MAMMOTH TRUMPET

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Center for the Study of the First Americans
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The Oldest Fishhooks in the Americas

This hook, carved from a mussel shell, was found on Cedros Island, off the coast of Baja California. Radiocarbon dating of associated marine shell sets its age at 11,735–9520 CALYBP. Excavations on the island by Matthew Des Lauriers, Director of the Anthropological Research Institute at California State Northridge, and archaeologist Loren Davis of Oregon State University reveal that fishing technology was present here before 12,500 yr B.P. That's persuasive evidence for the coastal-entry model for the peopling of the Americas.

See our story on **page 7.**

Photo by Des Lauriers

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The Native American Family Tree Branched Early

New Insights from Genomes of 91 Ancient Native Americans

ANCIENT HUMAN GENOMES are increasingly providing answers to many of the most important questions in First Americans archaeology. A new study of an impressive 91 ancient genomes from southern California and southwestern Ontario not only refines our understanding of the complicated family history of the First Americans, but also offers insights into the migration routes followed by these original pioneers. In addition, the study highlights the importance of working in partnership with the descendant communities for whom the answers to these questions are of more than academic interest.

A family tree with two branches

Previous studies of both ancient and modern genomes revealed a split in the ancient American Indian family tree that occurred sometime prior to 13,000 years ago and resulted in genetically distinctive northern and southern branches (**MT 32-1,** "Genetic clues answer fundamental questions about the peopling of the Americas"). The two groups are thought to have diverged somewhere in North America.

The northern branch includes Kennewick Man (**MT 31-3,** "Kennewick Man's dna reveals his ancestry"), the Ancient One as he is referred to by many American Indians, who is ancestral to many of the indigenous peoples of Canada, including Algonquian, Na-Dené, Salishan, and Tsimshian speakers. The southern branch includes the Anzick child, who belonged to a Clovis-related population (**MT 29-2,** "Clovis child answers fundamental questions about the First Americans"), as well as all indigenous Mexicans, Central Americans, and South Americans.

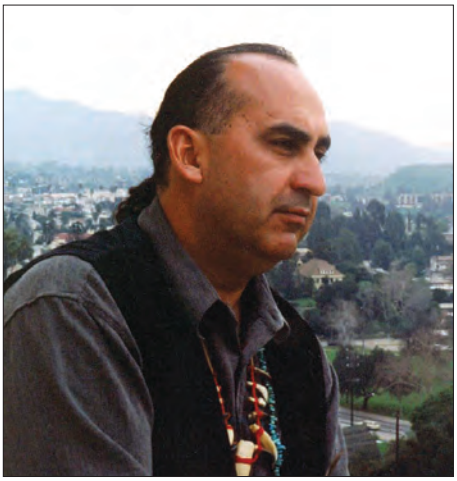
What 91 ancient genomes tell us about the First Americans

In the June 2018 issue of *Science,* Christiana Scheib, Toomas Kivisild, Ripan Malhi, and 37 coauthors representing 6 countries and 17 university-

INSIDE

affiliated labs or departments, 3 private firms or research groups, 2 museums, at least 6 American Indian tribes and one Canadian First Nation, report the results of their investigation of the ancestral relationships between the northern and southern branch populations.

The team sequenced 91 ancient whole genomes "mainly from two geographic areas, the California Channel Islands in the west, and Southwestern Ontario in the east, near modern Algonquian-speaking populations." These regions were selected because they both "show evidence of occupation from at least 13,000 years ago" and because they are located south of the known distribution of Paleo- and Neo-Eskimo groups that arrived in North America after about



JohnTommy Rosas.

4,500 years ago. This sample would, the team expected, give them their best shot at recovering the genetic legacies of the earliest peoples to arrive in the Americas and minimize any contributions from later arrivals that might make it harder to sort out what was original and what was a later addition to the gene pool.

Scheib, Kivisild, Malhi and their colleagues radiocarbon dated 27 of the individuals "to between ~4800 and ~200 [calibrated radiocarbon] years ago." This firmly provided much-needed context for the genetic variation they would be seeing.

The team determined the mitochondrial haplotypes of all the samples, which revealed their lineage following the female line of descent, since mtDNA is passed almost entirely from mother to child. In addition, they determined the Y-chromosome haplotypes of 34 of the male individuals, which revealed their lineage following the male line of descent since, of course, Y chromosomes are passed only from fathers to sons.

The authors appear not to have used these particular results in the analyses reported in their *Science* paper, though it was included in a previous version of the manuscript. In a commentary on the paper published in the same issue of *Science,* Allessandro Achilli, Anna Olivieri, Ornella Semino, and Antonio Torroni, all with the University of Pavia in Italy, highlighted the importance of these data. As an example, they note that the Ancient Southwestern Ontario groups include individuals with mitochondrial haplogroups X2a and C4c and that these also occur at high frequency in Algonquian-speaking populations.

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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

Therefore, they could be "distinctive mitochondrial markers" that would distinguish these groups from other potential populations. Hopefully, these data and the insights they can offer will be incorporated into future papers.

Another strike against Solutrean migration

In a sophisticated statistical analysis that compared the 91 whole ancient Native American genomes with populations worldwide, the team confirmed that all the "ancient Native American individuals clustered with modern Native Americans." Furthermore, Scheib, Kivisild, Malhi and their team found "no significant evidence of gene flow . . . from any non-American population" into the ancient southwestern Ontario individuals. Although these findings aren't surprising, they are important to take note of since they not only establish that the individuals they studied are definitively Native Americans, but also diminish the likelihood of any consequential ancient European migrations to the Americas, as proponents of the Solutrean theory claim (**MT 28-2,** "Do Clovis origins lie in Paleolithic Spain?"). Of the populations considered in this paper, the Ancient southwestern Ontario individuals, in particular, would have been most likely to encounter and interbreed with any hypothetical Solutrean immigrants arriving in America via a crossing of the North Atlantic. The complete absence of such evidence further weakens an already largely discredited idea (**MT 28-3,** "Alternative views of the Solutrean theory").

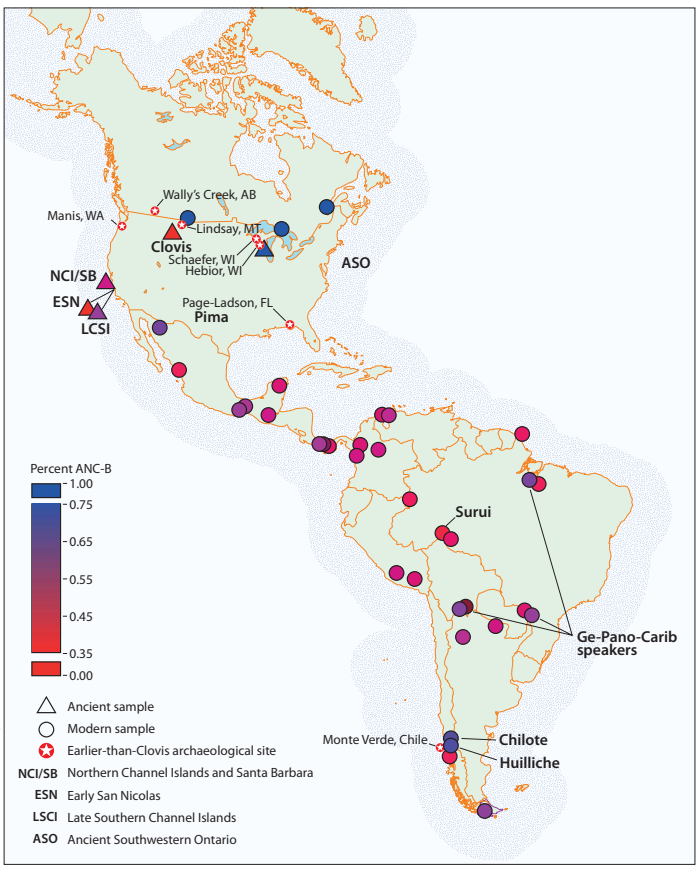
In a more narrowly focused analysis, Scheib, Kivisild, Malhi, and their colleagues didn't find a clear distinction in the Siberian groups that the Northern and Southern branch populations shared ancestry with. This led them to conclude that the split between the Northern and Southern populations occurred within the Americas and not in Beringia or in Siberia

BRIAN HOLGUIN

Coauthors Christiana Scheib (*left*) and John Johnson (*center*), curator of the Santa Barbara Museum of Natural History, and his museum colleague, Tacy Kennedy, visit Chumash petroglyphs in Southern California.

The ancient Southwestern Ontario groups clustered with modern Algonquian speakers and Kennewick Man, which wasn't necessarily a surprise. Remarkably, though, the ancient Californians clustered with the southern-branch populations and the Anzick child. Also unsurprisingly, the Upper Sun River children from Alaska (**MT 34-2,** "Beringian child's genome reveals the founding population of the First Americans ") and Shuká Káa from southeastern Alaska (**MT 33-2**, "Genetic insights into the First Americans") clustered between Central Siberians and the northern branch. The modern and ancient Na-Dene (Athabascans) clustered between northeastern Siberian groups and the Ancient Southwestern Ontario groups, which may reflect more recent additional ancestry from Northeastern Siberian populations on top of their underlying Native American ancestry.

Within the California Channel Islands group, the study found differences between early and late occupants of San Nicholas Island. Indeed, they represent two distinct genetic populations. The Early San Nicholas Island people appear to be "related to a population that expanded into South America." The later occupants of the island were more genetically diverse, which Scheib, Kivisild, Malhi and their team attribute to the fact that the larger group, partly because it was larger, had more genetic diversity than the earlier population. In addition, the lower diversity of the earlier group was due partly to its long period of isolation during which it had lost some of its original diversity.



FROM SCHEIB ET AL., *SCIENCE* 360

Proportion of ANC-B ancestry in Early American and modern Native American populations. The percentage ranges from 0% in Anzick-1 to 100% in ASO and modern Algonquian-speaking populations.

Modeling the population history of the Americas

Scheib, Kivisild, Malhi, and their team identified two "basal ancestries," which they named ANC-A and ANC-B, that roughly correspond to the northern and southern branches identified previously. The use of this terminology was to make it less specific to a certain language group or geographic area, because it turns out to be much more complicated than the simple north/south separation suggests. ANC-B is the northern branch and includes the Ancient Southwestern Ontario group as well as the modern Algonquians. ANC-A is the southern branch that includes the Clovis culture-related Anzick child. The rest of the populations studied exhibit a mixture of ANC-A and ANC-B

A Surprisingly Small Founding Population

GENETICS STUDIES consistently show that American Indian populations are the least genetically diverse in the world. Genetic diversity decreases with increasing distance from Africa—our ancestors' ultimate homeland. This is because each time a segment of a parent population leaves to migrate to a new region and becomes more or less isolated from the parent, that segment of the population necessarily suffers reduced genetic diversity because a subset of a population can't include all the genetic diversity that was present in the original, much larger source population. This classic example of genetic drift, a change in genetic diversity due to chance, is known as the Founder Effect. Consequently, when small groups of people left Africa and moved into Europe and Asia, they carried with them only a subset of Africa's genetic diversity. Likewise, when small groups of Eurasians left Asia to move into the Americas, they carried with them only a subset of Eurasia's genetic diversity.

