MAMMOTH TRUMPET

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Center for the Study of the First Americans
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Caught in the act!

A bearded capuchin monkey smashes a quartz cobble on an anvilstone in the Serra da Capivara National Park in Brazil. Witnessed and filmed by archaeologist Tiago Falótico of University of São Paulo, the monkey shattered the cobble, then threw it aside and licked up the dust, apparently to ingest the mineral and vegal content. Of interest to archaeologists is a sharp-edged fragment created by the monkey as a by-product, *which exactly mimics a conchoidal fragment made by a human flintknapper.*

Lithics analysts consequently caution of the need to refine the "criteria commonly used to distinguish intentional hominin lithic assemblages." This instance of monkey handiwork also challenges definitions in archaeology: Is the rock fragment an artifact? By definition that's an object created by humans. Since the monkey wasn't observed using the rock fragment in any manner, is it a tool? For our story, see **page 9.**

Photo by Michael Haslam

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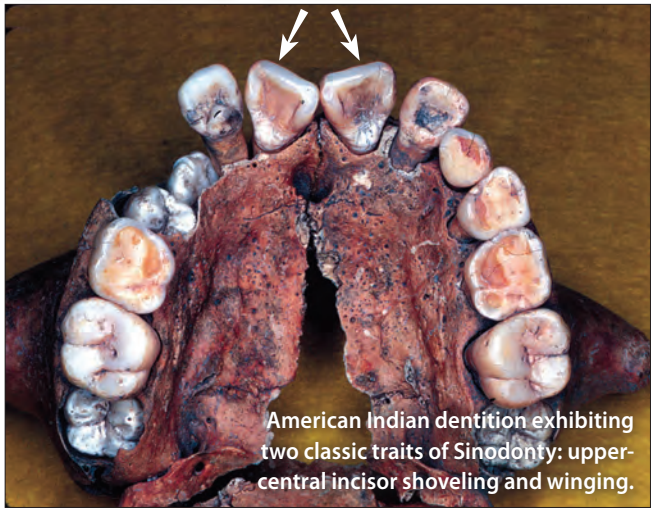
From Three Waves to a Standstill

An Evolving Story Based on Teeth



American Indian dentition exhibiting two classic traits of Sinodonty: upper-central incisor shoveling and winging.

UNLESS NOTED, ALL PHOTOS: G. RICHARD SCOTT

by G. Richard Scott

CHRISTY G. TURNER II published an article in 1971 on a single dental trait that would have lasting ramifications. The trait, 3RM1 (3-rooted lower first molars), revealed a distinctive pattern of variation among Native American populations. This extra root was very common in Eskimos and Aleuts, who had frequencies between 30% and 50%, and North American Indians, who had a frequency around 5%. Both frequencies were based on many samples and hundreds of individuals, so the dichotomy was firmly established. Another piece of the puzzle was an intermediate 3RM1 frequency of 15% noted in the X-rays of Navajo individuals, which fell between the two other Native American extremes. Turner recalled a proposal by world-renowned linguist Joseph Greenberg, who argued that New World languages fell into three large groups: Macro-Indians (most North American and all Middle, Central, and South American Indians); Na-Dene (Tlingit and Athapaskan groups of southeast and central Alaska and northwest Canada); and Eskimo-Aleuts (from the most westerly Aleuts to Inuit populations in Greenland). Given this agreement, Turner went out on a limb and proposed that 3RM1, in conjunction with Greenberg's linguistic inferences, suggested a three-wave model for the peopling of the Americas.

Over the next 20 years, Turner visited dozens of museums and ex-

INSIDE

amined thousands of dentitions, with special emphasis on populations of the Americas, Asia, and the Pacific. In the 1980s, he published a series of articles that proposed, based on his analysis, that multiple dental traits were consistent with his original 3-wave model. The best-known article was coauthored with Greenberg and geneticist Steven Zegura, who believed that three independent lines of evidence supported a 3-wave model for the settlement of the Americas.

The teeth of New World colonizers

Turner was the first researcher of Asian and Pacific populations to identify two distinct dental patterns in Asia, Sinodonty and Sundadonty. The Sinodont pattern was characterized by intensified traits like shoveling, winging, and UP1 (upper first molar) root reduction, compared with the more-generalized Sundadont pattern. Significantly, he concluded that two major peopling events could be identified by these dental patterns: New World populations were derived from East Asian Sinodont populations, while Polynesian and Micronesian populations were Sundadont derivatives from Southeast Asia.

For 25 years following the 1986 publication of Greenberg et al. in *Current Anthropology,* the 3-wave model was almost invariably considered by geneticists and skeletal biologists, who either supported it or rejected it. With papers on mtDNA (mitochondrial DNA) ramping up, especially following the development of PCR (polymerase chain reaction), which made the study of ancient DNA practicable, the model was often mentioned, then routinely dismissed in favor of proposals that focused on either simpler (one wave) or more complex (greater than three waves) models for the peopling of the Americas. Despite these setbacks, research in genomics by David Reich and his colleagues on over 375,000 SNPs (single-nucleotide polymorphisms) found a pattern of variation consistent with the neglected 3-wave model—and gave it new life. Moreover, when Reich et al. acknowledged that dental morphology yielded valid taxonomic markers traceable to specific founding populations, they vindicated Turner's proposal, which for years had been brutally criticized.

Eastward to Beringia, then *whoa!*

Backtracking a bit, Erica Tamm and her colleagues in 2007 published an article in *PLOS One* that suggested mtDNA evidence showed a pattern consistent with a Beringian Standstill. The standstill, or incubation, model proposes that Upper Paleolithic populations from northeast Asia colonized the Far North over 30,000 years ago. The key supporting archaeological site was the Yana Rhino Horn site, excavated by Vladimir Pitulko and his Russian colleagues (**MT 19-3. -4, 20-1,** "Yana River, Siberia: Implications for the Peopling of the Americas"). This exceptionally well preserved site, located on the banks of the Yana River, lies at 71° N latitude, a brutal environment for human existence then and now. Excellent organic preservation and a broad suite of C-14 dates firmly established an early human presence at high latitudes.

