ultimate source of all biological variation is mutation," Kemp explains. "When DNA is copied mistakes get made. That is where new variation arises." Although mutations are random occurrences, they occur at a predictably regular rate. Kemp's special interest is mutations in the HVRI, a region in the genome that does not code for a protein. The mitochondrial genome is the genetic material of the mitochondria; it consists of a circular DNA molecule, about 16.5k nucleotides in length, that carries all the genes. Random mutations occurring in HVRI can accumulate diversity without known consequences. "So if we can take a guess at how quickly mutations accumulate," says Kemp, "we can know how long ago two lineages diverged." The more recently two lineages shared a common ancestor, the fewer mutational differences will be evident because mutations will have had less time to accumulate.

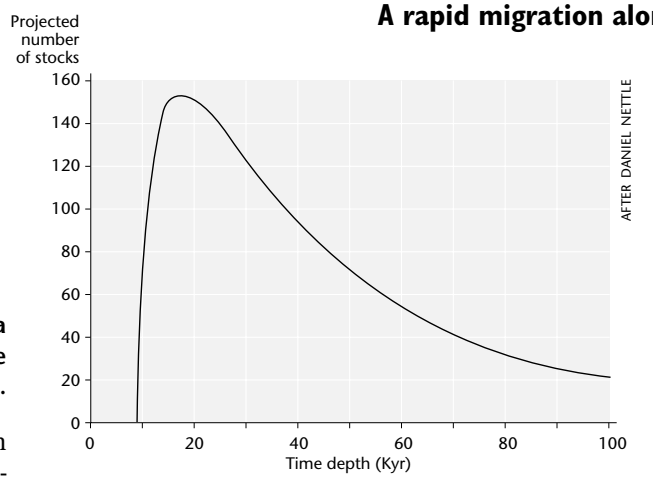


The haplotype identification system had to evolve to keep up with the whole-genome sequencing. Haplotypes are designated first by the common haplogroup letter, then by a number. Each time a new variant of a haplotype is discovered, a number or a letter is added in outline form to specify it.

Beringian standstill

Whole genome sequencing is now allowing scientists to define subhaplotypes and sub-subhaplotypes. Smith says the haplotype identification system has had to evolve to keep up. "To designate haplotypes," he explains, "we start with the common haplogroup letter (A, B, C, or D) and then we give them a number, like A2. Then A2 gets split down in to A2a or A2b, etc. It is like an outline, so each time you discover a new variant of a haplotype you add a number or a letter to specify it."

Whole mtDNA genomes were examined in detail in "Beringian Standstill and Spread of Native American Founders," a paper published in September 2007. Erika Tamm of the Department of Evolutionary Biology at the University of Tartu in Estonia, molecular anthropologist Ripan Malhi of the University of Illinois at Urbana-Champaign, and their colleagues undertook a study to "investigate the pioneering phase in the Americas." They analyzed 623 complete mtDNAs from the Americas and Asia; 20 from the Americas and 7 from Asia, they found, were completely new. In compiling this new dataset the team discovered three new subclades (subgroups) of haplogroup C: C1b, C1c, and C1d as well as an additional variant of haplogroup D, D4h3 (the same new founding haplotype discovered from the individual in On Your Knees Cave), and C4c in modern-day populations of Native Americans. A coalescence study of the mtDNA in the new dataset yields a date of 13,900 ± 2,700 calendar years ago.



Expected number of stocks in a continent plotted against time depth of human habitation.

Recent archaeological excavations place *Homo sapiens* in northeastern Siberia at the Yana Rhinoceros Horn site as early as 30,000 RCYBP (**MT 19-3** ff., "Yana River, Siberia: Implications for the Peopling of the Americas"). The team created the Beringian Isolation Model (BIM) as the most parsimonious explanation of this population, given the new archaeological and genetic evidence. According to the BIM, ancestors of the Native Americans populated Beringia before the Last Glacial Maximum and remained isolated there owing to ecological or other barriers until about 15,000 RCYBP, when they entered the Americas and rapidly spread along the coast.

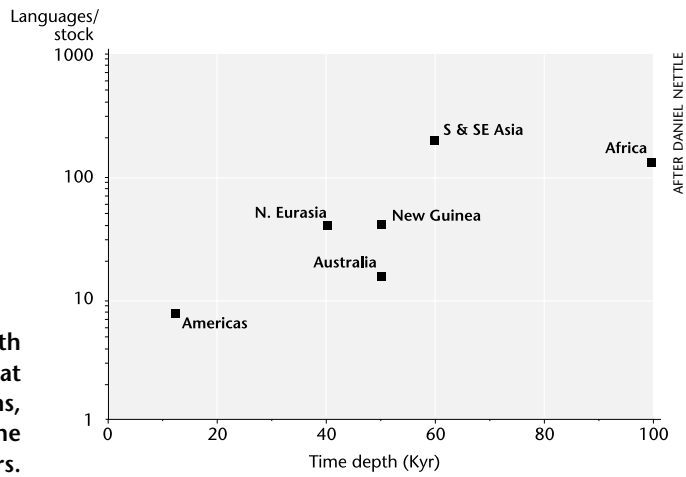
A rapid migration along the Pacific coast

Molecular anthropologist David Smith says the rapid migration is evident from the relatively even distribution of the new D haplotype along the Pacific coast. It exhibits closely related members all along the Pacific coast of the Americas, from the far north to the far south.

When the first Americans began to move inland, migration rates slowed because time was needed to create new subsistence strategies and technologies. The ecological learning curve for a coastal people moving inland is much more substantial than for moving along a coastline. As a result the genetic haplotypes became more nested farther inland.

When did the migration take place?

Kemp's study argues for a much faster rate of molecular evolution in the control region of the HVRI of the mtDNA than previously estimated—two to four times the previous rate. What's the significance? Dating. Previous estimates dating the peopling of the Americas were too old. Applying the rate suggested by the study of the individual in On Your Knees Cave to past scenarios produces a date much more in line with physical archaeological evidence.

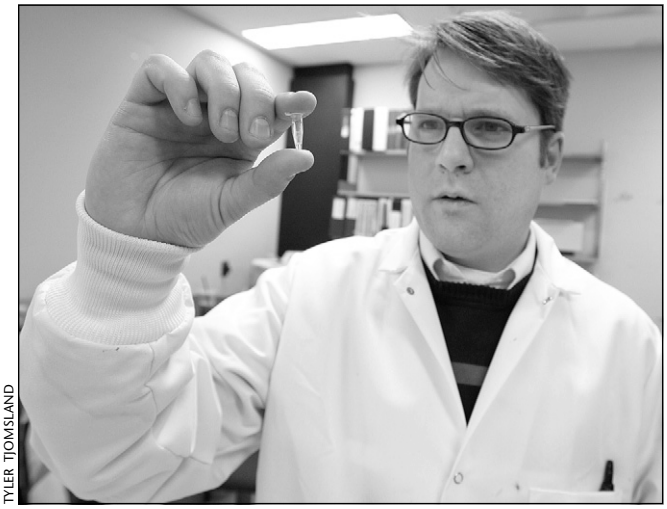


The language families of North and South America, the last great land masses settled by humans, are the youngest and have the fewest members.

Archaeology isn't the only field producing evidence consistent with Kemp's conclusions. In the past, many scientists reasoned that the extreme linguistic diversity of the Americas could only be achieved by a

great time depth (earlier than 35,000 RCYBP) of in situ evolution; however, Daniel Nettle's paper "Linguistic Diversity of the Americas Can Be Reconciled with a Recent Colonization" published in the March 1999 *Proceedings of the National Academy of Sciences,* Vol. 96, objectively concludes that linguistic diversity doesn't support the argument for an early date. This means a fairly recent (11,000–15,000 RCYBP) colonization can no longer be ruled out on the basis of linguistic diversity. By comparing language stocks of the major continents, Dr. Nettle demonstrates that, if anything, the converse is true, that greater time depth leads to *less* diversity.

Mathematics, too, provides compelling evidence for the need to recalibrate the molecular clock. In February 2006, while getting his doctorate at Oxford, biologist and computer scientist Simon Y. W. Ho wrote a paper with Greger Larson that posits a curve in the rate of molecular evolution. Dr. Ho mathematically demonstrates that "instead of a simple dichotomy between fast (recent) rates and slow (older) rates . . . there exists a measurable transition between the two." He describes this transition as a "vertically translated exponential decay curve." Although the exact causes of this phenomenon are not clear, Ho believes it could be linked to a combination of natural selection and saturation. Kemp doesn't even try to explain the details of what he called Ho's "mathematical wizardry," saying only that it utilizes statistics and divergence times in a linear model. Unknowns can be plugged into the model to get an estimated mutation rate. Kemp was ecstatic to find that the model almost precisely mimicked his own estimated rate of mutation for 10,000 years of evolution.

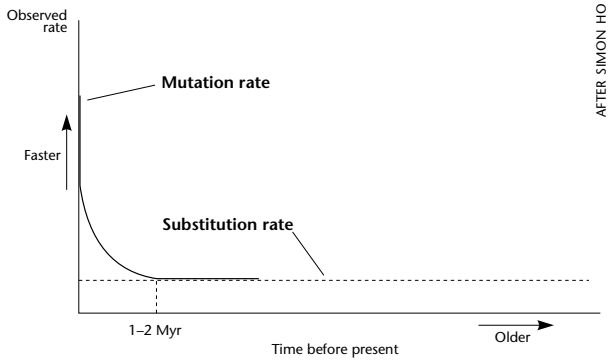


TYLER TJOMSLAND

Kemp in the lab.

No European or Polynesian settlers

Some think Kennewick Man looks like actor Patrick Stewart, the captain on the television show *Star Trek: The Next Generation.* (Actually, when you put *hair* on Kennewick Man the resemblance instantly diminishes.) Nevertheless, Kennewick Man originally caused many people to speculate that Europeans may have settled the Americas. Archaeologists have tried to correct this misconception for years and would dearly love to put it finally to rest. For those wondering where Europeans fit into the migration story—they don't. Smith points out that the two dozen oldest remains in both North America and Asia show an astonishing range of morphological variation; Kennewick Man's features, "more than being Caucasoid, were atypical of most modern Native Americans." Kemp notes that several tries have been made to get DNA out of Kennewick Man, "The morphologists made their best guess given the data they had, but my bet is that if DNA can ever be extracted it will show to be derived from Asian ancestors. Kennewick is not European."