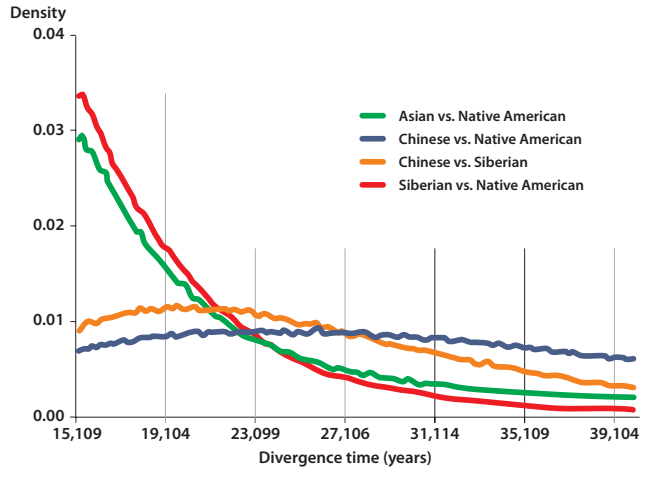
Genetic bottlenecks: blips in the colonizing record

Geneticist Nelson Fagundes and five Brazilian and one American colleagues, writing in the journal *Genetics and Molecular Biology*, point out that "some colonization events may amplify the [normal and expected] loss of genetic diversity if they are accompanied by a strong genetic bottleneck." Such a bottleneck would be a further and drastic reduction in the population due to various factors, such as an environmental catastrophe. Their paper is an attempt to answer the question, Was this the case for Native Americans?

To develop a more reliable and precise estimate, Fagundes and his team generated detailed DNA sequence data from 10 individuals from 10 different indigenous groups living in Central and South America, and 10 individuals from 10 different indigenous groups from Siberia. In addition, they added data from 15 individuals from China to get a broader sampling of the genetic diversity of Asia.

Importantly, ethical approval for the collection and use of the Native American samples used in this analysis was obtained through the Brazilian National Ethics Committee in accordance with all the ethical standards applicable at the time of the study, which included getting verbal consent from all the tribes and individuals involved. Verbal consent also was obtained for the samples from the Siberian populations.

Fagundes and his team studied nine segments of non-coding DNA (DNA that doesn't provide instructions for manufacturing proteins). This is important because it means differences in this segment of code didn't confer an evident advantage or disadvantage on individuals; thus changes over time in the frequency of various mutations in this code weren't subject to natural selection.



FROM FAGUNDES ET AL., 2019

Plot of the likelihood of the timing of divergence between various populations. Note that when Siberians/Asians and Native Americans are compared (red and green lines), the most likely time of divergence is at around 15,000 years ago. In contrast, the timing of divergence between Chinese and either Native Americans or Siberians (blue and orange lines) are much flatter curves, indicating that their shared ancestry likely goes back to at least 19,000 or even 25,000 years.

Previous estimates of the numbers of reproductively mature individuals in the founding population of the first Americans have ranged from unrealistically precise extremes of 42 to 5,400 individuals; the most recent estimates settle between about 150 and 2,000 individuals. The lower estimates, of course, suggest the First Americans experienced an extreme bottleneck at some point in their history.

Changes in the frequency of particular variants between populations were therefore more likely to reflect vagaries of population history than, for example, a mutation that helps individuals adapt to a changing environment.

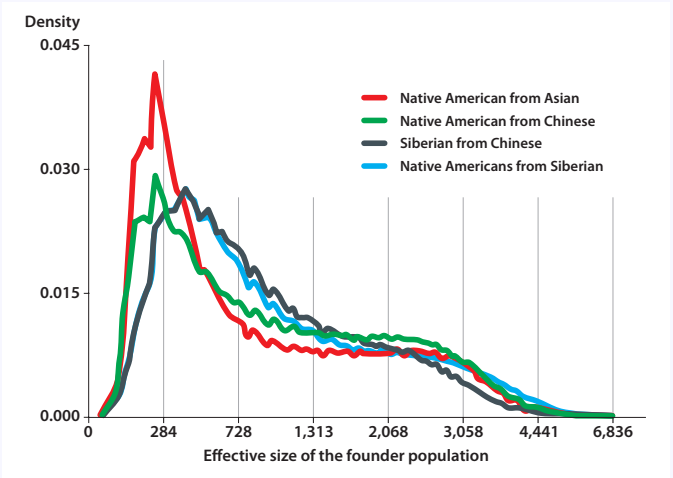
Bottlenecks followed population separations

Fagundes and his team used reasonable assumptions, including

in varying and occasionally unexpected proportions, which indicates that a few thousand years after separating, members of the two lineages could have come together again at various times and places. The varying proportions of ANC-A to ANC-B in the surveyed populations, however, carry important clues to the routes followed by these First Americans.

The Early San Nicholas Island population, Northern Channel Islands and Santa Barbara groups, and the Surui of Brazil all share similar proportions of ANC-A and ANC-B. The Mexican Pima have a substantially larger percentage of ANC-B ancestry. Modern indigenous Central American and South American groups, for example, have a high proportion of ANC-B ancestry.

placing a date of 15,000 years ago as the "lower limit for population split," and employed some high-powered statistical methods in analyzing their data. Their results suggest that Native Americans and Siberians separated from Asians 25,000 to 19,000 years ago, which is consistent with estimates obtained by other studies (**MT 32-2,**



FROM FAGUNDES ET AL., 2019

Plot of the likelihood of the size of the founding population for various migrations. For Native Americans, the most likely size of the founding population peaks sharply at around 229 individuals when compared with Asians (red line), 223 when compared with Chinese (green line), and 300 when compared with Siberians (blue line). All the peaks cluster at the very small population size end of the graph, which is an indication of population bottlenecks. The most severe bottlenecks involve Asian and Chinese populations migrating to the Americas.

"A high-resolution timeline for peopling of the Americas"). Native Americans appear to have separated from Siberians around 15,000 years ago, though it's possible that subsequent migrations from Siberia may be masking the date of the initial separation of the two populations.

Fagundes and his colleagues estimate the population size of the First Americans at around 300 individuals. They give a range of 100 to 3,700, but they note that the true number is probably between 100 and 600. This study indicates that "the Native American founder population underwent a strong bottleneck, though less extreme than previously suggested." This is the second genetic bottleneck suggested by their data. Another suspected genetic bottleneck occurred earlier, when Siberian populations separated from their Asian ancestors.

Fagundes and colleagues admit that they determined population size based on a relatively small number of individuals from a small number of groups. They argue that the sample size, although much too small to adequately characterize the genetic diversity of these populations, was nevertheless sufficient to produce a reliable "broad characterization" of the size of the original founder population of First Americans.

Two continents colonized by a handful of founders

University of Kansas anthropologist Michael Crawford, one of the contributors to the study, said the implications of such a small founding population for the First Americans are profound: "Going from a few hundred founders to around 40 million inhabitants of the Americas, who eventually live under different environmental conditions to which they adapt, is pretty exciting stuff." He added that the genetic data contribute to a fuller understanding of how the peopling of the Americas unfolded: "It wasn't a matter of a group that announced, 'Let's go follow this one.' It was a matter of population fission among hunters and gatherers. There would be about 50 people, and when the population's fertility gets higher and higher, the population splits into the next so-called 'county' and then the next. After 15,000 years, you can put them all the way down in Argentina."

Fagundes and his coauthors are optimistic that future studies, using a much larger sample size, could address other questions, such as estimating the size of the group that first moved into a particular region of North and South America. It seems clear that it's only a matter of time before genetics combined with archaeology will give us an even more complete understanding of the original discovery and settlement of the Americas.

–Brad Lepper

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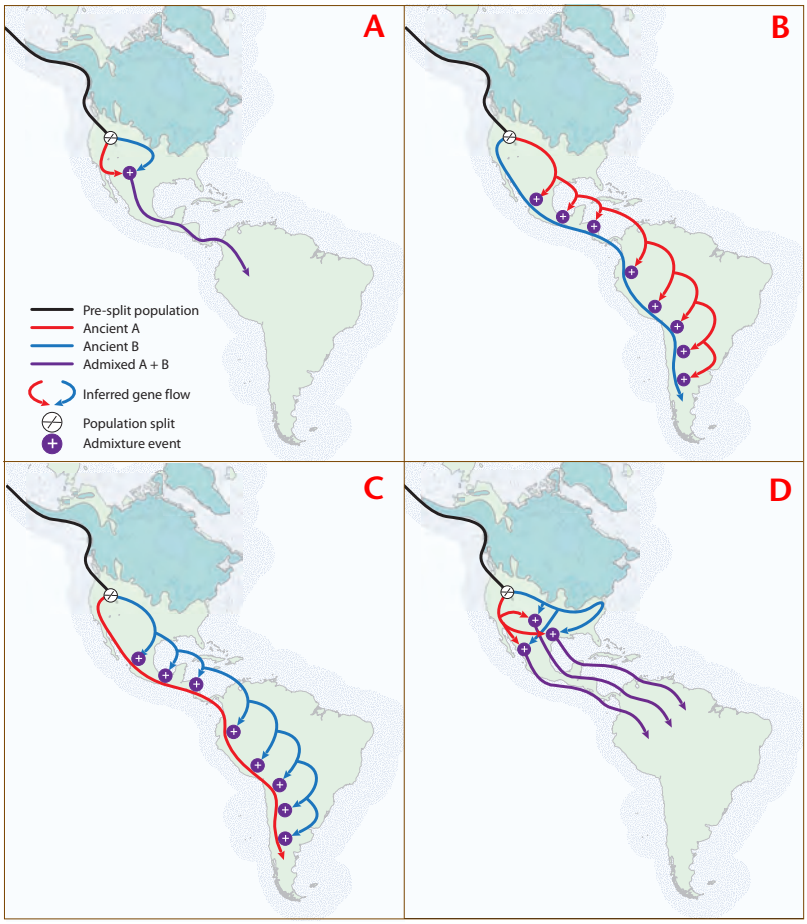
Suggested Readings

Fagundes, N. J. R., A. Tagliani-Ribeiro, R. Rubicz, L. Tarskaia, M. H. Crawford, F. M. Salzano, and S. L. Bonatto 2018 How strong was the bottleneck associated to the peopling of the Americas? New insights from multilocus sequence data. *Genetics and Molecular Biology* 41:206–14. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1415-47572018000200206&lng=en&tlng=en

University of Kansas 2018 How strong was the bottleneck associated to the peopling of the Americas? New insights from multilocus sequence data. Phys.org website: https://phys.org/news/2018-05-dna-sequences-people-native-american.html

In contrast, the South Americans, the "Amazonian Equatorial Tucanoan-speaking groups (including Surui)" have the lowest proportion of ANC-B genes. The highest level of ANC-B ancestry is found among the Andeans. Of special interest is the fact that the Chilote and Huilliche peoples, who have among the highest levels of ANC-B ancestry, also live in close proximity to the pre-Clovis Monte Verde site, which is dated to 18,500–14,500 CALYBP. Scheib, Kivisild, Malhi, and their coauthors suggest that these data are consistent with a probable rapid coastal dispersal of the ANC-A ancestral population, with multiple admixture events with ANC-B related groups taking place either along the way or at a later date.

Scheib, Kivisild, Malhi, and their coauthors argue that their data refute the idea of a genetically homogenous "first wave" population from which the Ancient Southwestern Ontario group diverged sometime after the peopling of South America. They conclude that the ANC-A and ANC-B split likely occurred quite early in North America south of the Laurentide and Cordilleran ice sheets, since the American populations they studied "vary in ANC-A and ANC-B proportions but do not differ significantly in their affinity to non-American populations." If the split had occurred in Beringia, presumably we would find evidence for more or less ongoing gene flow with Siberia.



ALL FROM SCHEIB ET AL., *SCIENCE* 360

Models consistent with the results of the study of Scheib, Kivisild, Malhi, and their team that show possible events and paths by which ANC-A and ANC-B populations dispersed in the Americas.

A One admixture event in North America.

B An ANC-B population first reaches South America, followed by an ANC-A population with multiple admixture events.

C The same model as B, but with ANC-A and ANC-B populations reversed.

D The result of multiple admixture events and subsequent dispersals.

Scheib, Kivisild, Malhi, and their team describe four possible scenarios that could explain the varying proportions of ANC-A and ANC-B found in the Central and South American populations. First, the two lineages may have come together somewhere in North America and descendants of these various admixture events moved southward following different routes. Second, ANC-B related groups may have been the first to expand into South America, followed later by ANC-A groups, and this is where they came together. Third, the ANC-A groups dispersed into South America first and the ANC-B groups followed. And fourth, the lineages came together many times in different parts of North America and dispersed into South America in multiple waves following different routes.