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–Michael R. Waters, Director

If people had the cultural means to adapt to this harsh environment, what kept them from pressing on to the east for an early entry into the Americas? The answer is ice. North America was enveloped by two enormous ice sheets, the Cordilleran Ice Sheet in the west, the Laurentide Ice Sheet in the east, that extended across the breadth of Canada, from the Gulf of Alaska to Newfoundland (**MT 32-4,** "Was the Ice-free Corridor the route followed by the First Americans?"). These ice sheets blocked terrestrial travel to the south, and massive glaciers along the Gulf of Alaska and Pacific coast made human movement along the coast no easier or any more feasible. The hardy populations that made their way to Greater Beringia during the Upper Pleistocene were left with two choices. They could retreat farther south, or remain in Beringia and find habitats that would sustain a hunting-gathering economy. Some groups may have followed the path of least resistance, falling back to more moderate climatic regimes in East Asia. Accumulating evidence, however, suggests that some groups stayed the path and remained in Greater Beringia for 8–12 millennia until, by 15,000–17,000 CALYBP, climatic conditions of the Upper Pleistocene ameliorated and made southerly movement along the coast possible.

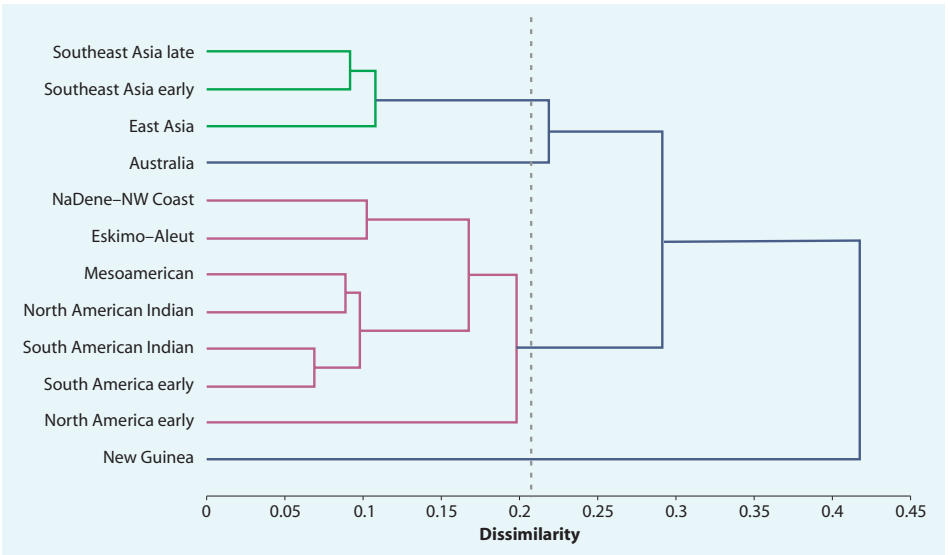
Three-rooted lower first molar (3RM1), the key trait that initially led Christy G. Turner II to propose a 3-wave model for the peopling of the Americas.

What are the biological ramifications of a Beringian Standstill? Ironically, Turner never contemplated this possibility. The final decade of his life was devoted to a detailed study of Siberian cave taphonomy. He never wavered from the general notion that Native Americans came in three successive waves from northeast Asia: Macro-Indians in the first wave, Na Dene and Eskimo-Aleuts in the second and third waves. (He wasn't sure of the order of these latter two groups, just that they were more recent than American Indians.)

In the footsteps of the master

After a long, productive, and often controversial career, Christy Turner passed away in August 2013. As his first Ph.D. student, long-time collaborator, and friend, I took it upon myself to salvage the dental portion of his enormous data-gathering efforts. To this end, I repeatedly visited Tempe and with the kind assistance of daughter Korri and second wife, Olga, I scanned hundreds of computer printouts, 30,000 individual data sheets, and over 3,000 slides. This effort, which received no support from other persons or agencies, has been informally dubbed the Christy G. Turner II Legacy Project. Given that Turner not only laid the foundation for the anthropological uses of dental variation but also pioneered the study of cannibalism and violence in the American Southwest, it was hardly any wonder that he wasn't able to analyze fully the mountain of data he amassed through the years. With the Legacy Project, his efforts will be utilized and recognized for decades to come.

In 2014, I was invited to participate in an SAA symposium in honor of Gary Haynes. Dr. Haynes, known primarily for his foundational research in taphonomy, devoted part of his professional life to issues surrounding the peopling of the New World. Since my own research didn't touch on taphonomy, I decided that my contribution should address Haynes's ancillary research on Native American origins. Now that I had all Christy's data sheets and not simply the large combined samples used in our

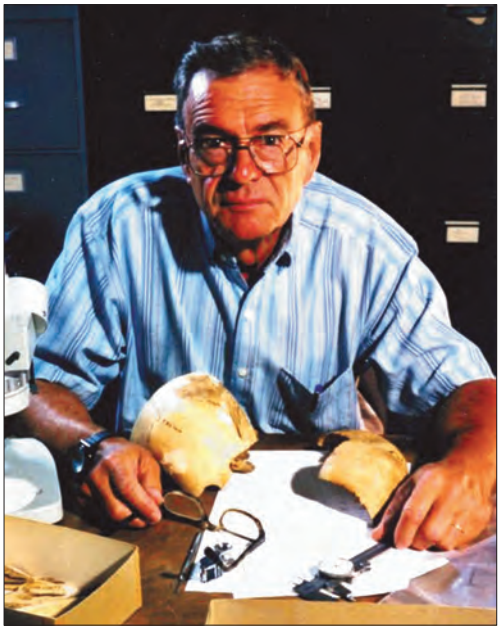


A dendrogram with Asian, Pacific, and New World populations. Note that East Asia clusters with Southeast Asia, while all New World groups cluster together. This level of differentiation from Old World groups required an extended period of time and spatial isolation, which supports the idea that populations ancestral to Native Americans were isolated from other Asians in Greater Beringia during the latter stages of the Pleistocene. The dotted line marks the depth of divergence of Asian populations from New World populations.