AFTER SIMON HO

The rate of molecular mutation, Simon Ho discovered, underwent a radical change at about the time of the onset of the Quaternary. This molecular-rate curve shows the transition between the instantaneous mutation rate and the long-term substitution rate, passing through a critical region at about 1–2 Myr.

You might ask, What about the X haplotype found in the Americas? Isn't X European? Doesn't that mean the Americas must have had European immigrants at some point? The answer is that although X is found in Europe, X didn't originate in Europe. An ancient population (founding haplogroup X) is the common ancestor between Europe and the Americas. It split a long time ago, with some of the population going to Asia and some going to Europe. The X found in the Americas is not European and does not source from Europe.

What about the B haplogroup? Haplogroup B is extant throughout Polynesia (in some areas 100 percent of the people are haplogroup B). But B is rare in East Asia and Siberia. Kari Schroeder, a student of Smith's, believes geneticists need to look to south-central Asia as a possible source for the First Americans. Her hypothesis, which implies a deeper split between the Native American founders and the Asian population, lends even more weight to the Beringian Incubation Model, BIM, since haplogroup B is more prevalent in South Asia. Just as the presence of haplogroup X doesn't imply immigration from Europe, the presence of haplogroup B in the Americas doesn't argue for a transpacific migration by Polynesians. Rather, it points to a common, perhaps South Asian, ancestor. Moreover, haplogroup B has been recorded in Native American remains dating to more than 8,000 years ago, long before Polynesia was settled.

An emerging consensus

According to current genetic evidence, all clues point to a single source population. Smith says, "A consensus is emerging toward the single migration or single source out of Beringia, clearly one single source. Science is very conservative, of

Remembering Robert H. Weber 1919–2008

ON FEBRUARY 19, 2008, New Mexico lost one of the people most responsible for bringing to professional archaeological attention the rich record of Paleoindian occupation in the west-central part of the state. Robert (Bob) Weber was a professional geologist, earning a Ph.D. from the University of Arizona in 1950 and spending the next 35 years at the New Mexico Bureau of Mines and Mineral Resources at New Mexico Tech in Socorro. His varied geological interests included the Quaternary period, and a boyhood love of collecting arrowheads and rocks in his native Ohio led him to look for prehistoric archaeological sites in central New Mexico. Much could be written about Bob and his contributions to many aspects of geology, history, and post-Paleoindian archaeology, but we focus on his Paleoindian work and his generosity to those of us who were privileged to work with him. Those interested in Weber's varied career can consult Alexander (1997) for his biography.

A couple of years ago, in responding to a question about how he got started looking for Paleoindian sites, he said that the close resemblance of much of Socorro and Catron counties to the Plains made him think that those wide-ranging folks ought to have found this country attractive. From 1950 onward, he devoted much of his free time to the search, establishing beyond any doubt that Paleoindians had indeed appreciated what the country had to offer at the close of the Pleistocene and early Holocene.

Bob's understanding of landscapes and the geomorphic processes that had affected them over time gave him the keys to find sites in parts of the Plains of San Agustin, the northern end of the Jornada del Muerto, and the Rio Grande Valley. It is safe to say that he discovered hundreds of Clovis, Folsom, and later Paleoindian sites, not to mention Archaic and younger ones. His collection included not only points but also tools and in some instances debitage; he appreciated the value of all classes of lithic artifacts and developed keen insights into lithic technology. Bob did not merely find sites—he recorded them meticulously, developing his own numbering system, cataloguing all collected specimens, and precisely locating them on topographic maps. He was also incredibly generous with his collection, freely sharing it with archaeologists and students; contacting Bob to see his collections was one of those "must-do" things for archaeologists visiting Socorro. Three of us—Amick, LeTourneau, and Hamilton—were privileged to use portions of the collection in our dissertation research.

Bob was keenly aware of the importance of lithic raw material sources to prehistoric societies, and due to his geological training he was able to locate several lithic material sources in Socorro County. His near-encyclopedic knowledge of raw materials and their geological contexts he also readily shared, helping to flesh out patterns of movement and aspects of lithic technological organization.

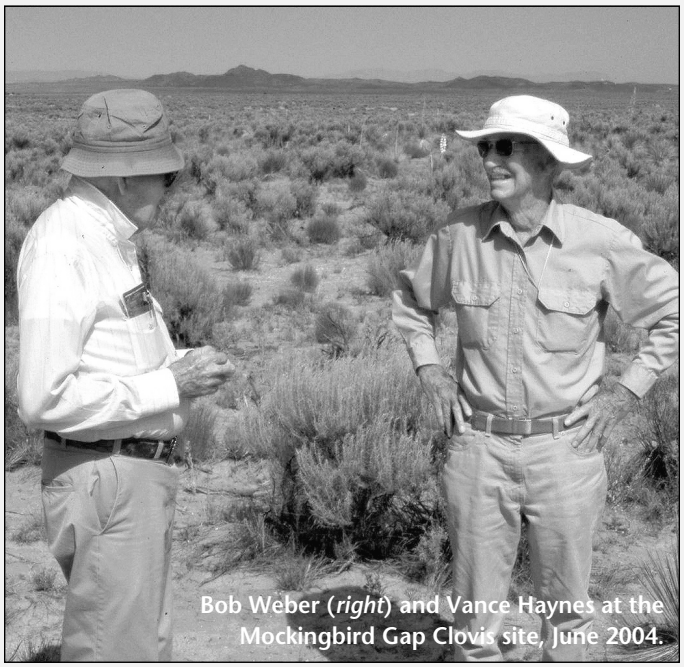
Identifying any one of Bob's many contributions as the most significant is difficult, but certainly his discovery of the Mockingbird Gap Clovis site ranks high on the list. This remarkable locale extends over some 800 m along Chupadera Wash, and is a repeatedly occupied camp that consists of more than a dozen localized, high-density artifact concentrations. Some of them are largely surficial while others are shallowly buried. Bob collected some 300 Clovis points and point preforms, as well as hundreds of scrapers, gravers, and other flake tools. He also produced one of the most remarkably detailed plane table maps imaginable, covering more than 1100 m by 550 m of Mockingbird Gap at a 1-ft contour interval. This involved mapping a relief of more than 15 vertical ft that encompassed ridges, complex dune forms, eroded swales, and recent cultural features, along with Clovis artifacts and excavation area locations, from over 20 individual mapping stations. He enlisted his wife, Margaret, and his daughter, Lynn, in the effort; if no one was available he occasionally worked alone, propping up the stadia rod with a tripod, shooting distance and elevation, and then moving the rod to the next shot location. The effort spanned at least 35 years.

In 1966–68, Bob collaborated with George Agogino to excavate a portion of the site with the Eastern New Mexico University summer field school. A few published results are available from that work (Weber and Agogino 1997; Weber 1997). Bob also explored the soil-stratigraphic record of the on-site deposits and that of the adjacent Chupadera Wash floodplain. He documented the incredible depth of accumulation of sediments along the wash, even obtaining a Clovis-age radiocarbon date from sediments several m below the modern floodplain surface. Beginning in 2004, Bob fully supported, and stayed involved with, new geological and archaeological research at the site and along the wash by Holliday and Huckell, including excavations by the University of New Mexico summer archaeological field school in 2007 (Huckell et al. 2006, 2007, in review).

course, and it just takes time. As more work is done and as more models fit those inferences I think it comes to be a consensus."

Schroeder's recently published paper in *Biology Letters* further supports the BIM. She discusses a mutation that is globally extremely rare but pervasive in the Americas (**MT 22-4,** "Genetic Discovery Refines Our View of the Peopling of the Americas"). Dr. Malhi explains that Schroeder's findings at locus D9S1120 suggest "a pattern unique to the Americas that was also likely found in the ancestral population of Native Americans." An isolated ancestral Beringian population would explain the absence of this mutation in northeast Asia.

While many are aware of Bob's work on Clovis, he also developed a robust record of Folsom in the Central Rio Grande Valley and San Agustin Plains. Bob was project geologist during work on the Ake Folsom site (Weber 1980) at the northern end of the San Agustin Plains, the only Paleoindian excavation conducted in that part of New Mexico. Bob's insights resulted in realizing that the Folsom materials were redeposited in the middle Holocene, and also in identifying the original site context. In 2006 Hill began a systematic survey of Paleoindian sites in the northern San Agustin Plains, linking Bob's superb field maps of paleolake levels with his carefully documented collections from the area in order to understand Paleoindian adaptations to the rapidly changing landscape in the basin. This project is sadly on hold.



BRUCE HUCKELL

Bob Weber (*right*) and Vance Haynes at the Mockingbird Gap Clovis site, June 2004.

In the summer of 1991, Bob generously shared his central New Mexico data with Amick for his regional studies of Folsom land use and mobility. Those data provided the critical linkage for modeling the Folsom archaeological record throughout the Rio Grande Valley of New Mexico. He also shared his knowledge of local lithic resources and was keen to learn what had been found outside his field research area. The remarkable depth of Bob's understanding of lithic technology was reflected in one of the small waste flakes he collected. Many might have overlooked the significance of this minuscule flake, which represented basal pressure retouch that removed the lateral ridge of the flute on a Folsom perform.

LeTourneau also utilized Bob's Folsom materials for his dissertation research, beginning in 1995. From 2002 to the time of his death, LeTourneau worked closely with Bob and his collection. This research, primarily concerned with Folsom lithic technology and toolstone use (LeTourneau and Weber 2004a and b), also included Cody and the earliest Archaic.

Bob was an expert in many different areas. But unlike many experts, he was humble, generous, and genuinely enjoyed sharing his extensive experience and knowledge. He once said that he didn't view his collection as his own property, but something that ultimately belonged to the people of New Mexico. With his passing, this unparalleled collection will be donated to the state of New Mexico. Bob's many contributions to Paleoindian research in New Mexico and across the country are only beginning to be realized with his passing; we will sorely miss him but count ourselves fortunate to have come to know and work with such an outstanding man.