Scheib, Kivisild, Malhi, and their coauthors conclude that testing these alternative models will require additional studies of ancient DNA, ideally from very early human remains from across the Americas, particularly in under-sampled regions such as southeastern North America and southeastern Brazil. To accomplish this ambitious research agenda will require working closely with descendent communities in these areas. This is something Scheib, Kivisild, Malhi, and their colleagues are already doing. Coauthors of their paper include Rosemary Cambra with the Muwekma Ohlone Tribe of the San Francisco Bay Area, Louis Lesage with Huron-Wendat Nation of Canada, and JohnTommy Rosas with the Tongva Nation of California.

Scheib told the *New York Times* that she traveled to California to meet with tribal representatives and explain why she wanted to study the bones of people they regarded as their ancestors: "Some of them were surprised. They said, 'You're the first researcher to talk to us and ask our opinion.' " Not only is working with descendent communities an ethical necessity, it also rewards these indigenous communities with information about their ancestors otherwise unavailable to them. That eight members of these communities are coauthors of this paper is a testament to their interest in obtaining this information and willingness to actively engage in the research to obtain it.

Moving beyond simplistic models of the peopling of the Americas

All this complexity in the story of the First Americans has been revealed only because the authors were able to

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Hooked on Cedros Island

An Oasis for Prehistoric Fishermen

A kelp bass caught on Cedros Island by a shell fishhook experimentally replicated by Dustin McKenzie.

ALL PHOTOS: MATTHEW DES LAURIERS

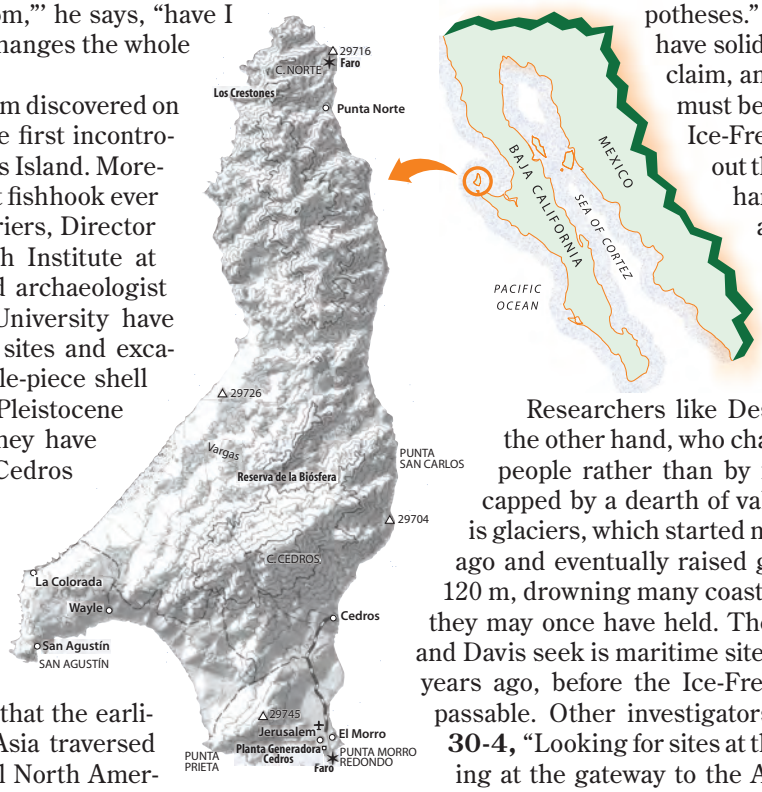
MATTHEW DES LAURIERS remembers his *Eureka!* moment vividly. A windstorm had savaged the team members' tents all night, depriving them of sleep, followed by gentle rain, which settled the dust at their site on Cedros Island, a mountainous outcropping that lies 15 km off the Pacific coast of Baja California. Bleary-eyed, they set to work excavating. When the fishhook was found, Des Lauriers recalls having to rub his eyes to be sure he was actually seeing what he held in his hand. "Seldom,"' he says, "have I found something that instantly changes the whole story in a mere moment!"

What Des Lauriers and his team discovered on this January day in 2009 was the first incontrovertible fishhook found on Cedros Island. Moreover, it turned out to be the oldest fishhook ever found in the Americas. Des Lauriers, Director of the Anthropological Research Institute at California State Northridge, and archaeologist Loren Davis of Oregon State University have since discovered 14 other early sites and excavated 2. They have found 4 single-piece shell fishhooks dating to the terminal Pleistocene 11,300–10,700 years ago. And they have pushed back the settlement of Cedros Island to 13,000 years ago.

Taking the coastal view

The Cedros Island sites add to a growing list of maritime sites that argue for the model of a coastal entry into the Americas. Gospel once decreed that the earliest arrivals from northeastern Asia traversed Beringia and entered continental North America through the Ice-Free Corridor, a gap in the Ice Age glaciers that spanned Canada. An alternative hypothesis, however, and one that has gained traction with an impressive slice of the scientific community, proposes that explorers voyaged by boat from Beringia sometime before 15,000 years ago, hopscotching along refugia down the Pacific Coast and reaching Chile no later than 14,500 years ago.

Davis allows that "it's fair to keep both ideas in play as hypotheses." Proponents of both camps have solid evidence to support their claim, and both face obstacles that must be overcome. Regarding the Ice-Free Corridor, Davis points out that "it's getting harder and harder to use something like an interior route to explain the antiquity of sites south of the ice. There's not really a window of opportunity open early enough."



Researchers like Des Lauriers and Davis, on the other hand, who champion colonizing by boat people rather than by foot travelers, are handicapped by a dearth of validating sites. The culprit is glaciers, which started melting about 16,500 years ago and eventually raised global sea levels by about 120 m, drowning many coastlines and any settlements they may once have held. The holy grail Des Lauriers and Davis seek is maritime sites dating to 14,000–16,000 years ago, before the Ice-Free Corridor became fully passable. Other investigators of maritime sites (**MT 30-4,** "Looking for sites at the water's edge) tare looking at the gateway to the Americas, along stretches

of the Alaskan and Canadian coasts that were spared post–Ice Age flooding. They're also looking underwater. In fact, some archaeologists view submerged sites as the last frontier for American archaeology.

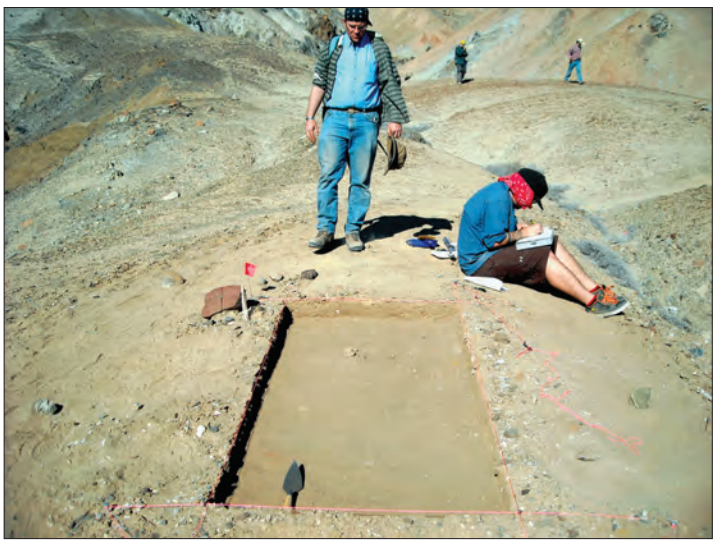
To make a convincing case for the coastal route, researchers must find earlier-than-Clovis sites at the doorway to the Americas itself, on the shores of southeastern Alaska or British Columbia.

On Cedros Island, Des Lauriers and Davis are filling in the picture of how early coastal people lived and what tools they made, details that link them to maritime cultures around the Pacific Rim. What makes Cedros Island especially attractive to Des Lauriers is that it boasts a per-acre density of early sites that's one of the highest of any area along the coast, and "one of the reasons for that is the specific geomorphological features."

Fishhook found at Punta Prieta, PAIC-32c. Attaching a line to a fishhook with no eyelet wasn't a problem for Cedros Island fishermen. Des Lauriers assures us that "there is no natural fiber with better 'gripping' properties for lashing than agave fiber. " For extra strength the line may have been cemented in place with a binding agent, "conifer resin mixed with wood ash, herbivore scat or other macerated fibers, and either burnt mollusk or eggshell."

A jewel in arid wilderness

Probably what first attracted colonizers to Isla Cedros was its unusually profuse sources of freshwater. "The persistence of numerous freshwater springs and seeps up to the present day is something of a hydrological puzzle," Des Lauriers and Davis write, "as most of the islands of the Baja California Peninsula lack abundant permanent water sources." Abundant freshwater drew the First Americans, and Spanish colonizers as well. Today the island supports a population of about 2,000, who draw their water from a spring complex and pumps situated on the high peak.



Excavations at Richard's Ridge (PAIC-49).

Cedros Island before 14,500 CALYBP may have been connected to the Baja California peninsula by a land bridge, possibly traversable only at low tide. By about 8000 CALYBP rising sea levels had completely enveloped the rocky promontory and its low-lying plains. The sites Des Lauriers and Davis's team excavated are well-stratified, gently sloping sequences of sand and silt from slope wash and windblown sediment, in which are embedded scattered marine shells, lithic artifacts, and concentrations of charcoal. These alluvial fans preserve the record of successive occupations over millennia, all overlain by sedimentary blankets.

A complete fishhook and a fragment of the shank of a similar fishhook, both made of mussel shell, were found in one excavation. In another excavation, a midden of shell and bone refuse yielded a complete fishhook made of red abalone shell. The shank was directly radiocarbon dated; the ages of the other items were determined by radiocarbon dating associated shell fragments and charcoal. The results are exhilarating: a calibrated date of 11,165–9185 CALYBP for the shank. The ages of the indirectly dated items are less precise but equally breathtaking, ranging from about 12,600 to 10,400 CALYBP. Even more tantalizing are the conclusions drawn by the team: "The lowest occupational layers at Richard's Ridge (PAIC-49) [one of the excavations] date to at least 12,000 cal B.P. (Des Lauriers 2010) and contain similar icthyofaunal species profiles to those layers that contained shell fishhooks, raising the possibility that the technology was present even earlier than the particular artifacts recovered thus far suggest." Even more groundbreaking discoveries at Cedros Island and other marine sites may lie ahead.

Thumbing a ride on the Kelp Highway

University of Oregon anthropologist Jon Erlandson proposes an ecological correlate to the Coastal Migration model—the Kelp Highway hypothesis—that credits kelp forests and other North Pacific coastal ecosystems with contributing to the peopling of the Americas after the LGM. He observes that extensive, highly productive kelp forests from Japan to Baja California supported similar marine organisms: sea otters and other marine mammals, abalones, urchins, and other shellfish, seabirds, seaweeds, and more. As the Earth warmed 17,000 years ago and the Cordilleran ice retreated from the coastlines of northwestern North America, seafaring peoples traversed the Pacific Rim fairly quickly, following a coastal route at sea level without major obstructions, while

enjoying a diverse array of terrestrial and marine resources.

Identifying early coastal sites is challenging, given the effects of post-glacial sea-level rise and landscape changes along North Pacific coastlines. Genetic hints and the discovery of late-Pleistocene technological assemblages, however, may support the Coastal Migration model and companion Kelp Highway hypothesis. Adherents point, for example, to stemmed projectile points found around the Pacific Rim from Japan and Northeast Asia, and similar points found in the Pacific Northwest, California's Channel Islands, and in South America. Paleocoastal archaeologists like Des Lauriers and Davis are actively engaged in studying the possible maritime origins of the First Americans.