1997 publication *The Anthropology of Modern Human Teeth,* I could do a much more thorough analysis.

Verifying Turner's insistence on exclusive Sinodonty

Some physical anthropologists, notably skeletal biologists who measure crania, have long contended that early American Indians didn't look like later American Indians. In many biodistance analyses, they often found similarities with Pacific Island populations or Australian aboriginals. Some dental anthropologists also took issue with Turner's proposal that *all* New World groups were derived from northeast Asian Sinodont populations. Instead, they proposed that some groups exhibited Sundadonty, which intimated possible ties to Southeast Asian groups. These contentious points provided an issue to focus on: Was there any evidence in the massive Turner dataset that would support the presence of Sundadont groups in the Americas? Considering that many researchers favored at least two major waves of migrants, I evaluated each trait in the context of Sundadont-early, Sinodont-late, or Sinodont-only. No one has ever suggested a Sundadont-only model, which could be easily and immediately disproved. I compared histograms of 24 crown and root trait frequencies for Australians, New Guineans, Southeast Asia early, Southeast Asia late, East Asia, American Arctic, Northwest Coast/Na Dene, North American early, North American late, Mesoamerica, South American early, and South American late. Seven traits showed little variation among any of the 12 groups and contributed nothing to the problem. Most traits, however, were consistent with the Sinodont-only model. Ironically, of the three traits consistent with Sundadont-early, Sinodont-late, 3RM1 was the single trait that precipitated the formulation of the three-wave model.



Christy Turner at work.

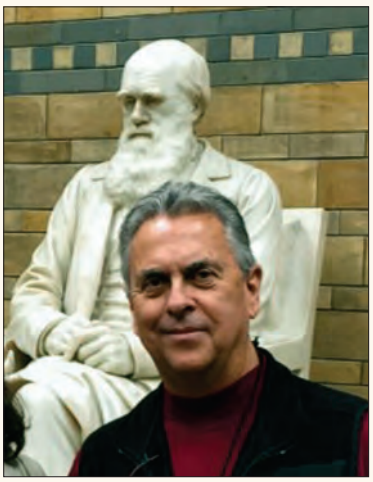
Although it wasn't a surprise that most dental traits supported the Sinodont-only model, the next step of the analysis led to an unanticipated result. I recruited three graduate students to do a biodistance analysis of the Asian/New World data set. Different distance measures and clustering algorithms all pointed in the same direction. Turner had viewed Native Americans as Sinodonts, with dental linkages to China, Japan, and Mongolia. No dendrogram, however, supported a close link between Native Americans and East Asians. Instead, East Asians clustered with Southeast Asians. All distance measures indicate that Native Americans are more like East Asians than Southeast Asians, but they are still distinctly different from East Asians. In the original 2016 article in *Quaternary International*, we referred to Native Americans as Sinodonts on steroids or super-Sinodonts. Native Americans do share Sinodont traits with East Asians, but they consistently show higher frequencies and more pronounced trait expressions. Thus they cluster together as a coherent group, but one differentiated from East Asians long ago. Turner never noted this because Beringian Standstill as a concept hadn't been broached. The difference between China–Mongolia and New World groups has long been known but never emphasized; the emphasis was on their commonalities, not the differences. Moreover, without a standstill, there would be no obvious mechanism for proto-Native Americans to differentiate radically from populations in northeast Asia.

The Beringian Standstill to the rescue

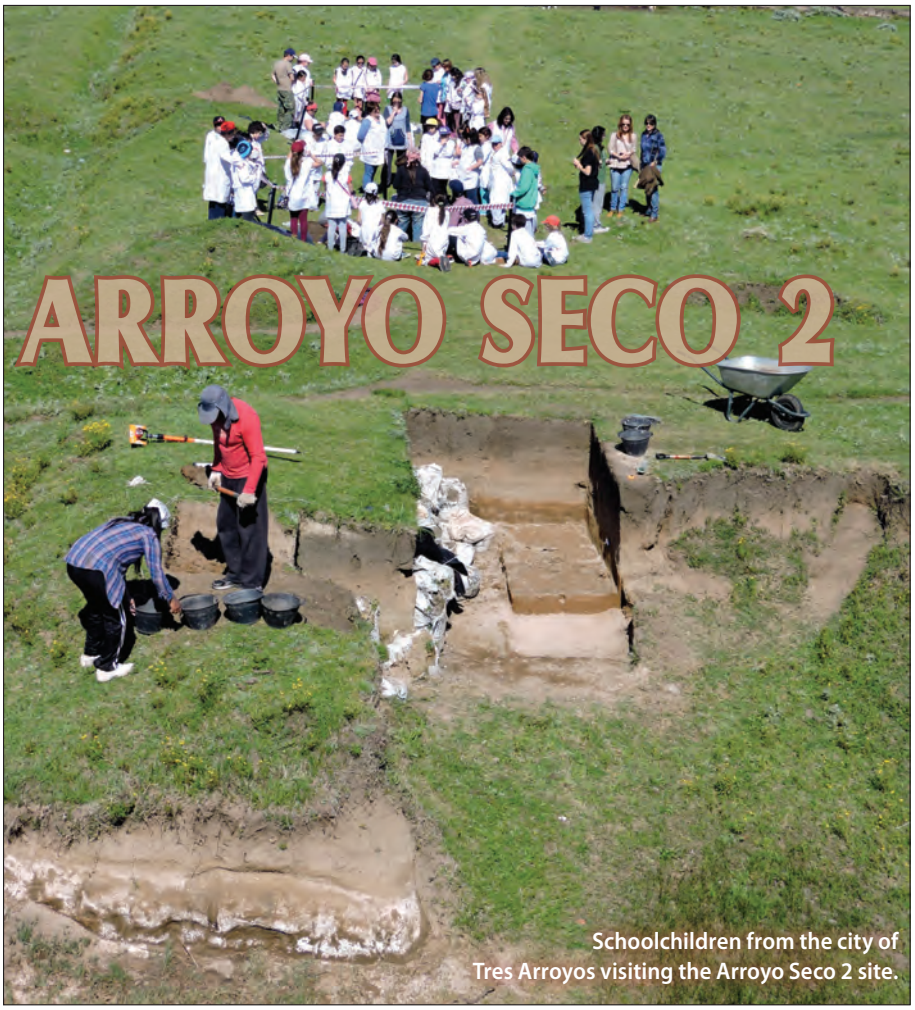
Although Turner's original formulation for the peopling of the New World requires modifying, his recognition of three distinct groups in the New World still stands. North and South American Indians are like one another and are the most distinct from East Asian groups. Eskimo-Aleuts, although part of the standstill population, nonetheless show closer ties to East Asians than any other Native Americans. This is indicated by both genetic and dental data. As usual, Na Dene–Greater Northwest Coast remains the muddle in the middle. Without question, North and South American Indians deviated first from the standstill population. As detailed in the