–Bruce B. Huckell, Vance T. Holliday, Daniel S. Amick, Philippe D. LeTourneau, Matthew E. Hill, C. Vance Haynes, Marcus J. Hamilton

Suggested Readings

Alexander, L. E. 1997 A Biography of Robert Harrison Weber. In *Layers of Time, Papers in Honor of Robert H. Weber*, edited by M. S. Duran and D. T. Kirkpatrick, pp. 1–12. The Archaeological Society of New Mexico 23, Albuquerque.

Huckell, B. B., V. T. Holliday, R. H. Weber, and J. H. Mayer 2006 Archaeological and Geological Test Investigations at the Mockingbird Gap Clovis Site, Central New Mexico. *Current Research in the Pleistocene* 23:115–16.

Huckell, B. B., V. T. Holliday, and R. H. Weber 2007 Test Investigations at the Mockingbird Gap Clovis Site: Results of the 2006 Field Season. *Current Research in the Pleistocene* 24: 102–04.

Huckell, B. B., V. T. Holliday, M. Hamilton, C. Sinkovec, C. Merriman, M. S. Shackley, R. H. Weber 2008 (in review) The Mockingbird Gap Clovis Site: 2007 Investigations. *Current Research in the Pleistocene* 25.

LeTourneau, P., and R. H. Weber 2004a Folsom Occupation in Socorro County, New Mexico. Paper presented at the 69th Annual Meeting of the Society for American Archaeology, Montreal.

——— 2004b Distribution of Edwards Chert Folsom Artifacts in Socorro County, New Mexico. *Current Research in the Pleistocene* 21:60–62.

Weber, R. H. 1980 Geology of the Ake site. In *The Ake Site: Collection and Excavation of LA 13423, Catron County, New Mexico,* edited by P.H. Beckett, pp. 221–38. New Mexico State University, Department of Sociology and Anthropology, Cultural Resources Management Division Report 357, Las Cruces.

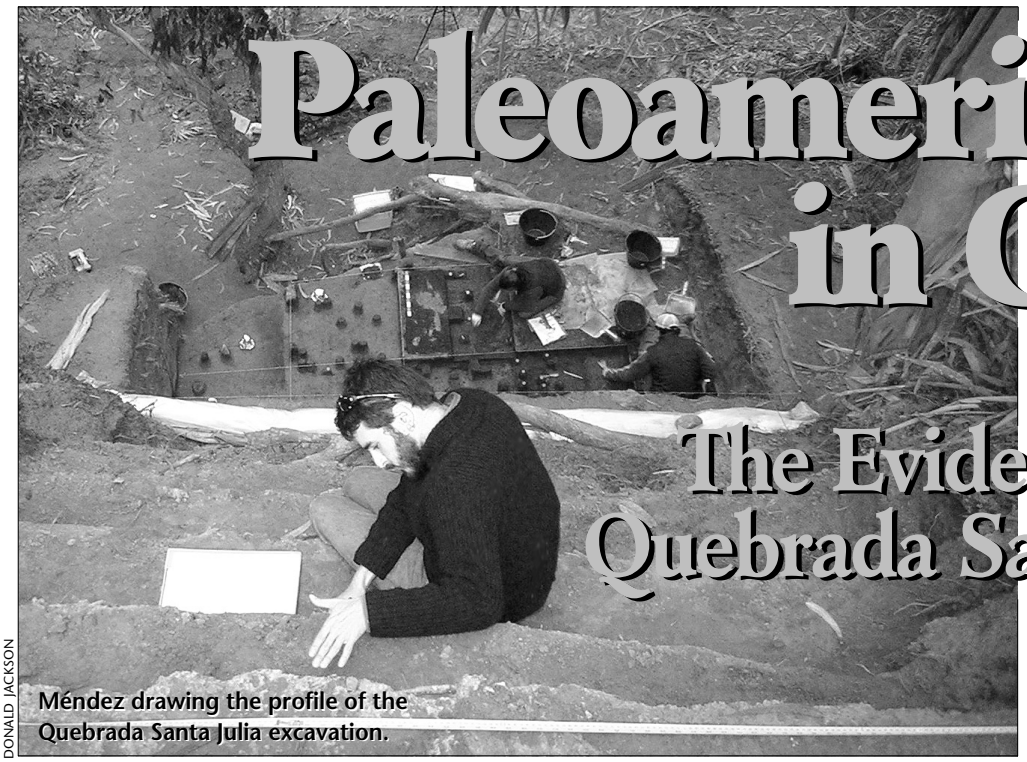
——— 1997 Geology of Mockingbird Gap Site in Central New Mexico. In *Layers of Time, Papers in Honor of Robert H. Weber*, edited by M. S. Duran and D. T. Kirkpatrick, pp. 115–22. The Archaeological Society of New Mexico 23, Albuquerque.

Totally separate fields of expertise all point to the possibility of a relatively recent colonization of the Americas. Kemp is confident anthropology is getting its brain around human prehistory and migrations. Science, however, is cautious. It will take some time for solidly set ideas regarding the rate of molecular evolution to be reconsidered. Kemp concludes, "Ask me in 20 years if I haven't completely revised this, but I think we pretty much have it down—the major movements of people and when they occurred. Genetics and archaeology are coming together. Now we are putting fine scale detail on it, like the peopling of the Americas."

continued on page 16

Paleoamericans in Chile

The Evidence from Quebrada Santa Julia



DONALD JACKSON

Méndez drawing the profile of the Quebrada Santa Julia excavation.

DESPITE MORE THAN A CENTURY OF RESEARCH, our understanding of the initial peopling of South America remains tantalizingly incomplete. It's not just that the continent offers surprises like Monte Verde, which suggest that our New World colonization models may be overdue for a paradigm shift; there are also substantial chronological and geographical gaps in the archaeological record. But thanks to Donald Jackson, César Méndez, and their colleagues, we now have a much better idea of who some of the first South Americans were.

Dr. Jackson and Dr. Méndez, both of the Department of Anthropology at the University of Chile's Santiago campus, specialize in the early peopling of Chile's semiarid northern Pacific coast. Until recently, not a single indisputable Paleoamerican site was known in that region—mostly, they say, because of a lack of appropriate research strategies. In 2003 they set out to change that, assembling a crack team of investigators who initiated a search program using relic Pleistocene landforms as their guide. Aiding them were conservationist Roxana Seguel, geologist Gabriel Vargas, and Antonio Maldonado, a specialist in arid-zone ecologies. It wasn't long before they identified several promising sites in a 29-km^2 area in the Los Vilos region. One of these sites, Quebrada Santa Julia, yielded deeply buried cultural remains dating to approximately 13,000 CALYBP—just about the same time that the Clovis culture in North America was coming to an end.

CÉSAR MÉNDEZ

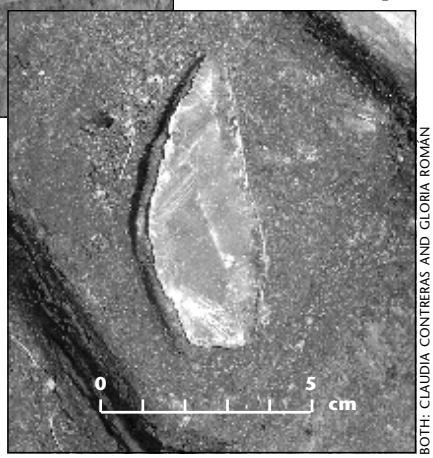
Field crew excavating the Paleoamerican occupation level at Quebrada Santa Julia during the 2005 field season.

Science, not serendipity

Several years before Quebrada Santa Julia was discovered, Jackson and Méndez published a paper pointing out that all Pleistocene archaeological sites in Chile had, up to that point, been discovered fortuitously. "Therefore, we thought that chance was leading our knowledge of the early peopling of this area," Méndez points out. "We believe this scenario isn't particular to Chile. Talking to foreign colleagues and reading their papers has corroborated [the idea] that the situation in the southern cone is pretty similar to the one we observed. In the paper, we called for a research strategy in which archaeological problems led our searches; only in that manner would we be able to develop strategies that searched for sites deliberately, rather than just found them accidentally."

Based on regional knowledge obtained over several decades of work, it became clear to Jackson and Méndez that there

were two basic types of early archaeological sites in Chile: surface "palimpsests," significantly deflated sites with poor integrity that are easily visible and easily discovered; and deeply buried sites with intact contextual integrity. The latter are obviously the more valuable, because they're easier to date and interpret; but they're also vastly more difficult to discover, since they're basically invisible from the surface and impossible to find without a great deal of effort. These sites require the application of a good predictive model to be discovered at all.



BOTH: CLAUDIA CONTRERAS AND GLORIA ROMÁN

Excavating the stake imprint feature ▲ in the Paleoamerican occupation level at Quebrada Santa Julia.

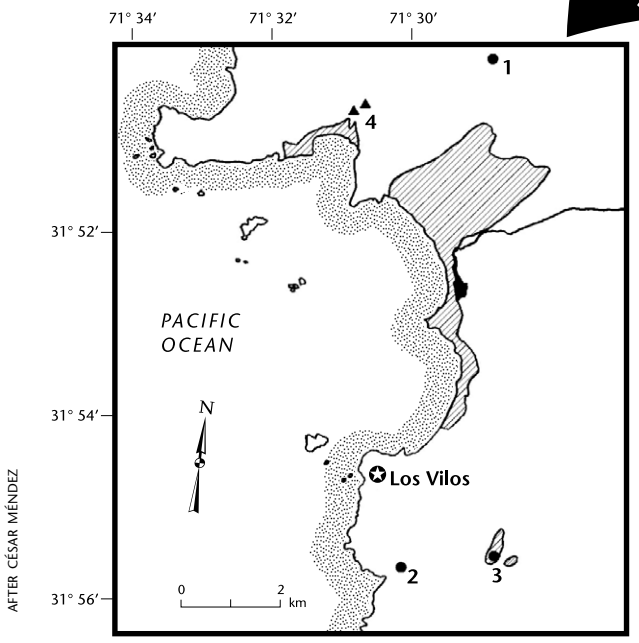
In situ quartz instrument. ▶

Hence the Los Vilos survey program, which focused on identifying and investigating old Pleistocene landscapes. Their survey model was rewarded with 24 sites that produced Pleistocene faunal remains. Three sites—El Membrillo, Quereo, and Quebrada Santa Julia—yielded cultural materials along with the bones. El Membrillo offers a radiocarbon date of 16,000 CALYBP in association with lithic artifacts; but it's one of those deflated palimpsest sites, so its integrity is suspect. Of the two remaining sites, only Quebrada Santa Julia produced diagnostic Paleoamerican artifacts, in this case from a cultural deposit fully 10 m (33 ft) below the surface. Considering the great depth, it seems a miracle the site was ever found at all—and it might not have been, if the team hadn't been specifically looking for sites just like it.