Des Lauriers scaling El Coloradito on the west coast of Cedros Island.

The paleoenvironment as a classroom

Davis notes the daunting challenge confronting migrants traveling overland. "One problem you'd run into is that the kinds of plants that grow in British Columbia aren't the same ones that grow in Baja California, so you'd have to learn that landscape. There's a steep learning curve."

Fortunately for boat people traveling along the Pacific coast, marine ecosystems have a lower range of variation than terrestrial landscapes, which would favor travel by boat rather than overland. The consistent and sustained exploitation of marine resources speaks of a long familiarity with the ecozone. "The discoveries at Cedros Island show that people have this complex knowledge of how to use the ocean, how to pull big fishes from the depths of the sea. That's pretty incredible," Davis tells us. "The vertebrae of these fishes are human size! That blew my mind at first. These black sea bass are still around in higher numbers off of Baja California than in Alta California." Many people believe this sort of knowledge had to develop thousands of years after people were in the Americas, but Davis and Des Lauriers are demonstrating that First Americans already possessed this detailed understanding of how to use the environment to their advantage.

Field crew at Cerritos Pedregoso: (*left–right*) Sean Brown, Mikael Fauvelle, Aaron Elzinga, Oswaldo Cuadra, and Des Lauriers.

Des Lauriers believes that late-Pleistocene human populations that migrated along the Pacific coast of North America already possessed knowledge of how to exploit aquatic resources and simply adjusted existing strategies and technologies to adapt to an unfamiliar environment and raw materials. Don't try to explore the origins of maritime adaptation in the Americas, he warns. "It'd be like trying to study the origins of the English language in Australia. You can't find it because that's not where it happened."

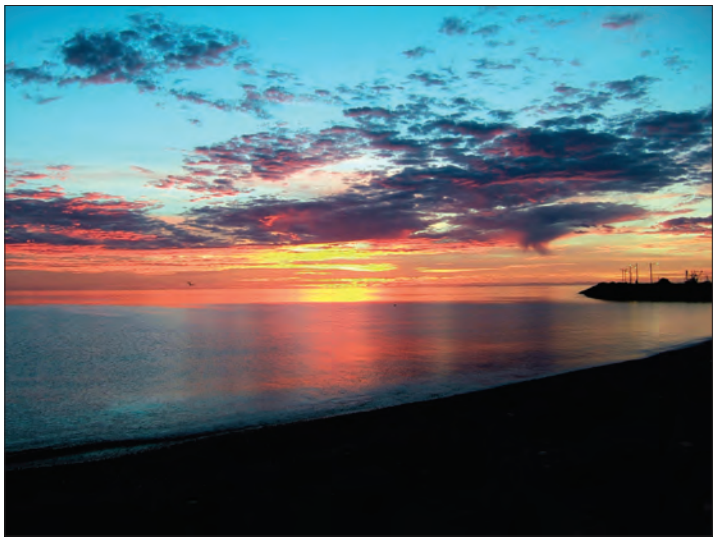
Addressing the sophisticated fishing technologies they found on Cedros Island, Des Lauriers argues that they may not have been developed on the island. Rather, colonizers probably brought them with them when they entered the New World. He urges us to look at comparable technology in the western Pacific in places like Okinawa. Inhabitants of the Japanese archipelago have always been on the cutting edge of technology, even tens of thousands of years ago. A telling fact: Researchers on the island of Okinawa unearthed a pair of 23,000-year-old fishhooks from Sakitari Cave, the oldest ever discovered, made from snail shell and found in a midden with the remains of crabs and freshwater snails.

That early coastal peoples on Okinawa used shell hooks as early as 23,000 years ago bolsters the argument that Pleistocene peoples of East Asia who migrated to North America possessed knowledge of marine fishes and were skilled practitioners of deepwater fishing as well. "These people were damn good at fishing in a marine environment," Des Lauriers says, "so it's clear this was not their first rodeo. If they had fished their way from Okinawa, it would have given them time to learn." At the risk of outpacing their data, Des Lauriers boldly ventures that the early technology found along the western Pacific Rim is so strikingly similar to that found later along the Pacific coast of North America that it begs us to draw an ancestral inference. Although he readily admits that a parent-child relationship isn't conclusive, nonetheless he believes "it's certainly a plausible data-driven hypothesis."

Exploiting a diverse economy

Late-Pleistocene artifacts and faunal remains suggest that people found diverse ways to earn a living from the sea. Des

Lauriers and Davis found evidence that the Cedros Islanders exploited shellfish, sea lions, elephant seals, seabirds, and fish from different regions of the ocean, including deepwater regions accessible only by boat. The discovery of shell fishhooks, agave fiber-processing technology for making cordage, and the remains of fishes native to offshore waters and deep reefs confirm that by the late Pleistocene the occupants of Cedros Island were experienced maritime foragers who used watercraft for deepwater fishing.



Sunrise on the east coast of Cedros Island.

"We used to think that people only used resources they could get at low tide, acquiring whatever they could grab, or only fishing at the edge, which doesn't suggest they're paddling down the coast of the Americas," says Davis, "but what the record at Cedros shows is that people really had a knowledge base of how to use a full range of resources. We went from a view of people hugging the edge of the ocean and not showing interest in going out very far, to the discovery that people were doing all kinds of things—going fishing, pulling out fishes as big as they are, going way out. We've changed our world view right away. There's evidence of a mastery of the ocean."

The slope of the sea floor is a significant factor in determining the technique fishermen use. Given a pier, fishermen can reach deeper waters. Davis explains that Cedros Island, especially when it was probably attached to the peninsula during the late Pleistocene, "can be conceptualized as a fishing pier of sorts, sticking out into deeper waters, offering early coastal peoples access to special kinds of marine environments." People could access different kinds of ecology without having to paddle too far off shore. And there are lots of freshwater springs, too, so we're finding a lot of 'inland attraction,' which brings people in." Davis says. When water comes out of the ground, it evaporates quickly, leaving behind mineral deposits that serve as white markers. "You can even find these markers of ancient freshwater sites on Google Earth," Davis says.

Des Lauriers studying an ancient trail on Cedros Island.

Where these early humans chose to settle hinged on one resource: available freshwater. Water is the lifeblood of everything. Davis created a topographic map of the bed of the Sea of Cortez west of Santa Espiritu Island to identify ancient occupations (**MT 24-3,** "Putting muscle into coastal-entry research") and plans to map the probable courses of ancient rivers across the now-drowned coastline of southern California and Oregon, seeking channels that are now filled with sediment and covered by ocean. By taking core samples of the ocean floor and comparing them with samples from river banks and estuaries, he hopes to understand the paleoenvironment and thereby identify the sites early Americans occupied.

Resilient and adaptable

Deepwater seas and inland freshwater springs yielded a diverse array of species to sustain human life. According to Des Lauriers, "There was at least a 95% reliance on marine birds, fishes, and sea turtles. If it was in or near the water, these people went after it. We have evidence of the full sweep of everything that was edible in the water.

Surprisingly, his team has found little evidence that rabbits and deer were exploited, even though an endemic subspecies of deer is found today on the island. "That those deer survived 13,000 years of human occupation is very unusual. Around the world, one of the markers of people showing up somewhere is that everything larger than a mouse gets eaten, and here on Cedros Island they weren't hunting deer."

Another surprise is that of all the sites Des Lauriers and Davis's investigated, occupants of the earliest site exercised the most diverse subsistence strategy. "They show up," Des Lauriers elaborates, "and they're exploiting everything. Later they narrow the range of resources that they use. . . . People who study hunter-gatherers expect them to focus on the big-ticket items or the easy-to-get stuff, and only when there isn't enough of that do they broaden out their economy, but we're finding the opposite at Cedros." Des Lauriers and Davis are finding an older site on the island with every field season, and they expect that new finds will confirm this pattern of events.

Putting botanical resources to work

The marine economy didn't claim exclusive rights to the knowledge of occupants of Cedros Island. They were also well versed in identifying and using terrestrial plant materials. A fishhook, after all, is only one part of a fish-gathering system; you need fishing lines and nets to go with it. "We shouldn't ignore the contribution of the plants, and especially plant fibers, to these economies," Des Lauriers advises. "Look around the world at any fishing village anywhere, and the major things you'll see strewn about are pieces of nets, rope, anchor, all the fiber technology that goes into fishing. It's still a plant-based industry."

Besides making fishhooks, Cedros Island inhabitants fashioned beach cobbles into crude scrapers, "disposable razors" useful for scraping and cutting agave fibers, which islanders used to make fishing lines and nets. Interestingly, researchers have found a similar toolkit at other early sites along the Pacific coast as far north as British Columbia and as far south as Chile, hinting that fishing technologies were widespread. Des Lauriers has found stemmed projectile points on Cedros Island, a style of spear point found from Japan to Peru and perhaps used by islanders to hunt sea mammals.

Des Lauriers

Colonizers to the core

Cedros Islanders appear to have explored their surroundings with a pioneer mentality, says Des Lauriers. "They weren't limiting their options in terms of food. Having that breadth and exploiting lots of things is what you'd expect when you're learning a new landscape. It's like when you move to a new town, you want to try out all the restaurants to see which one is good. It's the same way with people moving into a new landscape. 'Is this dish good? Is this shellfish good to eat?'"

The islanders' adaptability and resiliency is also reflected in their tools, which could be replicated from the worst possible toolstone. Des Lauriers deems such a strategy eminently sensible, since a technology that requires high-quality toolstone is impractical if you're moving into an area where only low-quality stone can be found. "If you can make your toolkit after whatever you can find, you don't have to worry. You know you're always going to be able to find quartz or basalt."

No new toolkit needed, just a few new tools

Just as the toolstone was local to the environment, so were the mussel and abalone shells used to make fishhooks. Davis allows that "it would be a good thing to map the distribution of those, but I think you can find versions of mussels and abalone shells on Okinawa. Wherever people came from before they came to the Americas, they had similar materials there, too. They just used slightly different species as they moved around." Wherever the First Americans came from, they had an ocean there, too. "Sometimes," Davis muses, "the narrative is people got amnesia as they came into the New World and had to reinvent everything. This seems kind of crazy."

Whenever humans migrate, they merge their existing knowledge, traditions, and ideologies with what they encounter. Des Lauriers points to an example of such a template: "You see similar things in Polynesia. When people go from one island to another, they don't re-domesticate sweet potato and chickens. They transport them from place to place. These kinds of legacies can connect to ideology and language and social structure. When people move to a new place, they don't forget their language or their traditions or identity living in a new place. They still have all their history and family. They can genuinely connect in a cultural way."

Pushing back history

With every field season, Des Lauriers and Davis are pushing further back the antiquity of early sites on Cedros Island. They hope one day to find human remains, which will shed more light on the lifestyle of these early humans. Already, researchers have found fragments of ancient plant material preserved by the dry climate. Working with the support of the Ensenada and Mexicali offices of Baja California Centro INAH (Instituto Nacional de Antropologia e Historia), particularly with Director Julia Bendimez Patterson and archaeologist Antonio Porcayo Michelini, has given a huge boost to their project. Currently, the team of researchers is developing 3-D models of some of the artifacts from these early sites on Cedros Island, "probably the highest level of artifact documentation you can do," says Des Lauriers. "Better than a photograph or drawing, and because it's digital it can be shared, which makes a huge impact."