continued on page 8

About the author G. Richard Scott is a Foundation Professor of Anthropology at the University of Nevada, Reno. He earned his B.A. and Ph.D. degrees in Anthropology at Arizona State University. After completing his degree under Christy G. Turner II in 1973, he taught at the University of Alaska Fairbanks from 1973 to 1997. After a short-lived retirement, he resumed his academic career at the University of Nevada, Reno in 2001. His specialty is dental anthropology, with a focus on human tooth crown and root morphology. He has written or edited four books in this area, including *The Anthropology of Modern Human Teeth* (1997), which will come out as a second edition in 2018. Geographically, he has worked in the American Southwest, Alaska, the North Atlantic, and Spain. He collaborated with Turner on a dozen articles, many of which focused on how tooth morphology informs the early settlement of the Americas.



Prehistory in the Southern Cone



GUSTAVO POLITIS

Schoolchildren from the city of Tres Arroyos visiting the Arroyo Seco 2 site.

ARCHAEOLOGICAL EVIDENCE gathered in recent years suggests that humans reached the Americas 16,000 to 18,000 years ago, after the Last Glacial Maximum, when glaciers and an icy, barren environment blocked easy access to the Americas by way of northern Canada. So it's likely humans came from Asia via a coastal route. That would also explain why many early sites lie on or near the coast, or near rivers that meet the sea. Earlier-than-Clovis humans left evidence in sites where they processed animals during hunting excursions. One such processing site, Arroyo Seco 2 (AS2), provides a multidimensional look at these early occupations.

Located just 5 km outside the city of Tres Arroyos in Buenos Aires province in the Pampas region of Argentina, AS2 is one of the oldest archaeological sites in the Southern Cone. Dating the occupation of the Southern Cone is important because it could be the last stage in the expansion of *Homo sapiens* throughout the world. The occupants of AS2 were one of the first groups that moved into this region some 14,000 to 15,000 calendar years ago.

Indisputable evidence

Gustavo Politis, Professor of Archaeology at the Universidad Nacional del Centro de la provincia de Buenos Aires, Argentina, who worked on the site as an undergraduate student in the late '70s and has been returning ever since, cites undeniable evidence for human occupation and reoccupation of AS2 over thousands of years. First, stone tools bear sharp edges from intentional flaking and many show evidence of use wear from scraping hides. These early settlers were hunter-gatherers who used stone tools for hunting, butchering, scraping hides, preparing food, and making other tools of bone and wood.

Second, most of the toolstone, quartzite and chert, can only be obtained from two outcrops in the area. AS2 lies 150 km from the closest outcrop and 60 km from the coast. These hardy settlers, who predate the North American Clovis culture by at least 1,000 years, were highly mobile, traveling to the hills and the coast to obtain what they needed.

Third, the profusion of animal bones from a diversity of species grouped in one place can't be accidental. The Pampas is a grassland, a superb environment for large herbivores. Horses, for example, have few predators except for humans. The landscape, like an African savannah, was home to diverse animals that grazed the lush grasses (**MT 29-2,** "Footprints of the Pampas: A past worth saving"). Moreover, a large paleo lagoon, which formed a backdrop to this late-Pleistocene scene, made plenty of water available and was undoubtedly visited often by land animals and fowl. AS2 has the hallmark of a prime processing site that was visited and revisited seasonally for thousands of years.

This processing site served as a way station between kill sites and the residential camp. "Several African models show the same thing," Politis says, "with hunters moving from kill sites to process sites, then returning home." The kill site was purely opportunistic. Foragers left the residential campsite on trips for food, raw material, and information. And most important, according to Politis, was information. Technology spread rapidly among bands of people. "What was transmitted was the knowledge," says Politis, "not the people."

A site replete with frustration for the archaeologist

Viewing the complete assemblage of artifacts and animal remains unearthed at AS2 brings evidence of human activity into sharp relief. "The bones aren't just on their own in the middle of nowhere," says Daniel Rafuse, a postdoctoral fellow at the Universidad Nacional del Centro in Buenos Aires. A wide variety

of animal bones are intermingled with stone tools, "all part of this larger, general site. We don't have a natural accumulation of material. Looking at the whole assemblage, we can tell this must have been brought there by humans."