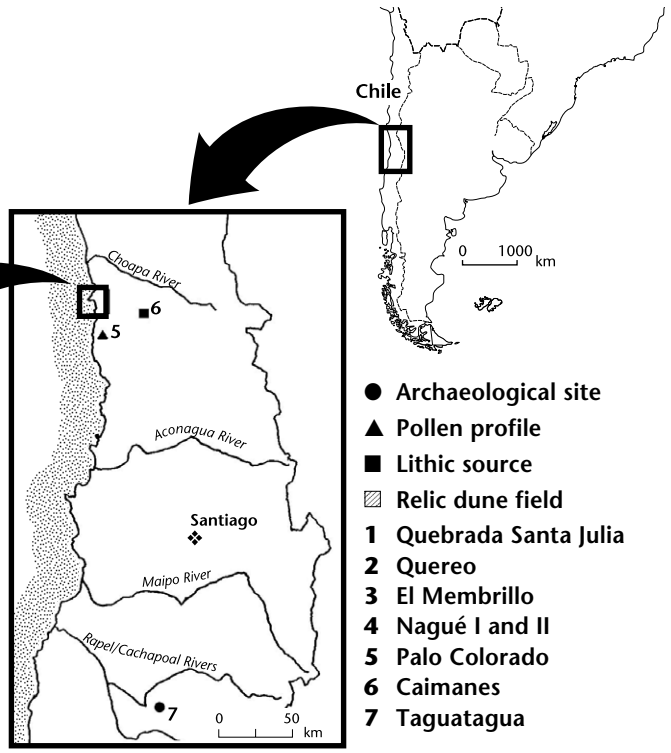
Perseverance rewarded

While serendipity had little to do with Quebrada Santa Julia's discovery, you have to give Mother Nature credit for a little help. The site was so deeply buried that it was protected from the ravages of time for millennia, but it's currently located on the edge of a ravine that drains to the Pacific Ocean just 3.5 km (2.1 mi) to the west. Erosion had prepared a complete 10-m profile with classic layer-cake stratigraphy, which a close examination proved contained not only Pleistocene faunal remains but diagnostic artifacts as well.

Quebrada Santa Julia is a superb example of an occupation that was quickly and effectively sealed away by fluvial deposits, and then even more completely buried by repeated flooding. Apparently the site originated on the shores of a small lake. Although there's evidence of a high-energy event at one point—this is indicated by a poorly sorted cobbly layer about 8 m down—the fluvial environment was mostly a gentle one: The majority of the deposits are fine-grained flood couplets interleaved with organic peat layers. As a result, preservation and contextual integrity are excellent.

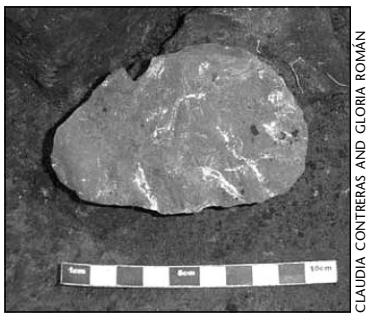


AFTER CÉSAR MÉNDEZ

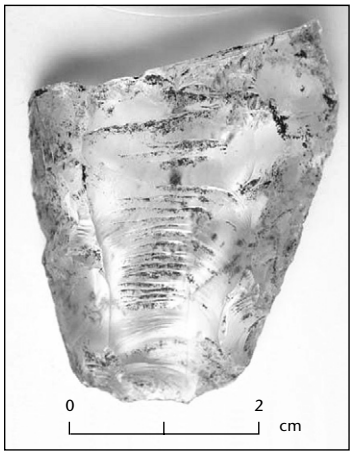


Quebrada Santa Julia artifacts: Fluted quartz preform. ▶

Retouched silicified tuff flake in situ. ▼



CLAUDIA CONTRERAS AND GLORIA ROMÁN



MARCELA ROUBILLAR

"Regarding the site-formation processes," says Jackson, "we would have to say that these are not only unique in terms of the large sediment deposit covering the Pleistocene occupation, but also because of the high integrity of the remains we found. This integrity is especially manifested in the resolution of associations, which clearly show a distinct activity area with artifacts, extinct faunal bones, a hearth and other features."

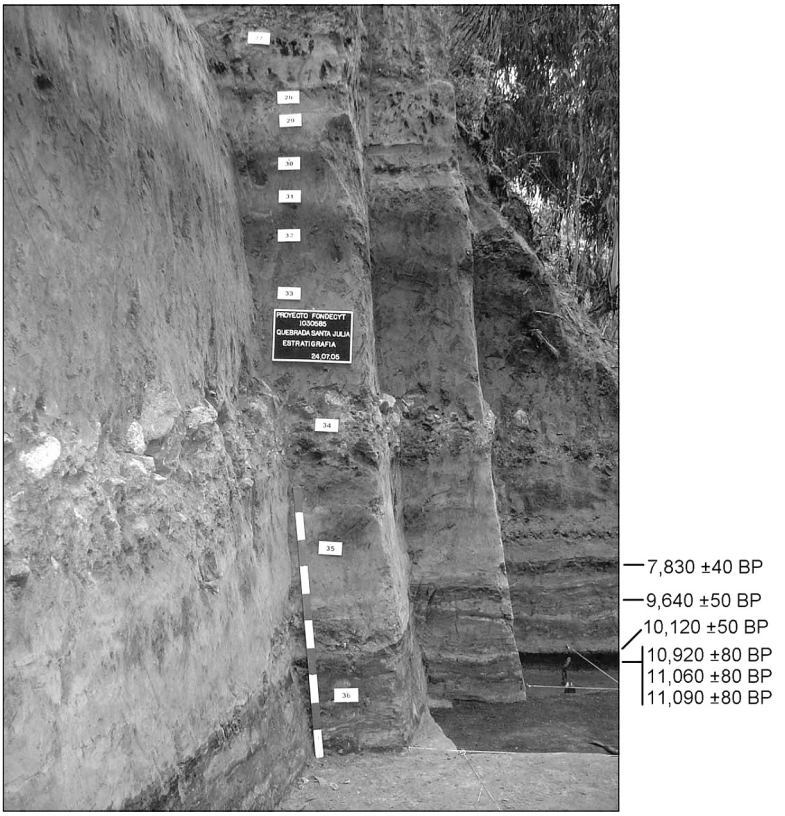
An 8-cm-thick layer of peat forms the Paleoamerican occupation level. Among the artifacts recovered from it were expedient stone tools made from coarse-grained silicified tuff: a retouched flake, several other flakes, a scraper, a graver, and a unidirectional core. Most of the lithic assemblage, however, consisted of chipped quartz crystal, including a bifacial projectile-point blank that apparently snapped in two during the fluting process. A partial fluting flake that refitted to the blank was found nearby, along with more than 190 quartz flakes. Interestingly, the nearest source of quartz is the Caimanes area, 30 km (18 mi) inland; this strongly suggests a rather wide-ranging resource procurement area for the people who occupied the site. But why quartz?

"We're far from knowing the real motivations for their lithic resource selection, besides such commonly discussed attributes as knapping quality, abundance, and availability," say Jackson and Méndez. "Nevertheless, it's interesting to note that several early projectile point specimens along the western slope of the Andes are manufactured on quartz and quartz crystal. For instance, sites in northern Perú, ascribed to the Paiján complex, are known for the use of this raw material in projectile-point production. Also, in central Chile, Lautaro Núñez identified fishtail projectile points manufactured with quartz at the Taguatagua site, where several mastodons were butchered. Though we can't yet ascertain symbolic reasons in stone tool production, we shouldn't disregard the possibility of such factors in the cultural trends of early Americans."

The preform itself closely resembles a Clovis blank. Especially interesting is the biface style of manufacture: As with most Clovis points, a "nipple" was prepared at the base before the channel flake was struck off. This is extremely uncommon in regional Paeloamerican points, which tend toward the fishtail type in any case.

Processed horse remains were also collected from the occupation zone. No cutmarks were observed on the *Equus* bone, but the way the bones were fractured and the fact that they were in close association with a hearth suggest they resulted from food processing. The lack of visible rodent and carnivore disturbances further indicates that these articles were still in primary context when found (and, incidentally, that the site was quickly buried). The hearth itself contained charcoal, unburnt wood, a small amount of burnt bone, and a sharpened wooden artifact—possibly a stake. Perhaps even more intriguing, if only because of their great rarity, were several associated soil features; given their morphology, contours, and depth, they may be post molds. This leads one to wonder, Was the wooden artifact once embedded in one of the observed soil features, before one of the occupants removed it and tossed it into the remains of the fire? And what type of structure might it have been a part of?

Jackson and Méndez remain noncommittal on this point. "Both the features and the wooden artifact were found in close proximity to each other, and to the hearth," they report. "Nevertheless, it's very difficult to be certain of a particular function, until further excavations report more meaningful evidence or similar artifacts. The more plausible scenarios are that these



CÉSAR MÉNDEZ

The lower portion of the Quebrada Santa Julia stratigraphic profile, showing radiocarbon ages for the bottommost strata (including the Paleoamerican occupation level).

were part of the stakes holding up a light habitation, or some kind of structure associated with the function of the hearth."