–Katy Dycus

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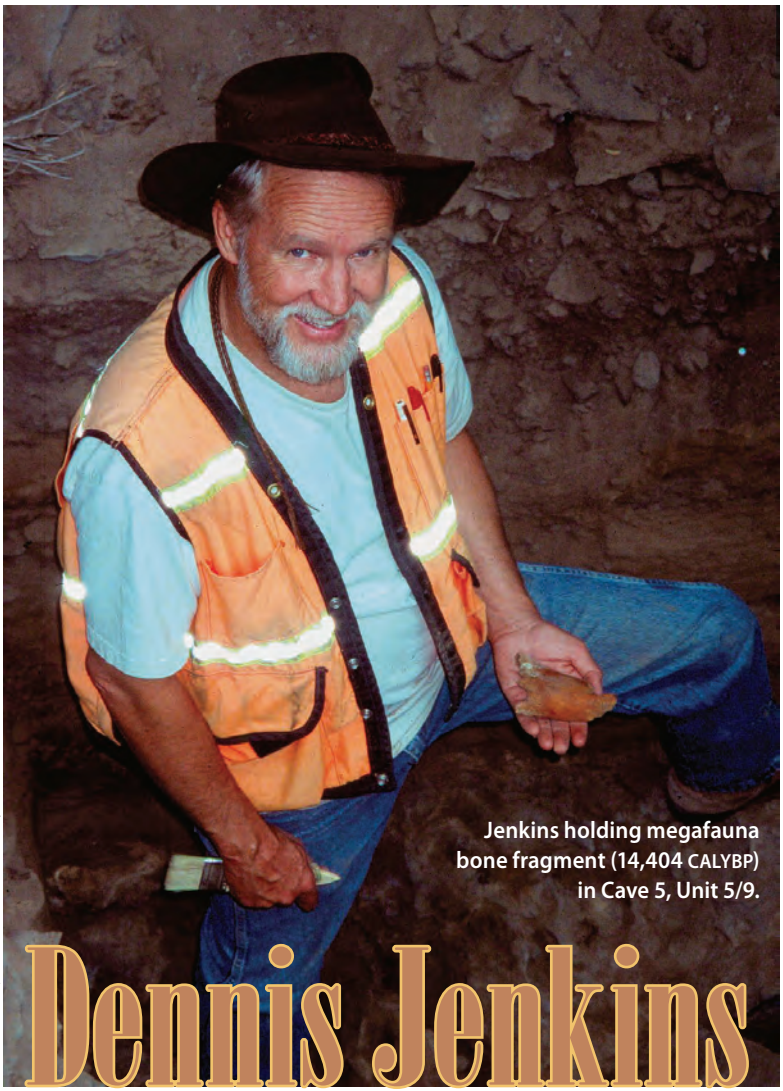
Suggested Readings

Des Lauriers, M., et. al. The earliest shell fishhooks from the Americas reveal fishing technology of Pleistocene maritime foragers. *American Antiquity* 82.3 (2017): 498–516.



Jenkins holding megafauna bone fragment (14,404 CALYBP) in Cave 5, Unit 5/9.

UNLESS NOTED, ALL PHOTOS DENNIS L. JENKINS

Dennis Jenkins

Pre-Clovis DNA Deposits at the Paisley Caves

VITAL INFORMATION can sometimes be found in something as unassuming as poop, an unlikely fact proved true in 2002 when Dennis L. Jenkins, Senior Staff Archaeologist at the Museum of Natural and Cultural History, University of Oregon, made an astonishing discovery in the lower reaches of Paisley 5-Mile Point Caves in south-central Oregon. Jenkins instantly understood the significance of what he believed were human coprolites he and his field-school students uncovered in caves first excavated by Luther Cressman in 1937. The caves, it turned out, contained spectacular secrets waiting to be revealed.

A lifetime immersed in Native American culture

Jenkins was born in 1952 in Eugene, Oregon. When 10 years old he found an obsidian arrowhead in San Diego County, California, and thereafter kept his eyes on the ground. He grew up in Las Vegas and enrolled in anthropology classes at the University of Nevada, Las Vegas, in the early 1970s.

In spring 1974 Jenkins learned a hard lesson about the inestimable value of provenience in archaeology. While conducting a survey for milk cows in the state of Nevada for the Environmental Protection Agency, his truck crested a rise near the town of Pioche and below him lay a small stream valley rich with pinyon pines, willows, and canes useful for making arrows and collecting "honeydew." Set above the floodplain was a terrace that struck him as an ideal place to camp if he were a Shoshoni. Indeed, after exploring the location his pockets were filled with artifacts.

When Jenkins offered his artifacts to a museum collection, the curator told him that without provenience

Coprolite, 14,377 CALYBP, from the Bone Pit in Cave 5.

BRIAN LANKER

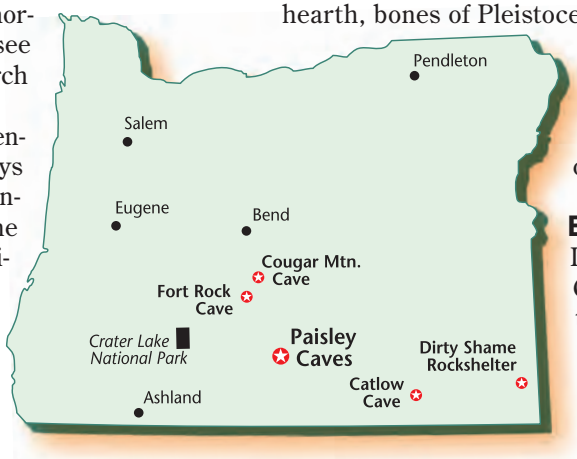
they were worthless. Moreover, Jenkins suffered the archaeologist's wrath: To collect artifacts for personal gratification, the curator declared with unmistakable scorn, was immoral. Jenkins, mortified, nevertheless persisted, until eventually the curator relented and agreed to accept artifacts that Jenkins could accurately place on a topographic map of the site. Thus was Jenkins introduced to the nuts-and-bolts of archaeology, how to plot finds on a site map and how to inscribe tiny museum numbers on artifacts. His career in archaeology had got off to a rocky start.

He earned his B.A. (1977) and M.A. (1981) at UNLV. To fuel his doctoral dissertation he served as Field Director at the Fort Irwin Archaeological project, where he investigated the connection between the Pinto and Lake Mohave techno-cultures. In 1989 he began teaching and directing the Northern Great Basin Archaeological Field School, and in 1991 he received his Ph.D. from the University of Oregon.

What drives his research? "The extreme age of the topic and the challenge of validating the finds," he tells us. "There are very few sites and researchers with strong evidence for human occupations in the Americas older than 13,000 years. That sets a very high bar to surpass for my research. It's a challenge to think creatively, to get out of the box and ask, 'If it was this way, then what? How do I test for that? Am I testing what I think I am testing?' He finds it exhilarating that in his research he expects to get worthwhile advice from only very few colleagues, friends that he respects tremendously and to whom he owes a huge

debt. He is candidly self-effacing: "I'm not brilliant and can do very little without the help of a team of creative researchers. I just try to work hard, be creative, be honorable, and honestly contribute to what I see is an incredibly important line of research in American archaeology."

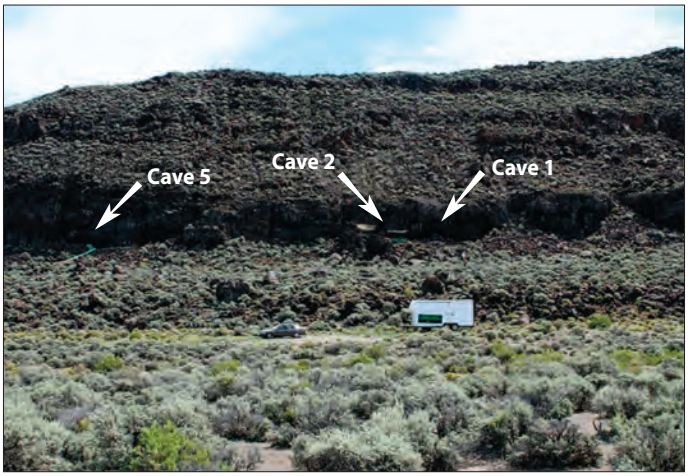
"Dennis Jenkins has taught and mentored generations of archaeologists," says former student Richard "Richie" Rosencrance, now a Master's student in the Department of Anthropology at the University of Nevada, Reno. "In directing the University of Oregon archaeology field school for 30 years, he has been one of the few contributors who have essentially created 'Oregon archaeology' during this time—all the while inspiring and teaching students from all walks of life and levels of professional development. My attendance at the field school changed my life in many ways, and my continued work with Dennis brings new lessons and experiences I won't soon forget."



A window into the past

At the northernmost limit of the Great Basin in south-central Oregon lie the Paisley Caves, a system of eight shelters cut by waves on pluvial Lake Chewaucan into its highest shoreline (**MT25-4, 26-1,** "Paisley Caves: What's the scoop on the poop?"). Archaeologist Luther Cressman, acting on a local tip, first excavated there in 1938. At that time no human remains had been discovered that predated the Clovis era (13,500–12,800 years ago). Chapter and verse of the anthropology bible pronounced that Clovis people were the first inhabitants of the New World and that all native peoples in the Americas were descended from them.

In 1940 Cressman found in the Paisley Caves camel, bison, and horse bones associated with artifacts that appeared to be possibly the same age as Clovis or even earlier. Fellow archaeologists dismissed Cressman's discovery as the product of flawed methods. Willard Libby hadn't yet perfected radiocarbon dating, and prehistoric sediments in southeastern Oregon were abruptly disjointed at 7,700 years ago by a blanket of ash and pumice from the eruption of Mt. Mazama. Cressman dug below Mazama ash in the Paisley Caves and claimed to have found sediments that yielded a hearth, bones of Pleistocene horse and camel, and artifacts. Unfortunately, since he didn't keep or publish detailed stratigraphic data on his excavations, later scientists had no means of confirming or refuting his claims.



THOMAS W. STAFFORD, JR.

Looking east at the Paisley Caves from the basin that was once the bed of pluvial Lake Chewaucan.

Enter Dennis Jenkins

In 2002, Jenkins decided to test Cressman's controversial theory that humans occupied Paisley Caves when Pleistocene mammals roamed the Northern Great Basin. With a team of enthusiastic students of the UO summer field school, Jenkins set about the task.

He soon discovered that the site was fraught with problems. "Cressman hadn't backfilled his excavation site, and it had been heavily looted," Jenkins explains. "The floor was littered with basalt blocks that had fallen from the roof, windblown silt, organic matter, animal feces, food remains, and nesting materials. It reeked of rat urine."

In spite of the less than appealing atmosphere, Jenkins was determined to use precise methods to investigate unexplored areas of the strata in Cave 2 and Cave 5. Beneath the Mazama deposits in Cave 5, his team unearthed strands of thread made of grass fiber and processed sinew that yielded a calibrated AMS date of 12,750 CALYBP, making them among the earliest examples of human-made cordage in the Americas. The lower levels of the same stratum contained the highest concentration of artifacts including hundreds of pieces of lithic debitage, scrapers, bifaces, wooden artifacts, large-mammal bones, polished stone, cordage, basketry elements, and a spatula made from a bison-horn core.

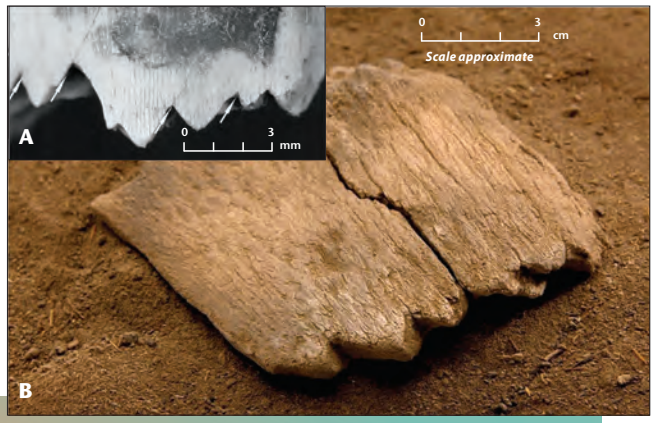
Geoarchaeological analysis found that sediments in the Paisley Caves are remarkably stable despite occasional rodent holes. Sheltered from moisture, the extremely dry deposits inside the caves preserved perishable human artifacts that in most other sites would have been degraded, thus providing a rare

Oldest Western Stemmed point (>13,500 CALYBP) found at Paisley Caves by Jenkins's crew. A sample was removed (notch) for obsidian-hydration dating.