Radiocarbon dating of associated organic materials dates tools found at Arroyo Seco 2 at 14,000 years old. Erosion at the site, however, has disturbed the stratigraphy. So even if a tool appears next to a bone in a given layer, it may have migrated from a later stratum under the influence of wind and water. Furthermore, natural processes sometimes affect bone. "When we see weathering of a bone," Politis explains, "we can tell it wasn't buried quickly but exposed and reexposed. These processes give us clues to reconstruct the story." On the other hand, natural processes like calcium carbonate precipitation can obscure cutmarks and other evidence of human modification, and diagenic processes sometimes impoverish the collagen content of bone and prevent radiocarbon dating.

MARIA GUTIERREZ

Quartz crystal associated with a human burial.

Reoccupation introduces yet another layer of difficulty. "There's a long record at this site, showing it was occupied and reoccupied by humans," says Maria Gutierrez, Professor of Taphonomy at the Universidad Nacional del Centro de la provincia de Buenos Aires and researcher at INCUAPA-CONICET. To identify a specific occupation, she reminds us, you need a cultural floor, but at AS2 14,000 years of occupation have been telescoped into a depth of less than 2 m.

Of more recent origin is the problem of human burials by local residents. "They mixed up some sectors of the site, and that just makes things more difficult," says Politis. "The formation processes—both natural and cultural—are very complex. We've been studying it for decades now, and there are still so many questions to answer. When you believe you can answer one question, you realize new questions open up, and it obligates you to return with a new perspective or line of evidence. You never say, 'This is the last time I'll come here.' "

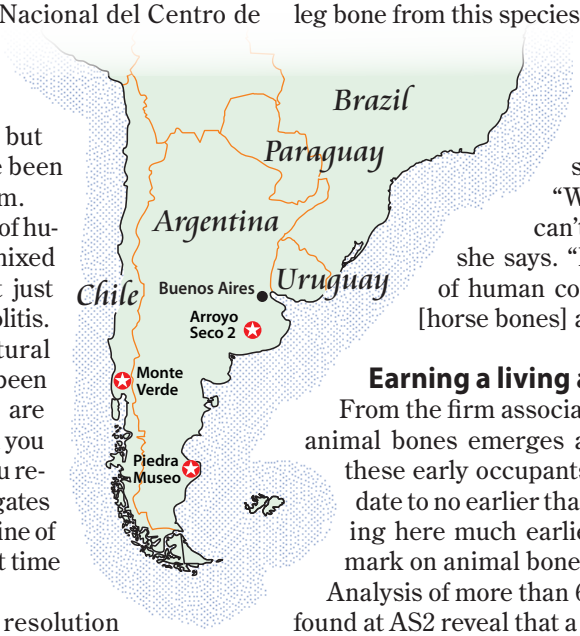
The vast chronology and uncertain resolution are formidable problems. For Politis, AS2 is an opportunity for scientists to refine their techniques of taphonomy and geoarchaeology and thereby refine the site chronology. He states frankly that "because of this low resolution, we study things that are sometimes not very strongly studied at sites."

What the bones tell us

The cataloguing of animal remains recovered at Arroyo Seco 2 has yielded a staggering record. Of more than 100,000 faunal remains recovered, about 6,200 have been classified taxonomically and 40 different taxa identified. In all, 272 extinct Pleistocene mammal remains have been identified. Besides guanaco and rodents, which are the most numerous, remains have also been recovered of giant ground sloth (*Glossotherium robustum, Megatherium americanum, Mylodon,* and *Lestodon*), extinct horse (*Equus neogeus* and *Hippidion*), South American ungulates (*Toxodon platensis* and *Macrauchenia*), Glypotodon, and giant armadillo (*Eutatus seguini*).

Researchers detect human interaction with animals by modifications made on the bones. "We look for cutmarks from a stone tool, or fractures on the bone to see if the bone was broken by humans to make tools or to get bone marrow for grease or consumption," Rafuse explains, "and we find a lot of natural processes happening to those bones after humans used them, too. We might find carnivore marks, or whether it was weathered or broken down. So all these things, the human activity and natural activity, are how we piece together the history of that bone."

Some of the animal bones bear clear evidence of human consumption, particularly on the guanaco, which was a main food source at AS2. Gutierrez notes that an extinct horse species, *E. neogeus,* shows clear evidence of human processing. A front leg bone from this species about 14,200 years old bears distinct marks from a hammerstone and green-bone fractures (**MT 23-1,** "Early mammoth bone flaking on the Great Plains"), evidence for humans shattering bones to extract marrow. "We found a lot of extinct fauna, but we can't say that all of them were consumed," she says. "It's not always easy to find evidence of human consumption of bones. But with these [horse bones] and *Megatherium,* we're convinced."



Earning a living at Arroyo Seco 2

From the firm association found between human tools and animal bones emerges an understanding of the lifestyle of these early occupants. Although the oldest human bones date to no earlier than 8,000 years ago, people were camping here much earlier. We know because they left their mark on animal bones.

Analysis of more than 600 bone fragments out of thousands found at AS2 reveal that a major part of the diet was meat from various extinct horse species, such as *E. neogeus,* and other

extinct megamammals like giant ground sloths, camelids, and giant armadillos.

The absence of certain bones also tells us a lot about how these people went about their work. Researchers found no megafaunal skulls or bones of chest or pelvis. For Rafuse, the reason is simple: It's because "people were transporting certain sections of the animal from the kill site to the archaeological site." Given, for instance, the enormous body of *Megatherium* (4–5 tons), to transport the entire carcass, or even complete hindquarters or forequarters, would be a herculean task. Therefore the animal was hunted or scavenged near the site, the skeleton butchered into smaller parts, which were then carried to AS2 for further processing.

DANIEL RAFUSE

Politis (*standing, center*) explaining the Arroyo Seco 2 site to visitors, 2009 field season.