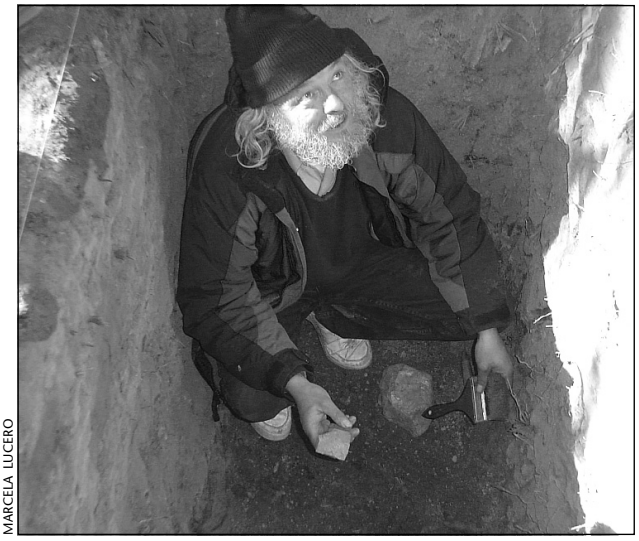
Not quite oceanfront property

Although Quebrada Santa Julia is located relatively near the modern coast, that doesn't signify much. Remember, this is where the site is located relative to the ocean *today*, during a warm interglacial period. Back in the terminal Pleistocene, a great deal of the world's water was sequestered in the great continental ice sheets, so the sea level was substantially depressed. During the site's initial occupation, the oceans were about 70 m below their present level and Quebrada Santa Julia was as much as 8 km (4.8 mi) away from the ocean, which probably explains the lack of evidence for maritime food resources or the technology used to exploit them.

CLAUDIA CONTRERAS AND GLORIA ROMÁN

Conservationist Roxana Seguel (*right*) and student excavating.

The earliest known coastal adaptation in the region, the Huentelauquén complex, was an early-Holocene manifestation—one that Jackson and Méndez don't believe was related at all, either temporally or culturally, to the occupation at Quebrada Santa Julia. Furthermore, sites of the Huentelauquén complex are clearly oriented toward exploiting maritime resources; they display a specialized technology and show evidence of intense consumption of mollusks, fish, seabirds, and sea lions by the occupants. This is not the case for Quebrada Santa Julia, where horse was on the menu. "Most probably," Jackson and Méndez suspect, "the occupants had an inland resource exploitation and settlement pattern, despite the proximity to the coast."



MARCELA LUCERO

Jackson during Quebrada Santa Julia site discovery.

They do believe, however, that the Santa Julians were the first settlers of the region; this is consistent with both their research experience and the very early dates for the peat in which the artifacts were embedded. "All the evidence we've found at Quebrada Santa Julia," they say, "is consistent with the expectations for an initial occupation; among other things, there's a discrete occupation, no site redundancy, expedient use of local lithic materials, and a transportable artifact kit." It can be argued, of course, that the Santa Julians were already well established in the Los Vilos region by then; lacking a preexisting trade network to tap into, they must have been familiar enough with the area to be aware of the quartz deposits at Caimanes. That said, the discovery of Caimanes just before the occupation of Quebrada Santa Julia isn't beyond the realm of possibility; it had to have occurred at some point.

Right now it's hard to say exactly who the Santa Julians actually were, and whom they derived from. One thing Jackson and Méndez are sure of is that Quebrada Santa Julia isn't related in any way to Monte Verde, the famous pre-Clovis site in south-central Chile, because the chronologies and artifact assemblages don't match. Otherwise, they say, "It's too soon yet for establishing direct cultural affinities; Santa Julia and the other new sites should be studied more. We plan to continue our research in the coming years, excavating the sites with new research questions in mind."

Obviously Quebrada Santa Julia is contemporary with Clovis; the recorded age of the occupation level proves that. Given the fluted biface and its Clovis affinities, it's tempting to posit a Clovis link—either through direct immigration from the north, or by means of cultural diffusion. Could we be looking at a Clovis outlier this far south?

Like all good scientists, Jackson, Méndez, and their team are cautious about reading too much into the possibility; as they point out, it's always best to sit tight and wait for whatever the new evidence tells us. It's too easy to jump to the wrong conclusions with only rudimentary data. In this case, if wishes were horses, Clovis would ride—all the way to South America.

–Floyd Largent

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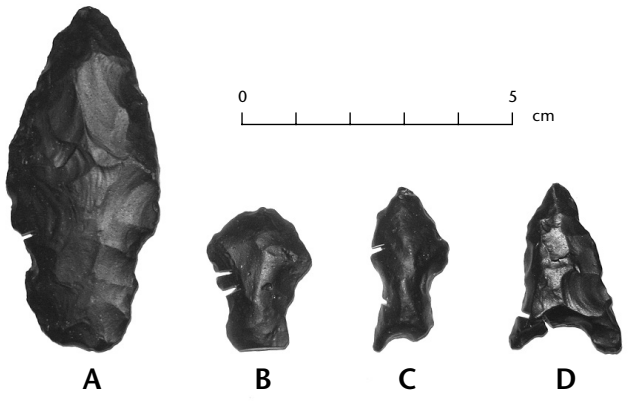
Through a Glass Darkly:

Dating Obsidian Points

OBSIDIAN IS VOLCANIC GLASS, usually black. When fractured, it yields shards with edges more than 100 times sharper than a steel scalpel. Like flint, obsidian can be chipped into lethal projectile points of varying shapes and sizes. Fortunately for archaeologists, the age of a point chipped from obsidian can be determined by gauging the amount of water absorbed into anciently fractured surfaces. Archaeologist Daron Duke of Far Western Anthropological Research Group, Inc., Tim Carpenter of ArchaeoMetrics in California, and David Page of the Desert Research Institute in Nevada have applied obsidian hydration dating to a sample of more than 400 spear points from western Utah—Topaz Mountain is the largest single source of obsidian in their study—and they've made surprising discoveries about the relative ages of various types of points. One type, known as the Pinto point, turns out to be considerably older than generally thought.



DARON DUKE

Western Stemmed (A, B) and Pinto (C, D) artifacts with thin-section cuts made for hydration analysis.

Morphology defines the point

The changing patterns of function and style make spear points useful indicators of cultural change over time and across space. Clovis points, for example, are recognized as one of the earliest widespread types of spear points in North America. They have been found in sites from Alaska to northern Mexico ranging in age from 13,250 to 12,800 CALYBP (**MT 22-3,** "Clovis Dethroned").

In the Great Basin, a number of other point types have been defined based primarily on the characteristics of their bases, which reflect differences in how the point was hafted to the spear shaft—or knife handle, since blades can be used as knives as effectively as spear tips. Many of the earliest varieties of Great Basin points are lumped together in what has come to be known as the Western Stemmed Tradition.

Western Stemmed points are usually large lanceolate points with prominent hafting stems and round, square, or sometimes slightly concave bases (they are often referred to as "indented"). Lithics authority C. Melvin Aikens notes that varieties of these points are "found everywhere west of the Rockies" and date from 10,500 to 7500 RCYBP (about 12,300–8500 CALYBP). Washington's Kennewick Man (**MT 17-3, -4,** "When Science and Politics Collide") and Nevada's Spirit Cave Man (**MT 12-2,** "Remarkable Discovery") date to this period. Indeed, Kennewick Man has what is likely a Western Stemmed point lodged in his pelvis.

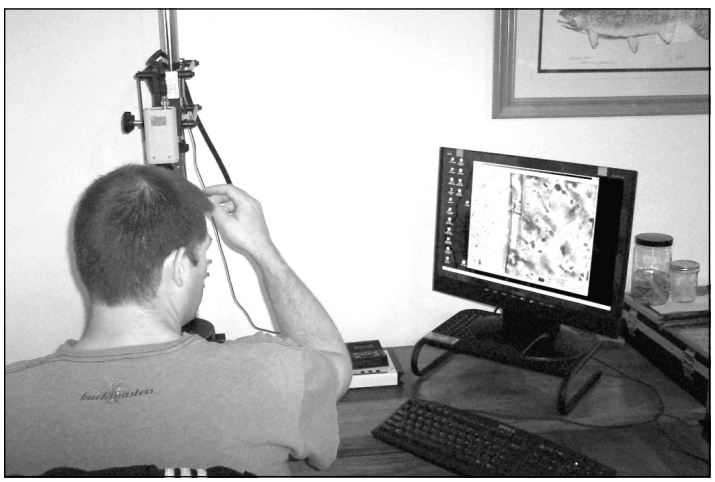
A similar style of point with a stem divided into two segments, or lobes, is called a Pinto point. Some researchers have argued that Pinto points are part of a separate, later cultural tradition, while others think they should be included within the Western Stemmed Tradition.

Determining the age of stone tools

In order to establish the age of a particular style of spear point, arrowhead, or knife made of flint, the blade must be found in a reliable context, such as a secure level, or stratum, within an archaeological site. The level must also contain, in close association with the point, organic material such as charcoal or bone, which can be dated using radiocarbon technology. The resulting radiocarbon date can be applied to all artifacts, including chipped-flint points, found in that level.

Artifacts made from obsidian, unlike flint, don't suffer from this limitation. Because of a special property of obsidian, tools chipped from it can be dated directly using a technique known as obsidian hydration dating.

Despite its glassy, brittle surface, obsidian has this in common with a sponge: It absorbs water over time. By knocking off a flake from a block, or core,

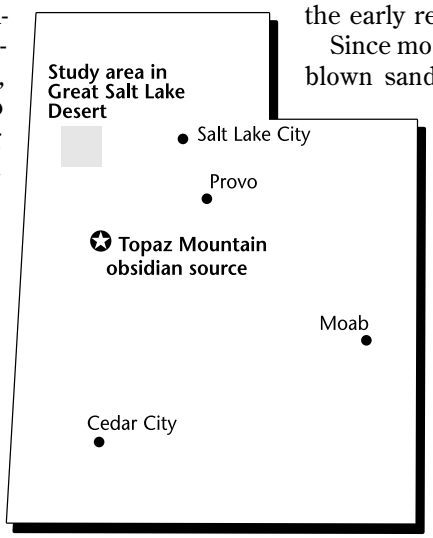


TIM CARPENTER

Tim Carpenter at the microscope making digital hydration measurements on computer screen enlargement.