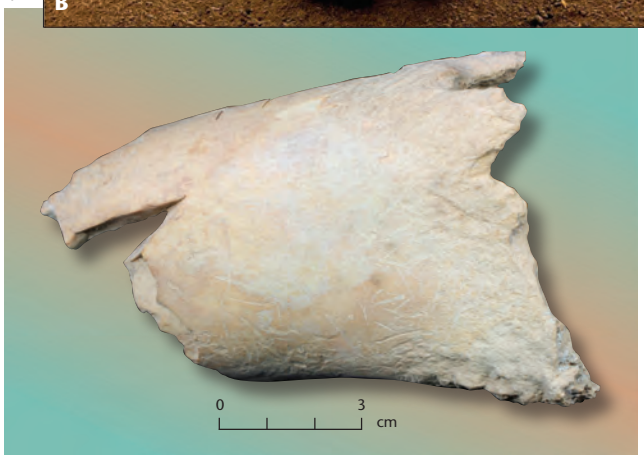
opportunity for Jenkins and his students to study evidence of human presence in unbroken stratigraphic sequence spanning the late Pleistocene and Holocene.

A (ahem) comfort station for pre-Clovis travelers

In the lowest levels of the Paisley Caves, Jenkins's team unearthed coprolites that appeared in size, shape, constituents, and color to be possibly of human origin. All 14 tested positive for human mitochondrial DNA (mtDNA), but since they had not been excavated under sterile conditions, further testing was needed to be certain the DNA wasn't derived from the excavation team. Jenkins explains that "human ancient DNA studies are extremely prone to contamination at the excavation and laboratory-analysis stages."

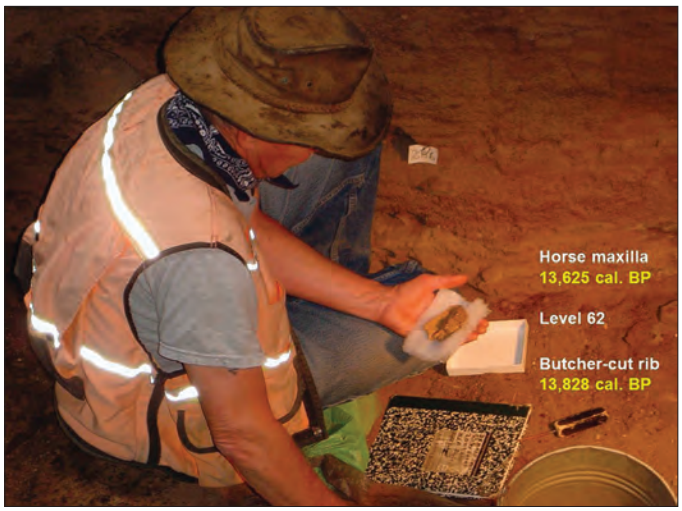


A, naturally broken artiodactyl bone, ▶ 12,200 CALYBP; B, culturally modified bear bone from Cave 5, 14,230 CALYBP, possibly used as a flesher. Note the uniform size of the teeth of B compared with the irregular teeth of A.



Fractured bone of a large mammal, 14,404 CALYBP, possibly processed for marrow. ▶

In Cave 5, Stratum 1 is a poorly sorted gravelly deposit containing packrat fecal pellets and organic materials embedded in sediments ranging from fine sand to silt-sized grains. This stratum dates to 13,140–15,900 CALYBP, approximately the same date range as a similar deposit in Cave 2. Organic materials are remarkably well preserved, but, as expected, the pre-Clovis deposits have provoked controversy. A camel ankle bone recovered from the "Bone Pit," a small trash pit among wave-rounded boulders on bedrock in Cave 5 capped by a large stone slab, produced a calibrated AMS date of 14,290 CALYBP, about 700 years before earliest Clovis. Jenkins believes that humans likely disposed of megafaunal and cultural remains in the pit, then set the slab in place. Human coprolites, identified by DNA, hair and protein, were found in and around this pit and dated to the same age, 14,141–14,525 CALYBP, as materials found in the pit.



Jenkins removing horse maxilla from Level 62 of Unit 2/6 in Cave 2, 2010.

The mandible of a mountain sheep—with a stone-tool cutmark—from the pit yielded a calibrated AMS date of 14,591 CALYBP. Lithic debitage in this deposit was sparse; most of it was traceable to nearby obsidian sources. Coprolites recovered from the lowest level in Cave 5 contained plant fibers that dated to 14,170–14,340 CALYBP—more than 1,000 years before Clovis. All the coprolites contained single-nucleotide polymorphisms (SNPs, aberrations in the chain of genetic material in DNA) characteristic of European populations, which therefore indicated modern contamination by field or lab personnel; six samples yielded SNPs diagnostic of haplogroup A, common to Native Americans in northernmost North America, and haplogroup B, present in natives of southwestern U.S. and the Andes of South America (**MT 24-4,** "Genetics study: Two Paleoindian migration routes into the Americas").

Denying skeptics every coign of advantage

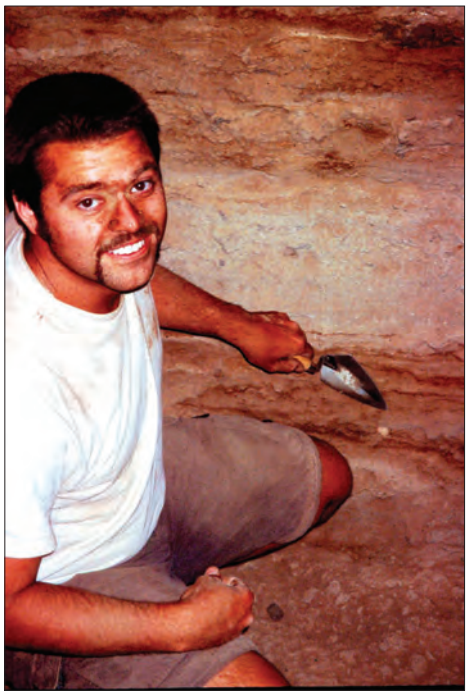
Jenkins has explored every conceivable avenue to confirm the human origin of the coprolites. The haplogroup A and B identities were verified independently by laboratories in Copenhagen, Denmark; Uppsala, Sweden; and Leipzig, Germany. To exclude the possibility of DNA contamination by modern humans, mitochondrial DNA analysis was done on the 55 individuals who had been present at the site and on the 12 researchers at the principal DNA laboratory. The results exclude all the individuals tested as possible sources of the haplogroup A and B mtDNA found in the coprolites. To be absolutely certain of the human origin of the coprolites, Jenkins submitted the four oldest samples for protein residue and reconstitution analysis. All results confirmed that the coprolites are human.

Since wood rats had nested in the caves throughout their his-

tory and their feces and urine permeated the strata in the caves, Jenkins also screened for *Neotoma* mtDNA in human coprolites, reasoning that water carrying younger human DNA downward through the sediments would also be carrying wood rat DNA. He found *Neotoma* mtDNA present in wood-rat fecal material, but not in the human coprolites.

Anticipating skeptical scientists' objections that human DNA may have infiltrated the coprolites from sources in higher strata, Jenkins asserts that all test results confirm that leaching of DNA is of negligible concern in the Paisley Caves. Empirical and theoretical evidence verify that a substantial quantity of water is required for free DNA molecules to migrate between strata. Water is conspicuously absent in the bone-dry Paisley Caves.

That hard work goes unrewarded is so frequent an occurrence as to be a commonplace. Not so, it's refreshing to report, for Dennis Jenkins. His discoveries have made the Paisley Caves the most widely accepted pre-Clovis site in North America—accepted, that is, by many members of the scientific community, but not by all. Perhaps their unanimous endorsement is beyond the reach of any scientist, but his success hasn't gone unnoticed by his peers. Says University of Oregon archaeologist Jon Erlandson, "Dennis is a truly outstanding archaeologist. His dogged, meticulous, and interdisciplinary research at Paisley Caves confirmed many of Luther Cressman's controversial interpretations, but also broke the 'Clovis barrier' with the best-documented pre-Clovis site in North America."



Student Mike Fallon pointing to WST-age deposits in nicely laminated stratigraphy of Unit 3, Cave 1.

◀Stratigraphy of the west wall of Unit 2/6, Cave 2. All dates are CALYBP.

◀ Student Mara Taft exposing pronghorn bones, hair, and artifacts in a botanical lens (12,800–11,000 CALYBP).

Interpreting clues to long-term human occupation

Radiocarbon dating of human coprolites, cultural materials, and animal remains suggests that the Paisley Caves hosted multiple phases of human occupation during the late Pleistocene. The Great Basin offers sparse evidence for humans' exploiting Ice Age megafauna because highly mobile small bands of hunter-gatherers usually left few clues behind and perishables quickly deteriorated in open settings. The Paisley Caves are a rare find, a textbook archaeological dig. The cultural deposits of Pleistocene age are stratigraphically distinct and separated from overlying deposits.

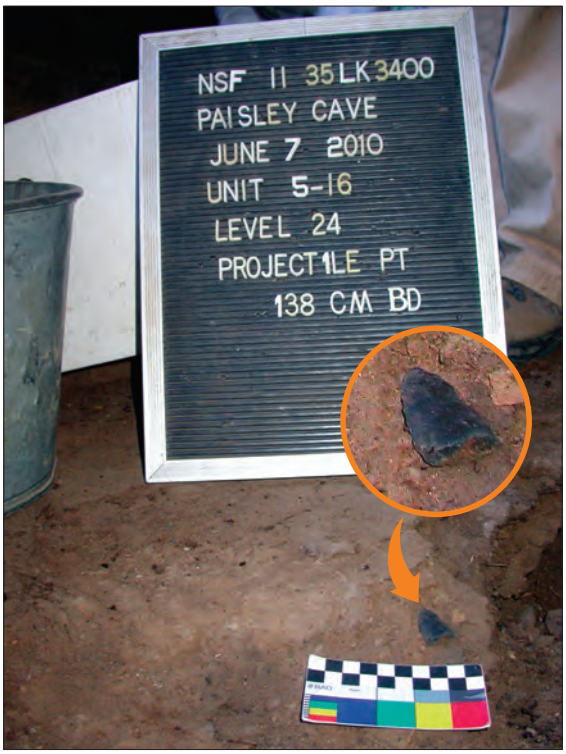
Another cluster of six horse and camel bones lodged in a crevice between a large boulder and the north cliff wall showed excellent preservation, including dried blood and fatty tissues. A sawtoothed bear-bone artifact (14,007–14,448 CALYBP) displays teeth uniform in size and moderately rounded from use. Although no evidence of use wear is visible, the beveled edges of the triangular teeth distinguish the artifact from naturally broken, culturally unmodified sawtoothed specimens.

Some megafauna bones in Paisley Caves exhibit spiral green fractures and conchoidal impact impressions, evidence that humans possibly smashed them with hammerstones to extract marrow (**MT 23-1,** "Early mammoth bone flaking on the Great Plains"). In the Paisley Caves, megafaunal skeletal remains are generally found associated with artifacts.

His painstaking methods and exquisite attention to detail have made a lasting impression on his students. "Dennis Jenkins radiates a high energy that is impossible to ignore," says Ph.D. student Katelyn McDonough. "His gregarious nature, fascination with the past, and grasp of the 'big picture' make him a catalyst for exciting and collaborative research. His work with the University of Oregon Archaeology Field School has advanced the field of anthropology, both through the data uncovered in excavation and the students who continued on to become archaeologists. I attended his field school at the Paisley Caves in 2011 and now I am a Ph.D. student with the Center for the Study of the First Americans at TAMU. I certainly have Dennis to thank for setting me on the academic archaeological path I find myself on today."