The most common extinct mammal discovered here is the horse, *E. neogeus*. Skeletal parts recovered are almost entirely from the appendicular skeleton, including limb bones, phalanges, and carpal and tarsal bones. A single molar is the sole item found of the axial skeleton. In fact, except for the molar, a single piece of rib bone, and a piece of the acetabulum (hipbone cavity), the extinct-horse assemblage consists entirely of bones of the appendicular skeleton. In the assemblage of skeletal remains from other Pleistocene megamammals, fragments of skull, vertebrae and rib are likewise largely absent.

By the time the Inca and other great South American civilizations appear, the horse species were gone. The continent wouldn't be populated again with horses until the European invasions.

Later came human burials

Thousands of years after the first colonizers arrived at AS2, humans started burying their dead there. According to 30 radiocarbon dates obtained from human skeletons, the site was used for burying people between 8500 and 4500 CALYBP. Found with them were burial ornaments consisting of shells used for headdresses or necklaces, and canine teeth pierced with holes. Rafuse recounts that "it's not like digging up an animal bone where there's not a personal relation with that bone, but when you find these personal items you can have a connection with that material. And since these people had no written language and didn't make artwork on rocks, finding human burials is a direct look into what kind of ritual activity they were doing." Politis is intent on exploring the "symbology or ideology behind this funerary activity" to grasp the semiotic and contextual importance of these burials.

The earliest level, dated 7600–7800 CALYBP, contains five human burials with triangular projectile points lodged between the ribs and vertebrae. So far, the team has found 15 projectile points among its group of 50 human skeletons. For Politis, this evidence of violent deaths "indicates ethnic violence or cultural conflict between bands in the early to middle Holocene in the Pampas." He hypothesizes that the people might have had two different kinds of points, one for killing people and one for killing animals.

When projectile points are absent, the cause of death is unknown. "Last year," Politis recalls, "for the first time we found the burial of a young boy maybe 12 to 14 years old, with two bola stones wrapped around his shoulder. Maybe it was a burial practice, or maybe he was killed. When we get a date from this burial we can get a direct date from the stone because they are absolutely contemporaneous—the stone and the burial."

DANIEL RAFUSE

Gutierrez and Politis conferring at the Arroyo Seco 2 excavation, 2009 field season.

DNA analysis and future aims

Researchers have found 50 human skeletons, a robust sample for DNA analysis. Because they are buried in the same place, they are likely members of the same cultural group. Politis has enlisted the help of Lars Fehren-Schmitz at University of California–Santa Cruz to perform mitochondrial and nuclear DNA analyses on the human skeletons. Fehren-Schmitz's human paleogenomics lab has collected data from different human bones in the Americas. Those from AS2 rank among the oldest. The aim is to study the microevolutionary process over 3,000 years. "The earliest skeleton isn't far from the first people who entered the continent," says Politis, "so we have clues to understanding the peopling of the Americas. Fehren-Schmitz

recently collected new results, and he and Politis are polishing the data for future publication. Politis, justifiably proud, boasts that "there aren't many places in the Americas where you get this kind of variety from early and middle Holocene times, right? Here we have 50, a great sample."

With human skeletons, animal bones, and tools, archaeologists have collected important pieces of the complete image of the Arroyo Seco 2 site. Now Gutierrez plans to reconstruct the paleoenvironment more fully to enlarge our knowledge of human-animal interactions. For his part, Rafuse is concentrating on pinpointing the dimensions of the AS2 site: "We need to keep digging to see where this site ends physically, to find the outer limits." AS2 offers ample opportunity for archaeological research for many years to come.

Local support is a bonus

The people of the Pampas are curious about their deep past, about a world inhabited by animals unrecognizable to them. Researchers can rely on support from the local community. "We're grateful to the people of the Pampas," says Gutierrez. "The site is close to the city of Tres Arroyos, and the local people are always very interested in their past and they're so helpful in many ways. They really think that past is there, even though it's 12,000 years away from them. It's not just our work, but our work in relation to them and how much our work contributes to our knowledge of their past." Gutierrez and her colleagues invite local schools to visit the site and learn about what archaeologists are doing there. Their efforts have paid off: Over the last 10 or 20 years, 3 students after visiting the site decided to become archaeologists. "So we're also uncovering professions. Uncovering dreams," she muses.

Much of the materials recovered from the Arroyo Seco 2 site are on display at the Jose A. Mulazzi Municipal Museum in Tres Arroyos, which features a reconstruction of how Pleistocene occupants lived. These learning centers offer opportunities for locals to connect with their past.

–Katy Dycus

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From Three Waves to a Standstill

continued from page 4

2008 article by Scott and Turner in *Alaska Journal of Anthropology,* the intermediacy of Na Dene–Greater Northwest Coast likely developed in the New World through admixture.

In sum, while all lines of biological evidence support the affinities of Native American populations with East Asians, significant dental differences exist between these broad geographic groups. In all analyses, Native Americans from Alaska to Tierra del Fuego form a coherent dental cluster set apart from all Old World populations. The homogeneity of Native American groups and their striking difference from Asian populations required two key elements, time and isolation. The Beringian Standstill model provides both.

–G. Richard Scott

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South American Monkeys Make Stone Pseudo Tools

WHEN JANE GOODALL informed the late Louis Leakey of her epic discovery that chimpanzees modified sticks so they could use them as termite fishing poles, he famously responded that "now we must redefine man, redefine tools, or accept chimpanzees as humans." New observations of capuchin monkeys making stone flakes and cores, reported late last year in the journal *Nature,* are similarly revolutionary for our understanding of the technological capabilities of early human ancestors as well as for interpreting the significance of stone tools at very early sites in South America and other regions inhabited by monkeys.