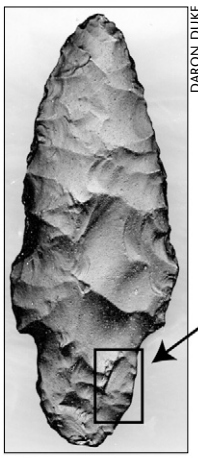
a flintknapper (in this case, an obsidian-knapper) exposes a fresh surface of obsidian to air. Once new material is exposed, water molecules begin slowly to diffuse into the obsidian, creating an ever-increasing layer, or rind. The thickness of the rind is a measure of elapsed time.

Unfortunately, the rate at which the water absorbs into the obsidian isn't fixed or constant. Instead, it depends on a variety of factors. According to Alexander Rogers of the Maturango Museum in Ridgecrest, California, the rate of absorption, or hydration, depends on the chemistry of the obsidian (the "intrinsic water content of the glass") and the temperature and relative humidity of the environment. By taking these variables into account, scientists can calculate the age of an obsidian artifact from the thickness of the hydration layer, or at least confidently sort them in relative temporal order.



Applying obsidian hydration dating to Paleoindian points

Duke, Carpenter, and Page decided to take advantage of the special nature of obsidian to work out the ages of various styles of spear points found in the Great Basin. Their results, reported in the 2007 volume of *Current Research in the Pleistocene*, provide "a much-needed clarification of Paleoindian point typology" in this region.

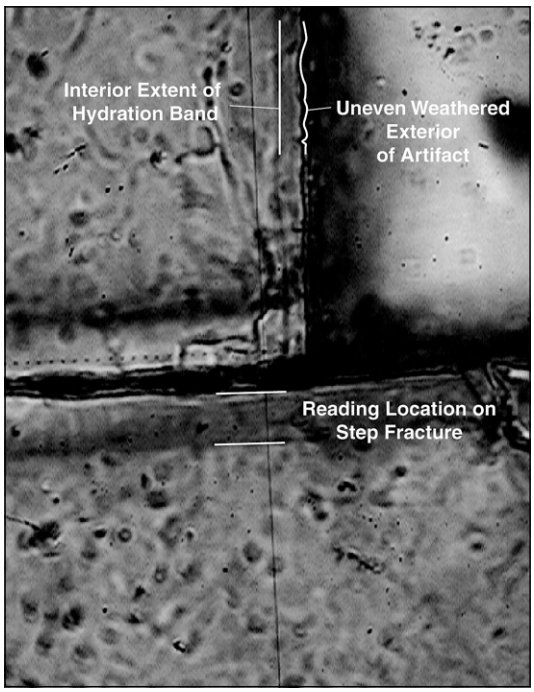


They obtained obsidian hydration dates for over 400 Western Stemmed and Pinto points, making it the largest collection of early Great Basin points so far assembled for this purpose. Obsidian from Utah's Topaz Mountain constituted the largest single source of material represented in the sample. Points made from this source included 164 Western Stemmed, 36 Pinto, 22 Elko, 37 Rosegate, and 7 Desert. (Elko, Rosegate, and Desert points postdate the Paleoindians and were used to situate the early readings according to the local chronology.)

Since most of these artifacts were surface finds, windblown sand will have abraded the hydration layer in most cases. Duke and his colleagues therefore took their samples from a kind of flake scar along the artifact edge known as a step fracture, which protected the surface from direct exposure to wind. This precautionary measure helped prevent the effects of wind abrasion from skewing the date of an artifact exposed to the elements for long periods of time.

They found that Western Stemmed points had an average hydration layer thickness of 9 microns, about 0.0004 inch. That translates to an age of between 10,000 and 8500 RCYBP. Although Pinto points had a slightly greater average thickness, a much smaller sample and larger standard deviation make the measurement less reliable than that for Western Stemmed points. In fact, based on the current sample, Pinto points may even be slightly older than the Western Stemmed Tradition. It's clear, however, that Western Stemmed and Pinto points were more or less contemporaneous in the Great Basin.

That the two point types were approximately coeval is significant because it means that, in this case, the two distinctive types of spear points don't reflect changing styles through time. Possibly they represent different social groups, each possessing a unique spear point. But if that were the case, then you'd expect to find each type restricted to an area that was the home range of the proprietary group. Since the two types are similarly distributed, however, it suggests the same group used the two kinds of points for specialized purposes. Perhaps, for example, one type was used as a knife, the other to tip a spear.



In this cross section of the edge of a Western Stemmed point, windblown sand has eroded the hydration band on the exposed edge of the step fracture. But in the protected area, the remnant of the attached flake has preserved the pristine surface.

Duke, Carpenter, and Page conclude their paper with the observation that "work continues toward increasing our sample and finding functional reasons for the concurrent usage of these two distinct morphological types." Future research may help clarify the issues of age and function. Nevertheless Duke, Carpenter, and Page have demonstrated that Pinto points are every bit as old as Western Stemmed points.

–Bradley Lepper

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Suggested Readings

Aikens, C. M. 2006 Paleo-Indian: West. *Handbook of North American Indians,* volume 3, edited by Douglas Ubelaker, pp. 194–207. Smithsonian Institution Press, Washington, D.C.

Duke, D. 2008 Obsidian Hydration Chronologies for the Great Salt Lake Desert. In *The Archaeology of Shifting Environments in the Great Salt Lake Desert: A Geoarchaeological Sensitivity Model and Relative Chronology for the Cultural Resources of the US Air Force Utah Test and Training Range*, edited by D. C. Young, pp. 73–98. Far Western Anthropological Research Group, Inc., Davis. Submitted to Select Engineering Services, Inc., Roy, and Hill Air Force Base, Utah. [The vast majority of the points reviewed in *Current Research in the Pleistocene,* vol. 24, were originally studied for this article.]

Duke, D., T. Carpenter, and D. Page 2007 New Obsidian Hydration Findings Suggest the Use of Split-Stem Points by Great Basin Paleoindians. *Current Research in the Pleistocene,* 24:80–82.

Rogers, A. K. 2007 Effective Hydration Temperature of Obsidian: A Diffusion Theory Analysis of Time-Dependent Hydration Rates. *Journal of Archaeological Science,* 34(4): 656–65.

Caveman Sinks His Teeth into Genetics

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It takes courage to make such a bold predictive statement, but Kemp, a scientist, knows even if all these assertions and conclusions are someday revised or even reversed, they won't have been produced in vain. Science builds upon science, new conclusions generate new questions, and there is no misdirection, only exploration. Newton, Copernicus and Edison would all certainly agree.

–Dale Graham

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Paleoamerican Origins Workshop

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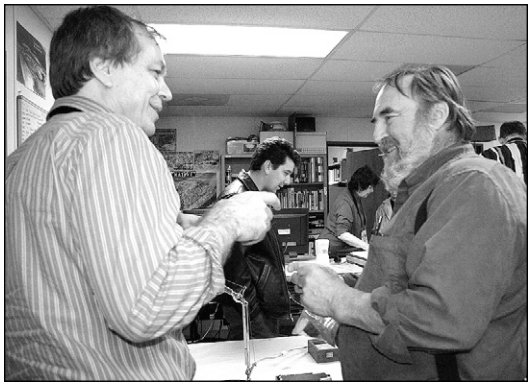
to approximately 18,000 RCYBP. **Al Goodyear** (Director of SEPAS, University of South Carolina) reported evidence for an early occupation at the Topper site. Topper's flaked-tool assemblage, dominated by a bend-break technology, is associated with dates ranging from 15,000 to as early as 50,000 RCYBP.

Launching brief updates on the excavation status at sites with potential pre-Clovis-age components was **Dennis Stanford** (Smithsonian Institution), whose presentation stimulated interest in the Eastern shoreline. He reports that three sites on the Delmarva Peninsula (Five Miles Point, Paw Paw Cove, and Jefferson Island) have diagnostic Clovis artifacts. At Five Miles Point in particular there is evidence of a blade and biface technology in a stratigraphic unit below the Clovis component. Moving back down to the Southern Plains, **Michael Collins** described lithic evidence of a potential human occupation below the rich Clovis component at the Gault site in central Texas, where artifacts associated with biface manufacture were found below a stratigraphic unconformity dated to 13,310 ± 830 RCYBP. On neighboring property the Texas A&M excavation team also recovered evidence to support early occupation in Texas; **Mike Waters** reported a biface tip and fragment found in brown clay stratigraphically below the Clovis component at the Buttermilk Creek site. At the Burnham site in Oklahoma, **Don Wycoff** (Sam Nobel Oklahoma Museum) cited evidence that's small but significant: a component with 51 small flakes that are possible remnants of tool retouch flaking, 4 of them associated with a bison skull. The site has been generally dated to before Clovis at 22,000–35,000 RCYBP.

Mike Collins reminded scholars not to overlook Monte Verde I as early evidence of human occupation in Chile. He reiterated that humans, following a coastal entry, may have been the agents that produced the basalt core and flakes and two

hammerstones recovered from the pre-Clovis-age component from Monte Verde I. **Andrei Tabarev,** visiting from the Institute of Archaeology at the Russian Academy of Sciences, gave scholars a view of the Far East. Reviewing both bifacial and unifacial technologies, he pointed out commonalities in the Clovis record from North America and the Paleolithic record from Siberia that support an early-entry model via Beringia. In the final presentation of the day, **Doug Owsley** (National Museum of Natural History, Smithsonian Institution) reported on skeletal evidence. Cranial morphometric comparisons, he argues, suggest that Paleoamericans show greater morphological affinities to Polynesians, Europeans, and the Ainu than to modern American Indian populations.



Neal Lopinot (*left*), co-investigator of the Big Eddy site in Missouri, banters with Smithsonian archaeologist Dennis Stanford.