An inhospitable dwelling for later inhabitants

Although the pre-Clovis elements uncovered at Cave 2 are the truly ground-breaking discovery, later inhabitants also left their mark on the Paisley Caves. A silt lens dating from the beginning of the Younger Dryas (about 12,900–11,700 CALYBP) yielded scraps of sagebrush matting, crystallized urine, fat, blood, bone, feathers, and fragments of hide from marmots, leporids (rabbits), and voles. It was a decidedly unhealthy atmosphere for human occupation: Head lice, bed bugs, and intestinal worms abounded. In fact, a clump of degraded human hair still bears eggs of head lice. Remains of waterfowl and fish from the adjacent lake attest to a prolific food source, but food prepared on the cave floor would have been easily contaminated with dirt, hair, feathers, and rodent feces.



WST point in situ in mud lens dated 12,959–13,228 CALYBP.

A 40-year focus on the First Americans

When did the First Americans arrive in the new world? Jenkins has two answers to this question. The first is: "Conservatively speaking, current evidence suggests sometime around 16,000 years ago." The second answer is nothing more, he admits, than his gut instinct: "While there is little, if any, solid support for it at the present, it looks to me like the standard conservative estimate in the next decade will be sometime around 20,000–22,000 years, and maybe earlier. It isn't set in stone, and it can all change in the twinkling of an eye with the publication of a single well-documented site."

Jenkins's research focuses on the first colonizing of the Americas, obsidian sourcing and hydration, prehistoric shell-bead trade, and settlement-subsistence patterns of the Northern Great Basin. With more than 100 site investigations under his belt, he has published 7 books, more than 80 chapters, articles, and reviews, and has presented more than 70 papers at professional meetings. He directs the Paisley Caves Archaeological Research Project in central Oregon, has been profiled in more than 50 newspaper and magazine articles, and has appeared in 12 television documentaries. And in case he has any time or energy left, he's the Senior Staff Archaeologist at the University of Oregon Museum of Natural and Cultural History.

"Over the past decade I've come to know Dennis as a mentor, colleague, and friend," says Geoffrey M. Smith, University of Nevada, Reno. "Our work together has helped me to understand what it means to be a good scientist and, more importantly, a good teacher and a good person."

What about his future? "In the short term," Jenkins replies, "I'm trying to raise funds so that I can take a sabbatical to write the Paisley Caves report. Meanwhile, research continues at the Connley Caves and other Western Stemmed Tradition (WST) sites in the northern Great Basin. The UO field school has had tremendously successful and exciting summers excavating rich WST components at the Connley Caves since 2014. This last summer we also initiated a program of dating Pleistocene-lake shorelines in the Fort Rock basin." Jenkins and his students know they can't expect to find truly old (13,000- to 14,000-year-old) sites if they were under water. If, however, they can determine where bodies of water lay at early times, then they can reconstruct the paleoenvironment and determine where shelter, fresh water, and firewood offered optimum locales for a campsite or occupation. It's a formidable task, he admits, "to calculate where the most productive spots remaining on the landscape would have been and where sites in those spots would be preserved after all these years, considering the many major environmental changes that have occurred to the landscape."

In First Americans studies, Jenkins anticipates "a whole new crop of talented students involved in First Colonization studies coming up. They work hard and will move our science forward. DNA, geochronology, chemistry, taphonomy, and botanical stud-

Suggested Readings

Jenkins, D. L. 2000 Early to Middle Holocene Cultural Transitions in the Northern Great Basin of Oregon: The View from Fort Rock. In "Archaeological passages: A volume in honor of Claude Nelson Warren." *Publications in Archaeology.* Western Center for Archaeology and Paleontology, pp. 69–109.

Jenkins, D. L., and C. N. Warren 1985 Obsidian Hydration and the Pinto Chronology in the Mojave Desert. *Journal of California and Great Basin Anthropology,* 6 (1): 44–60.

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Jenkins, D. L., L. G. Davis, T. W. Stafford, Jr., P. F. Campos, T. J. Connolly, L. S. Cummings, M. Hofreiter, B. Hockett, K. McDonough, I. Luthe, P. W. O'Grady, K. J. Reinhard, M. E. Swisher, F. White, B. Yates, R. M. Yohe II, C. Yost, and E. Willerslev 2013 Geochronology, archaeological context, and DNA at the Paisley Caves. *Paleoamerican Odyssey,* K. E. Graf, C. V. Ketron, and M. R. Waters, eds., pp. 485–510. Center for the Study of First Americans, College Station, Texas.

BRENT MCGREGOR

Jenkins overseeing early excavations in Cave 5 during the NSF-funded project, 2009.

ies will make important contributions. The future is bright."

After 30 years of ground-breaking research, Dennis Jenkins is still as enthusiastic as he was on his first job in archaeology, when he remembers thinking, "My God, you can get paid to do this! I would do it for free."

–Martha Deeringer

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The Native American Family Tree

continued from page 6

sequence and analyze 91 ancient whole genomes. As this technology improves and as more ancient American genomes are sequenced, especially genomes from underrepresented regions of North and South America, that complexity likely will only increase.

Deborah A. Bolnick, University of Connecticut biological anthropologist, told the *New York Times* that the study by Scheib, Kivisild, Malhi, and their colleagues "is important because it begins to move us away from overly simplistic models of how people first spread throughout the Americas." Jennifer Raff, University of Kansas biological anthropologist, told *The Atlantic* that the study makes it clear that the dispersal of humans into and through the Americas was a much more complicated process than we've previously imagined: "It was more like driblets of small groups moving down—and up—the coast, meeting up with each other to trade and marry. I expect that the more ancient genomes we get from North America, the more complex it's going to become. It's a very exciting time to be working in this field."

Achilli and his co-commentators agree. They suggest the rapid increase in ancient genome research will continue and provide answers to many long-standing questions. They think it likely, however, that many other questions will arise along the way. And that's exactly how science is supposed to work. With every question we answer, many more questions will arise, but with every answered question, we gain a clearer understanding of the story of the First Americans.

–Brad Lepper

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Achilli, A., A. Olivieri, O. Semino, and A. Torroni 2018 Ancient human genomes—keys to understanding our past. *Science* 360:964–65.

Scheib, C. L., L. Hongjie, T. Desai, V. Link, C. Kendall, G.Dewar, P. W. Griffith, A. Mörseburg, J. R. Johnson, A. Potter, S. L. Kerr, P. Endicott, J. Lindo, M. Haber, Y. Xue, C. Tyler-Smith, M. S. Sandhu, J. G. Lorenz, T. D. Randall, Z. Faltyskova, L. Pagani, P. Danecek, T. C. O'Connell, P. Martz, A. S. Boraas, B. F. Byrd, A. Leventhal, R. Cambra, R. Williamson, L. Lesage, B. Holguin, E. Ygnacio-De Soto, JT. Rosas, M. Metspalu, J. T. Stock, A. Manica, A. Scally, D. Wegmann, R. S. Malhi, and T. Kivisild 2018 Ancient human parallel lineages within North America contributed to a coastal expansion. *Science* 360:1024–27.

Yong, E. 2018 The increasingly intricate story of how the Americas were peopled. *The The Atlantic,* 31 May 2018; https://www.the The Atlantic.com/science/archive/2018/05/the-increasingly-intricate-story-of-how-the-americas-were-peopled/561638/

Zimmer, C. 2018 The great breakup: The first arrivals to the Americas split into two groups. *New York Times,* 31 May 2018; https://www.nytimes.com/2018/05/31/science/americans-migration-dna.html

An Ancient Maritime Economy
Part II

Work for Ecology Sleuths (cont'd)

TO BETTER UNDERSTAND the environmental landscape at Huaca Prieta, Tom Dillehay recruited Steven Goodbred, Professor and Chair of Vanderbilt University Department of Earth and Environmental Sciences. Goodbred studies the relationship between humans and depositional landscapes like river deltas. In Peru, Goodbred worked along the Chicama River, where erosion exposed layers of soil going back thousands of years. He obtained core samples that yield snapshots of the paleoenvironment harking back to the Ice Age.

He found that the north coast of Peru experienced several environmental shifts in the thousands of years while the mound was being constructed. Just as tree rings tally the passage of years, stratigraphic transitions in the mound record environmental spasms. One enormous environmental shift was the rise in sea level that resulted from retreating glaciers, which consequently created biodiverse lagoons near the mouth of the Chicama River. Yet another jolt was a series of El Niño floods, which deposited layers of silt throughout the Chicama Valley. This rich silt played an important role in later agricultural activity.

Dillehay is currently at work in Peru determining to what extent tsunamis and El Niños and droughts affected the inhabitants at Huaca Prieta. "Right now, we have no evidence to suggest these events interrupted the economy," he says. "Tsunamis and floods didn't really affect people because they could easily switch over to agriculture, and if they experienced drought they could switch back to seafood. So that's the advantage of people living in this rich coastal region."

Prehistoric life free of violence and conflict

Early settlers at Huaca Prieta, untroubled by natural disasters, appear also to have escaped the ravages of human conflict. Dillehay finds this surprising because "usually, for Preceramic sites dated between 8,000 and 4,000 years ago, you typically see a lot of violence, physical trauma on the bones indicating violence. But we saw none whatsoever at Huaca Prieta. These people seemed to be living in a state of social harmony. I haven't published this yet, but one reason may be they had an abundance and great diversity of resources."

ALL PHOTOS UNLESS NOTED: TOM D. DILLEHAY

Unit 3 excavation, chamber tombs on top of Huaca Prieta, dated 4500–3800 CALYBP.

Likewise, politics and religion, which we know only too well can incite ideological conflicts, didn't achieve sufficient prominence to leave a record at Huaca Prieta. Dillehay explains that "these people were kind of isolated and cut off from the interior by all these wetlands. It was quite an effort to get from the coast to the interior. There was no population pressure we found. So all those factors come together to reduce conflict."

A burgeoning trade economy

Given a choice, there's no need to compete. But how did these humans feel about sharing? Drawing on isotope studies of bones, Dillehay surmises that these people primarily ate food like corn, chili peppers, or seafood. "Surely, they exchanged things between them, but not enough to throw off the isotope signatures. Later in time, if you look at sites like after 2,000 years ago, into the interior, you begin to see many more marine resources moving there. There's a lot more exchange, and more conflict, too."

Dillehay reports that "all the way through time at this site, there's always an introduction of new cultigens coming in, most of them (all of them actually, except for cotton) not indigenous to the desert. So they're coming from the mountains or from the tropics to the north, or from the Amazon basin." The presence of exotic vegetals indicates active trade networks. His team also found the world's earliest-known collection of corn macroremains (stalks and cobs), which included many varieties of the plant—popcorn, corn used to brew chicha beer, corn flour, and corn for foraging animals. Because the plant originates in what is today Mexico, the presence of this plant in northern Peru suggests Huaca Prieta was part of an extensive trading network.

In addition to exchanging food, occupants of Huaca Prieta were also exchanging other items. "All the exotics we're getting was for their ceremonial activities associated with the mound," Dillehay says. "Exotic green stones were clearly coming from Ecuador, 500 to 600 km to the north. Copper sulfite was coming from the mountains at least 200 km away, and other exotics here and there. Many of the plants are exotics, and many of these items came with people in their pilgrimages to the site."

How the mound achieved cultural significance

Before these exchange networks emerged, say at least 10,500 years ago, the seashore likely lay 16 to 18 km farther to the west and the environment would have been characterized by a grassy coastal plain, with sand dunes close to the sea itself and brackish water estuaries. Always prominent was the Sangamon terrace, which, says Dillehay, "is really a platform that dates back over 100,000 years and eroded away as a consequence of glacial outwash. A little island was left there about 4 meters high, so people throughout time were living on it." Nature bequeathed these early humans an elevated platform equidistant from the foothills of the Andes to the east and the ocean to the west, almost perfectly centralized.