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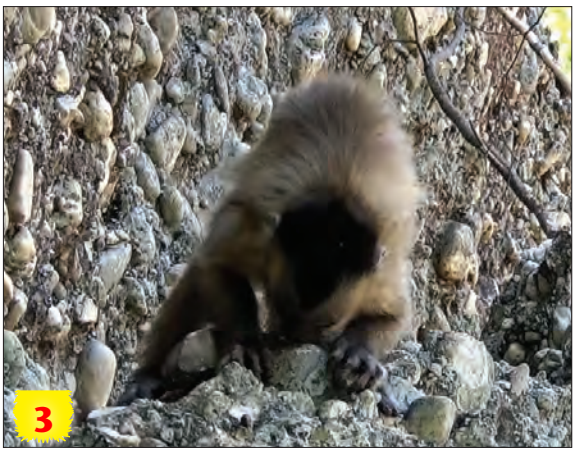
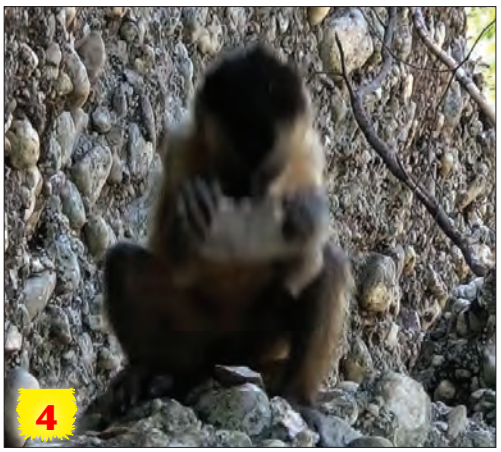




MICHAEL HASLAM

How a capuchin monkey emulates a human flintknapper.

1, the monkey selects a quartz cobble as a hammerstone from colluvium aggregate and carries it to a suitable anvilstone;

2, the monkey grasps the hammerstone, exactly as a human knapper might do it, and smashes it against the anvilstone;

3, the monkey sets the hammerstone aside and licks the anvilstone at the point of impact, possibly to ingest either nutritious plant matter or stone particles for their mineral content.

4. In a variation of the process, the monkey sets a fragment of quartz on the anvilstone and attempts to shatter it using the hammerstone. This attempt wasn't successful: The fragment flew off with the first blow.

Remembering

RUTHANN KNUDSON
1941–2018

RUTHANN was a solid, no-nonsense person when it came to science, a natural leader and born to organize––and at the same time, friendly, respectful, pitching in to help, truly good-hearted. Lithics was her passion, especially Paleoamerican lithics, along with a love of cooking and pickling that filled her cupboards, and relaxing with embroidery that covered the walls of her pleasant home. Around the house were fruit trees she planted, flowers and veggies masking the High Plains natural landscape. Ruthann lived life to the fullest, with an energy that seems to still vibrate when we think of her.

When Ruthann began her professional career in archaeology in the 1960s, Plains and Paleo research were dominated by men, and I do mean dominated. We women were called girl archaeologists, literally looked down upon (Ruthann would stare at the man she was talking to, minimizing that he might be taller than she). Washington State University at Pullman, in the desert eastern part of the state, had one of the few graduate programs in archaeology that seemed to acknowledge the potential of women students, although Ruthann confided that she and the other women known as Daugherty's Daughters, after the major professor Richard Daugherty, still had to assert themselves to succeed. Ruthann and Leslie Wildesen (died 2014) were especially prominent in that cohort. Wildesen chaired an SAA committee, which reported in 1980 that "becoming accepted as a professional" was the major issue women members said they dealt with.

We women were advised that if we wanted to do fieldwork, the degree we needed was the MRS.: marry a man archaeologist who would take you into the field with him. I was lucky that mine was comfortable with me as collaborator, not just a silent helpmate. Ruthann married Tom Shay, then W. Raymond Wood, a fact she noted he did not mention in his recently published autobiography, and the marriages did not last. As Wildesen stated in the 1980 SAA report, women archaeologists found discrimination against them in job opportunities and research support, resulting in women's being employed in lesser-ranked universities or in lab rather than professor positions, or taking jobs outside academia—this survey covering the late 1970s when CRM archaeology was not yet a major employer. Wildesen forged her own career in consulting; Ruthann taught at the University of Idaho, 1974–81, then worked for Woodward-Clyde Consultants, 1981–88, and finally took government work, 1989–90, for BLM in Montana, and 1990–2005 with the National Park Service. Her last position was Superintendent of Agate Fossil Beds National Monument, on the Niobrara in northwest Nebraska. Taking retirement, Ruthann chose Great Falls, Montana, as an affordable residence from which to work independently as Knudson Associates. Her e-mail address, paleoknute@optimum.net, reflected her preference for working on Paleo materials.

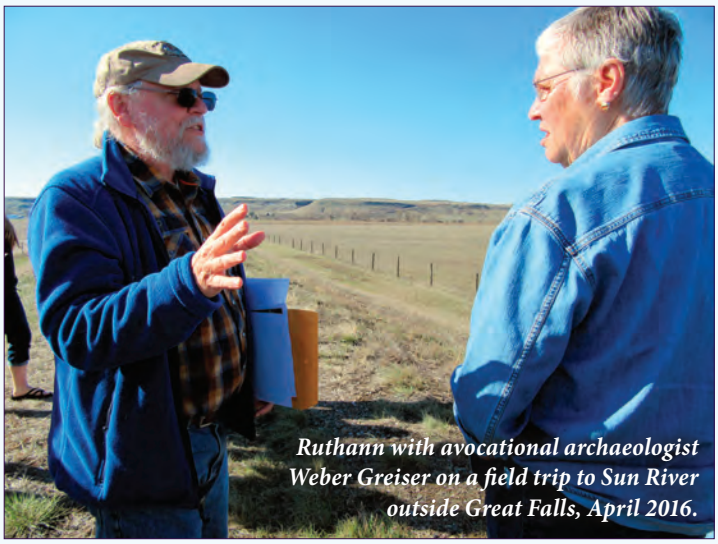
MONDAK HERITAGE CENTER

It was Ruthann who led the break-out of women in SAA. During an SAA meeting in the early 1980s, I was waiting outside a room where the SAA Board of Directors was meeting. Dena Dincauze, my classmate in college and grad school, was editor of *American Antiquity* at that time, requiring her to attend the Board meeting, and we were going to have dinner together after the meeting. The door of the conference room opened and five men walked out, arms around each other's shoulders, laughing and talking about getting a beer. Then the women in the meeting marched out, shoulder to shoulder, Ruthann in the middle. They stood watching their erstwhile colleagues. Ruthann spoke, "There go the Old Boys. Well, here's the Old Broads. Let's go to dinner!"