Not only did scholars hear evidence for early human occupation, they also got the chance to examine firsthand assemblages from potential pre-Clovis-age sites. Among the extensive assemblages on display were cutmarks on Mud Lake mammoth long bones; a conical core found at Five Miles Point, Delmarva Peninsula; a graver spur on a bend-break flake and a large flake core from the Topper site, South Carolina; Gainey points from the Big Eddy site, Missouri; a biface found below Clovis deposits at Buttermilk Creek, Texas; blade-like flakes from Cactus Hill, Virginia; small flakes from buried deposits at the Burnham Bison site, Oklahoma; a collection of possible artifacts from Calico Hills, California; and slides showing extraterrestrial particles collected as evidence for a catastrophic Pleistocene/Holocene transition.

Day 3: Model building

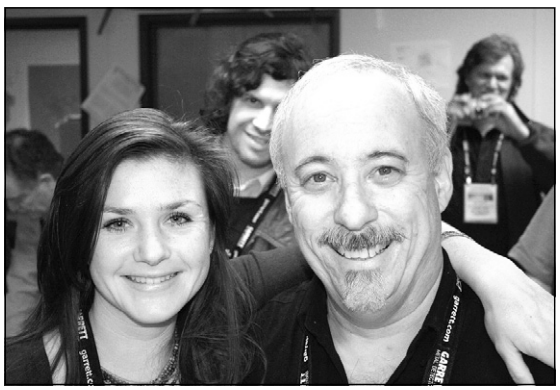
Presenters discussed migration models, then assessed how well reported sites fit models explaining the peopling of the Americas.

Gary Haynes (University of Nevada at Reno) and **Stuart Fiedel** (Louis Berger Group), both steadfast critics of theories that purport pre-Clovis human presence, questioned why the first human dispersal into the Americas is still so poorly understood. For **Fiedel,** potential pre-Clovis sites still lack credible stratigraphic and artifactual evidence to argue the case for early occupation in the New World. **Mike Collins**, quick to disagree, countered that evidence of early human entry can be found and that dispersal models should recognize that humans concentrate subsistence efforts on ecotones and waterway edges. To account for a pre-Clovis occupation, Collins turned his attention to human entry by watercraft along "edges" or by routes along the northern coastal margins of North America. Expanding on possible entry routes, **Loren Davis** (Department of Anthropology, Oregon State University) cited evidence supporting a Pacific coastal entry, reviewed alternative models for an early human coastal entry, and encouraged a geoarchaeological perspective for testing coastal sites for pre-Clovis-age components. In the final presentation, **Dennis Stanford** and **Bruce Bradley** (University of Exeter) revisited their theory of an Iberian connection, offering evidence from the Atlantic coastline. Stanford suggested that the progenitor of Clovis was a Solutrean technology from northern Spain.

The final, and possibly the critical, portion of the conference was an open discussion. Under the moderation of **Collins, Goebel, Goodyear, Stanford,** and **Waters,** scholars had the opportunity to voice their interpretations of potential pre-Clovis sites and to explore the broader context of early human occupation in the New World.

Peering into the future

It seems the tide has turned. Difficult though it is to reach consensus among scholars, the members of this esteemed convocation unanimously agreed that today every archaeologist must dig deeper. As Clovis becomes securely defined and potential pre-Clovis sites are identified, it is now our obligation as scientists to continue testing to find answers to the questions, Who were the First Americans? When did they arrive in the New World? To answer these significant questions we must go beyond what we know and start looking for what we don't know. Scholars are encouragingly optimistic about the future of First Americans studies. Such sites as Paisley Cave in Oregon and the Hebior and Schaefer sites of Wisconsin have caught their attention.



Our author/photographer, Ashley Smallwood, and Tom Pertierra, who organized the workshop.

The Paleoamerican Origins conference, by informing scientists of pre-Clovis evidence already in hand, promises exciting discoveries in the future. To find conclusive proof of human presence in the New World prior to the Clovis people, we have to open our minds, maintain a critical eye, and keep searching.

About the author Ashley Smallwood, a doctoral candidate in Anthropology at Texas A&M University, is a supervisor on the Clovis Hillside excavation at the Topper site in South Carolina. The quarry-related site allows her to pursue her interests in Clovis technology and mobility. The principal goal of her dissertation is to study site-level data to evaluate Clovis dispersion in the American Southeast.

THE CLOVIS COMET

Part III: The Implications

WHAT WOULD HAPPEN if a comet struck the Earth? It's an unsettling thought, made even more so by abundant geological evidence that it has, in fact, happened before—and not just once or twice, but many times throughout our planet's history. Indeed, according to a study recently published in the *Proceedings of the National Academy of Sciences,* the last such impact may have occurred just 12,900 years ago—practically yesterday, in geologic terms. If that time frame sounds auspicious, it should: It coincides with the demise of the last great Pleistocene megafauna and the end of the Clovis culture—the first widespread, archaeologically distinct human occupation in North America.

Parts I and II of this series outlined the basics of the Clovis Comet theory and discussed more than a dozen converging lines of evidence that led to its development by geophysicist Allen West, physicist Richard Firestone, archaeologist Al Goodyear, and a multidisciplinary team of 24 other scientists. In this installment, we'll take a closer look at the implications of the purported comet strike.

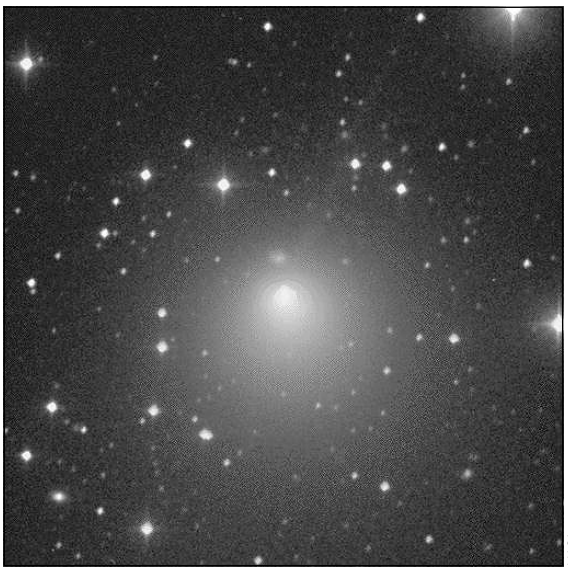
A long, cold winter

In the early 1980s, astrophysicist Carl Sagan and several of his colleagues published a study in which they argued that even a limited nuclear war would leave a pall of soot and dust in the atmosphere that would linger for months, possibly years. Their climatic models predicted a long, dark "nuclear winter," in which average global temperatures might drop as much as 20–30 degrees—enough to kill staple food crops, resulting in widespread famine even after the worst effects had passed. Although the concept of a nuclear winter received plenty of criticism in its early years, later real-world experience showed that it was valid. When Saddam Hussein lit off 526 Kuwaiti oil wells during Gulf War I, tons of particulate matter released into the atmosphere rendered the region pitch-black at noon and dropped local temperatures as much as 10 degrees.

The nuclear-winter theory was later expanded and refined by scientists working in a variety of fields. Volcanologists, for example, have collected copious data demonstrating that cataclysmic volcanic eruptions, like the 1883 Krakatoa explosion, do indeed affect the climate; and now there's evidence that a significant extraterrestrial (ET) impact, by injecting massive amounts of vaporized rock and soil into the atmosphere, would produce exactly the same effect. A firestorm would follow, caused by the initial thermal pulse and the scattering of burning debris from the crater. The fires would pump even more particulates into the air in the form of smoke and soot, which winds of the upper atmosphere would spread far and wide. If the impact were large enough (like the one implicated in the extinction of the dinosaurs), the atmospheric contamination could result in years of icy darkness. Even after the sun came out again, the ecological impact could last for decades or centuries—or perhaps longer.

Over in a flash

According to the Clovis Comet theory, the highly fragmented object that hit the Earth almost 13,000 years ago was relatively small—at most, 3–4 kilometers across before it broke up far out in space. Unfortunately, it happened to impact the kilometers-thick Laurentide ice sheet of eastern Canada, kicking off a thousand-year cooling event called the Younger Dryas Interval. Aside from its horrific short-term effects, "the conditions of the impact itself triggered long-term changes," points out Dr. West. "The Younger Dryas is an example of the latter. Fresh water from the ice sheet melted into the North Atlantic, and the pulse of water basically shut down ocean circulation. This caused the cooling to go on for a thousand years."

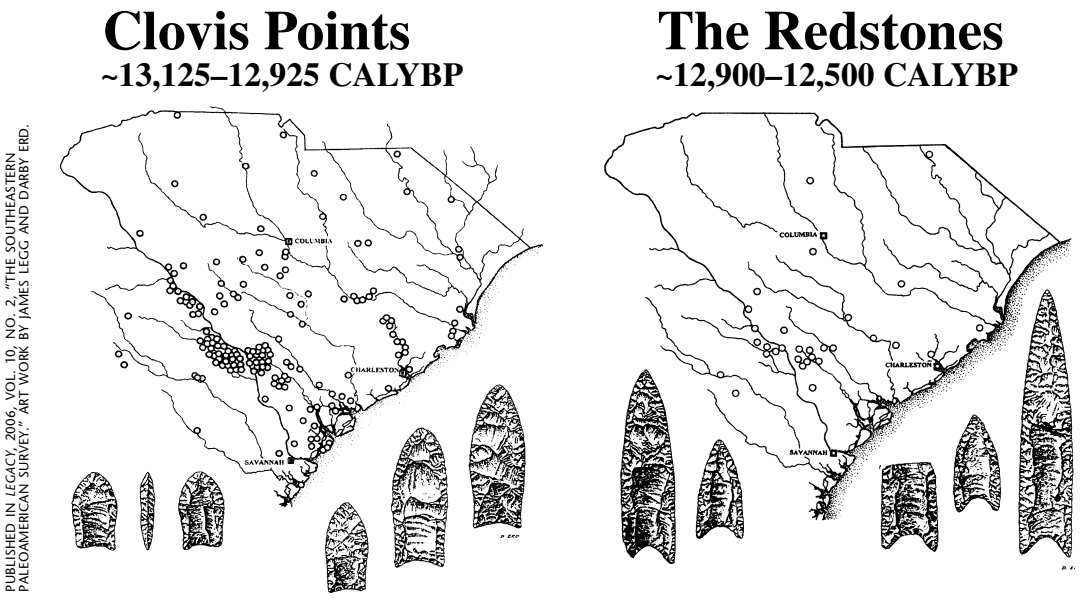


NASA

Comet Encke: A surviving fragment of the Clovis Comet?