Deep excavations at Huaca Prieta.

Around 7600–7800 CALYBP occurred an ontological, or religious, shift, perhaps related to an influx of cultigens or increased population. Perhaps galvanized by religious fervor, the people started remaking the mound into a public monument. "Not for camping out; there's little domestic debris like hearths," Dillehay explains. "Later in time, it became a burial place and was used as a ceremonial structure or mortuary." Charcoal and ash from countless ritual fires burned on its slopes made the mound increasingly dark and eventually gave rise to the name it bears today, Huaca Prieta, "*Black Pyramid.*"

Genetic protein sequencing reveals that among the burials at Huaca Prieta are people from distant regions. Some may have arrived from the mountains to the east, which is suggested by articles found that originated in the central Andes. With skeletons that date to around 7,000 CALYBP, Dillehay notes that "you get some pelican feathers, and seashells given as offerings to the bodies, with red ocher. People were placed on woven mats. Before, we weren't getting that. And you get these little burned areas associated with plants being burned, like cocoa leaves used as offerings. You get a layer choked full of trash and debris, then all of a sudden the surface becomes pretty clean. It's clear they're some sort of offering. It's a ritual practice."

The beginnings of Andean civilization

Huaca Prieta is an enigma in Andean archaeology because it has no known predecessors, either on the ancient terrace or farther out. Its complexity lies in its form, function, and location. The haystacking construction technique, the circular sunken plaza, retention walls, and the architecture of the mound impart the same sense of site planning seen in other public monuments dating to the late-Preceramic period.

The archaeological record and the age and construction of the mound at Huaca Prieta contribute to a growing body of evidence that human presence in the central Andes during the early to middle Holocene was a mosaic of different economies and social forms. In southwest coastal Ecuador, for example, mixed farming and foraging societies existed by 7000–9000 CALYBP. In the Andean highlands, from Peru and Bolivia to northern Chile and Argentina, economies based on camelid husbandry and high-altitude farming were developed as early as 7000–6000 CALYBP.

"Huaca Prieta is a stand-alone site," Dillehay says. "You can see that in the economy, in some of the artwork there (like pyro-etched drawings on gourds that date back 5,500 years, which is some of the earliest sophisticated artwork in the Americas). Then there's the cotton textiles, the weavings." In 2016, Dillehay's team unearthed a 6,000-year-old piece of fabric that retained traces of indigo dye, making it the earliest known use of indigo in the world, predating its use in ancient Egypt by 1,500 years. James M. Adovasio, an archaeologist at Florida Atlantic University, notes that "even the baskets reflect a level of complexity that signals a more sophisticated society."

In this one extraordinarily rich site, Dillehay emphasizes that "we find some of the earliest foundations of Andean civilization not only in terms of symbolism and maybe ontology or religion, but in the economy, and this sort of dual economy in particular." What's more, "We also found camelid bones at the site, and that element indicates mainly a highland economy. In the highlands of Peru you get a dual economy there of pastoral agriculture—pastoralism. It would be foolish to say Huaca Prieta kicked off Peruvian Andean civilization, but it certainly played a major role in it, along with other sites."

Research shows that the origins of Andean civilization are

a patchwork of regional roots, each characterized by a unique combination of social and economic components. Not only did the occupants around Huaca Prieta establish a complex society and create a public monument, they also wreaked environmental changes by modifying the landscape and contributed to the domestication and proliferation of plants and animals that led to the development of early states in the Andes.

The legacy of Huaca Prieta

As the food economy underwent changes, the ceremonial significance of the mound diminished. It did, however, continue to serve as a burial ground to today. Over time, other mounds such as Paredones and El Brujo rose in prominence. Yet the Black Pyramid remains today, its organic materials preserved by the arid climate.

Huaca Prieta belongs to a suite of pre-13,000-year-old sites that have reimagined the model of the peopling of the Americas. Archaeologists once accepted as gospel that the Americas were first peopled about 13,000 years ago by people who trod across the Bering Land Bridge and through an ice-free corridor into interior North America and continued their trek southward. Tom Dillehay challenged this paradigm by demonstrating human presence at Monte Verde in Chile 14,500 years ago. With each new discovery, the date of human entry into the Americas is pushed deeper into the past.

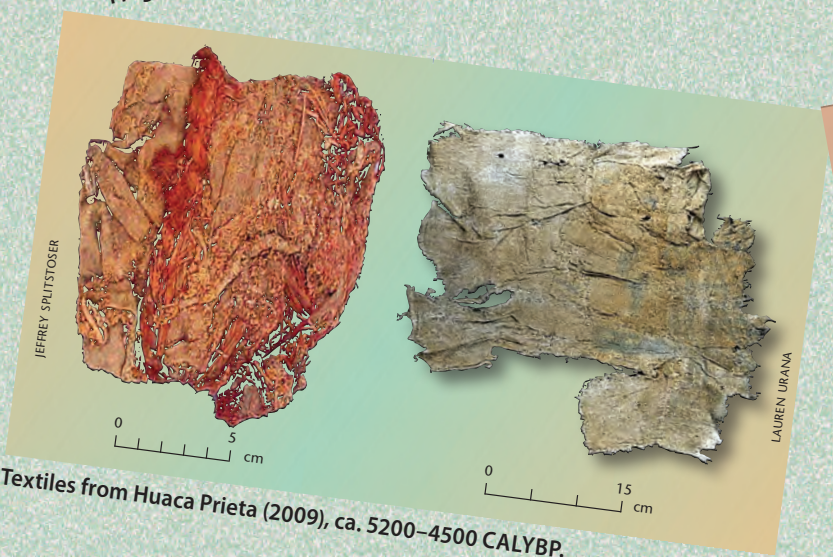
–Katy Dycus

THE CULTURAL HERITAGE

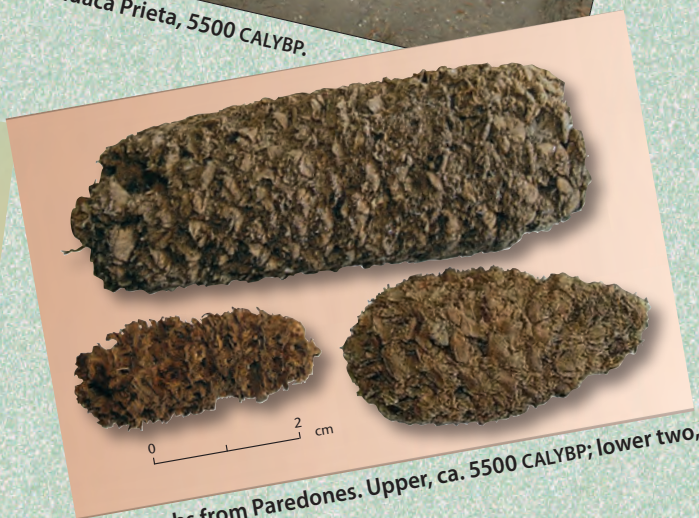
Fragments of engraved gourds from Paredones.

Maize from Paredones, 6500–3800 CALYBP.

Offerings at Huaca Prieta, 5500 CALYBP.



Textiles from Huaca Prieta (2009), ca. 5200–4500 CALYBP.



Maize cobs from Paredones. Upper, ca. 5500 CALYBP; lower two, ca. 6500–6200 CALYBP.

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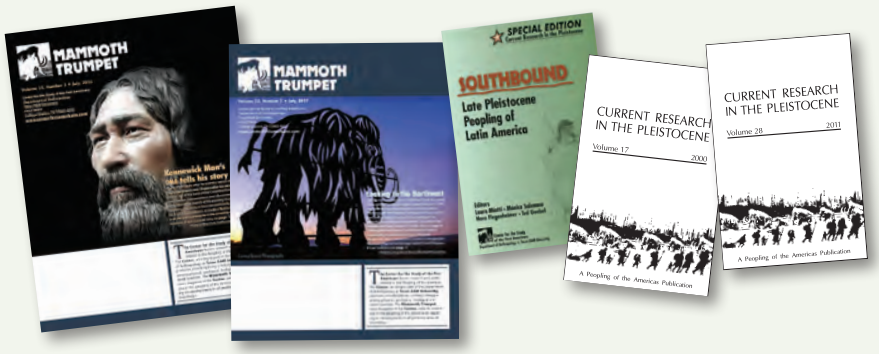

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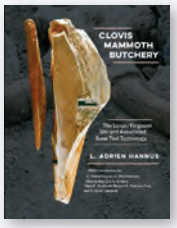
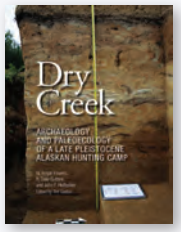


Clovis Mammoth Butchery: The Lange/Ferguson Site and Associated Bone Tool Technology, L. Adrien Hannus. 2018. 288 pages. Hardback (ISBN 978-1-62349-592-3).
Reg. price $60.00
CSFA members $48.00

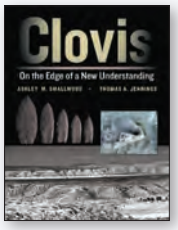


Dry Creek: Archaeology and Paleoecology of a Late Pleistocene Alaskan Hunting Camp, W. Roger Powers, R. Dale Guthrie, and John F. Hoffecker; edited by Ted Goebel. 2017. 344 pages. Hardback (ISBN 978-1-62349-538-1).
Reg. price $50.00
CSFA members $40.00

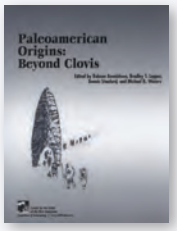
The Hogeye Clovis Cache, Michael R. Waters and Thomas A. Jennings. 2015. 159 pages. Hardback or e-book (ISBN 978-1-62349-214-4).
Reg. price $30.00
CSFA members $24.00

From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia, Ted Goebel and Ian Buvit, editors. 2011. 408 pages. Hardback or e-book (ISBN 978-1-60344-321-0).
Reg. price $80.00
CSFA members $64.00

Emergence and Diversity of Modern Human Behavior in Paleolithic Asia, Yousuke Kaifu, Masami Izuho, Ted Goebel, Hiroyuki Sato, and Akira Ono. 2014. 230 pages/ Hardback (ISBN 978-1-62349-276-2).
Reg. price $65.00
CSFA members $52.00



Clovis: On the Edge of a New Understanding, Ashley M. Smallwood and Thomas A. Jennings, editors. 2014. 376 pages. Hardback or e-book (ISBN 978-1-62349-201-4).
Reg. price $50.00
CSFA members $40.00



Paleoamerican Origins: Beyond Clovis, Robson Bonnichsen, Bradley T. Lepper, Dennis Stanford, and Michael R. Waters, editors. 2005. 384 pages. Paperback (ISBN 978-1-603448-12-3).
Reg. price $45.00
CSFA members $36.00

Paleoamerican Odyssey, Kelly E. Graf, Caroline V. Ketron, and Michael R. Waters, editors. 2014. 584 pages. Paperback (ISBN 978-1-62349-192-5)
Reg. price $45.00
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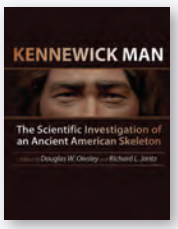

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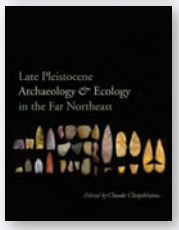

Late Pleistocene Archaeology and Ecology in the Far Northeast, Claude Chapdelaine, editor. 2012. 264 pages. Hardback or e-book (ISBN 978-1-60344-790-4).
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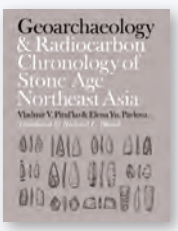

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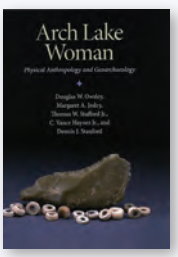

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