The short-term effects devastated anything living in the region. Regardless of whether the comet impacted Earth or exploded before hitting the ground, shock waves radiated

through the atmosphere in all directions, generating high winds that shredded vegetation, literally blew away people and animals within hundreds of miles of the impact, and possibly scooped out the series of elliptical depressions in the American Southeast known as the Carolina Bays (their axes all point toward eastern Canada). Soon thereafter, the atmosphere rushing out of the impact area came roaring back in a second-



PUBLISHED IN *LEGACY*, 2006, VOL. 10, NO. 2, "THE SOUTHEASTERN PALEOAMERICAN SURVEY." ART WORK BY JAMES LEGG AND DARBY ERD.

Clovis and post-Clovis Redstone point distributions, showing reduced number of post-Clovis points in South Carolina.

ary shock wave with similar effects. The fireball produced by the impact or air burst emitted a thermal pulse that flash-fried the environment for hundreds of miles around. "The combination of heat and shock wave was enough to set fires all over the place," West says. "At every place we have looked there is a peak of charcoal at the beginning of the Younger Dryas era." Charcoal peaks have been found in terminal Clovis sediments throughout North America, and even as far away as Belgium.

A grim fate

Many Clovis individuals and bands doubtless survived the comet impact, but apparently their culture as a whole did not, largely because the ecology collapsed around them. According to West, most of the megafauna probably went extinct within a matter of weeks. "There were grass and tree fires on a huge scale," he explains. "Imagine what would happen if you had millions of animals without grass and leaves to eat. The most significant kill mechanism was probably starvation." Add to that over-predation on the last surviving large herbivores (by humans and other hunters), disease, and the sudden climate change, and the surviving megafaunal populations eventually crashed, leaving species like elk, bison, caribou, and deer as the largest targets for hunters. Some evidence shows that even surviving large-animal populations suffered sharp declines. Even if, as some researchers argue, the Clovis people weren't fanatically devoted big-game hunters, they nevertheless faced a tragic shortage of food.

For humans who survived the canopy of fire, the immediate effects were over in less than a day. But because of enormous volumes of supersaturated soot, steam, and dust kicked up into the atmosphere by an ET impact of this scale, it remained cloudy and dark for weeks or months afterward—and it likely got very cold. Many survivors of the impact doubtless succumbed soon to the brutal environmental conditions. "They would have been facing day-to-day life in what was essentially a nuclear holocaust environment," says West. "The water was tainted, most animals and plants were killed, and the comet introduced relatively high levels of arsenic, radioactive thorium, and other poisons into the environment."

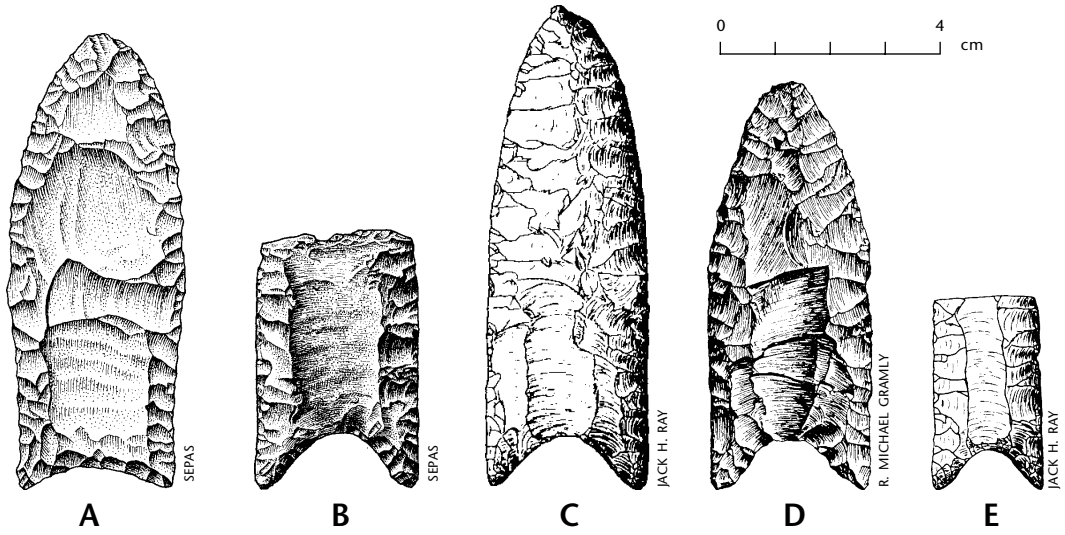
Given this grim scenario, it's reasonable to assume that the Clovis culture was severely affected by the event. Humanity may even have been rendered locally extinct in some parts of North America. Although it appears that Clovis was immediately succeeded by daughter cultures like Folsom and Plainview in some Western regions, there's evidence that even these cultures were severely depopulated compared with Clovis. In some parts of the continent, several hundred years may have passed before the human population rebounded to archaeologically significant levels. This appears to be the case for the American Southeast, where archaeologist Albert Goodyear has found evidence that the human population was spread much thinner after the beginning of the Younger Dryas than it had been before.

A clear demographic break

Several years ago, Dr. Goodyear—who is probably best known for his work at the Topper Paleoamerican site in South Carolina—was working to clarify the place of Redstone fluted projectile points within the South Carolina Paleoindian Point Database. "I was reclassifying certain fluted points as Redstone that had previously been misclassified as Clovis," he recalls. Redstone is the point type thought to come immediately after Clovis in the mid-South region. Although Redstones closely resemble Clovis points, several technological features distinguish them from their immediate ancestors. Redstone bases are much more distinctly concave, the points are less excurvate (resulting in a more triangular shape), and the tips tend to be sharper. Furthermore, the fluting technique of Redstones is fundamentally different from that used to make Clovis points. Small "guide flutes" found parallel to the main flute in most Redstones suggest these points were fluted using some kind of instrument-assisted method, rather than by means of the direct-percussion method favored by Clovis knappers. Thus, while Redstones are morphologically similar

to Clovis points in many ways, it's clear they were made using a different lithic-reduction strategy. This suggests, in turn, that they were created by another culture—probably a daughter culture of Clovis, but distinctly different.

After completing his reassessment, Goodyear says, "I found that I had from four to five times more Clovis points than Redstones. This seemed odd, as no other Paleo point is known to occur with any frequency in the Carolinas after Clovis and before Dalton." Points of the Dalton culture, which manifests itself throughout the American Southeast and has been firmly dated to 10,500–10,000 RCYBP, are up to 20 times more common than Redstones in the Carolinas. "I examined the North Carolina and Virginia data," he says, "and found essentially the same thing: more Clovis points, and much fewer deeply concave-based Redstone fluted points."



A, Clovis point from South Carolina. Post-Clovis points: B, Redstone from North Carolina; C, Gainey from Missouri[1]; D, Vail from Maine; E, Sedgwick from Missouri[2]. According to Neal Lopinot, "Gainey and Redstone are probably one in the same, at least technologically, although they have been named differently in the midcontinent and Southeast, respectively."

Goodyear reached the conclusion that the human population of the entire region abruptly crashed at the end of the Clovis era, possibly as the result of a catastrophic event that killed or forced out almost everyone—though he is careful to point out that this is by no means a certainty. For one thing, the age of the culture that made the Redstone points hasn't yet been solidly determined by radiometric dating. Based on significant technological differences, Goodyear considers the Redstone manufacturing style to be "post-Clovis" and infers that Redstone points date from after 10,900 RCYBP. "Although first named in the Southeast, they haven't been excavated or dated there," he notes. "However, technologically a Redstone is essentially a Gainey-Vail-Debert-type point. Those sites yield almost pure instrument-assisted fluted assemblages. In the case of Debert, it dates to 10,590 RCYBP, and in the case of Vail, to 10,518 RCYBP. To put it another way, a Gainey is a Yankee Redstone, or a Redstone is a Southern Gainey. They're virtually indistinguishable."

If the Gainey-Vail-Debert continuum of points and Redstone points are in fact synchronous types—perhaps even the same widespread type—then they date from a period commencing about 300 years after Clovis, suggesting that human populations took a very long time indeed to rebound after the Clovis Comet event. Whatever the case, "the dramatic drop in numbers of Redstones (and Gaineys) after Clovis is an intriguing pattern that can be observed from Wisconsin to Florida," Goodyear observes. "As such, it's at least suggestive of a population decline over the eastern U.S. I can't say it's direct archaeological evidence of a catastrophic impact on human populations, but it *is* a pattern that needs to be explained."

Even if (as the evidence strongly suggests) there really was a post-Clovis population crash, that doesn't necessarily mean it was caused by a cometary impact. An alternative explanation might be that post-Clovis peoples in the East migrated to the Plains, possibly because of climatic considerations, and participated in what we know as the Folsom culture. "It would be important, however, to see if there are occupational hiatuses between Clovis and Folsom sites, which might indicate some demographic dislocation," Goodyear says. "And, most importantly, we need to see if there's a drop in the number of Folsom sites that date in the two or three centuries following the end of Clovis. If this is the case, it suggests that some kind of decline occurred from the Rockies to the Atlantic Ocean."

In the next issue we'll conclude the Clovis Comet series with a look at mixed responses to the theory in "The Clovis Comet, Part IV: Reactions to the Theory."

–Floyd Largent

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[1] Ray, Jack H. 2000 Nonexcavated Collections from Big Eddy and Nearby Sites. In *The 1999 Excavations at the Big Eddy Site (23CE426),* edited by Neal H. Lopinot, Jack H. Ray, and Michael D. Conner, pp. 37–68. Special Publication No. 3. Center for Archaeological Research, Southwest Missouri State University, Springfield. Figure 4.3.

[2] ———. Figure 4.2.