For several years, the Old Broads dined together at SAA, talking about women's issues. Ruthann, Dena, Leslie Wildesen, Annetta Cheek, and I were joined by more and more women, until the dinner group grew so large that restaurant space had to be reserved, and conversations were limited. By then, only a few years later in the '80s, the chilly climate was warming a bit. Dena Dincauze became President of SAA, its third woman president (predecessors were H. Marie Wormington and then her protégée Cynthia Irwin-Williams). CRM was growing into a major employer of archaeologists, Ruthann included, during the 1980s. Consulting with Native Americans was growing, too, a highly contentious issue that came to a head in 1990 when Congress passed NAGPRA, Native American Graves Protection and Repatriation Act. Ruthann's employment with the National Park Service brought her into discussions with Native Americans and working on protocols. While living in Great Falls, she taught an online course on Montana's American Indians, in addition to Introduction to Anthropology, for Montana State University–Great Falls College, and was pleased with the appreciation from Native Americans tak-

ing the course. In my experience, at least, Ruthann's straight-arrow talk, respectful but not naïve, won her goodwill from tribes and from activists––she was invited to attend the reburial of the Clovis-era Anzick Child, under Crow auspices.

Ruthann had both superb organizational skills and a penetrating knowledge of the archaeological record. That talent for organizing carried into her studies of lithics, where she was concerned not only with figuring out the knapping and sourcing of stone, but with working out the range of variation that seemed appropriate for a named type. Not too long ago, that approach was sneered at by a pair of younger men archaeologists, who told her that she "didn't know Plainview" when she insisted they consider its range. When she recounted the episode to me, I was aghast: WHAT?! For 30 years, Ruthann studied all the lithics anyone wanted to label Plainview, she drew thousands of specimens as a record and a means to better understand the technology, she finally drew upon all those data to set out what seems legitimately the products of a community of practice. Those younger dudes were so poorly educated, they were thinking in nineteenth-century science, picking out type specimens instead of apprehending processes and range of variation. Of course, that's faster and easier than Ruthann's searching out every collection and painstaking ordering of the factors involved in each artifact. Probably the dudes don't experience as she did, as all good scholars do, what Dena Dincauze called "recursive ignorance"—translation: the more you know, the more you know you don't know. That drove Ruthann from Plainview into the project she was pursuing when the stroke broke, creating a definitive study of lithics labeled Goshen.



ALICE B. KEHOE

Ruthann with avocational archaeologist Weber Greiser on a field trip to Sun River outside Great Falls, April 2016.

The drive to collect and analyze data propelled Ruthann into leadership among professionals and avocationals alike. At Montana Archaeological Society meetings, she was a magnet. Around Great Falls, she identified endangered sites and those worth investigating for information, taking groups out for tours to see as she did. Her expertise and broad experience were called upon to serve on the Montana Burial Preservation Board, and earlier in Idaho and Nebraska, to advise on archaeological matters when she lived in those states. Because she never talked down to non-professionals (or to women), she was a true educator, an endeavor that brought her great satisfaction when she saw her efforts nurture understanding of scientific method and of the human dimensions hidden in the archaeological record.

The history of women in archaeology includes substantial research by Ruthann, particularly about women in River Basin Survey projects. In a session on River Basin Surveys at the 2014 SAA meeting, and in the edited book of papers from the session, Ruthann astounded the audience by asserting that the majority of employees in River Basin projects were women. How could that be, when we all knew that RBS notoriously did not employ women? Ruthann's straight-arrow gaze saw hundreds of women working as typists, lab personnel, cooks. Indeed, she figured about three-quarters of RBS employees were women. True, after a hushed-up assault by a professor upon a woman crew member in an RBS camp, the Survey announced it would not hire women as crew members. Guys were paid $40 per week, we young women at best got $18 per week as assistant field supervisors if (like Dena Dincauze and me) we had already a couple summers of fieldwork. Ruthann's eyes-wide-open view of women in archaeology was more than feminist, it was also throwing light on the social class structure Americans don't usually see. How many of those working women could have been professional archaeologists if they had been encouraged and supported?

Ruthann's own background was northern Midwest, Heartland. Her family included forebears who had been outcast by Roger Williams because they were too heretic for even that heretic Puritan. Seventh-Day Baptists became a small sect (not Seventh-Day Adventists) that settled in Milton, Wisconsin, a farm village south of Madison, when colonization began in that area in the 1840s. She lived in Milwaukee as a child, and matriculated at Hamline University in St. Paul, MN, then completed her B.A. and M.A. in Anthropology at the University of Minnesota before her doctoral work at Washington State University. It happens that my in-laws were farmers in Milton; steady hard work, no highfaluting nonsense has been the way of life there. Ruthann Knudson reflected that ethos and the unstinting neighborliness of the farmers. She accomplished a great deal as a scientist and in service to the profession and government agencies. Above and beyond, she was a real human being. The stroke that cut off her busy life left a hole in our world.

Ruthann's final published work, the fruit of years of attention and firsthand detailed study.

–Alice B. Kehoe

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Three years previous to the publication of this research, when Brazilian archaeologists announced that they had discovered stone tools at the Toca da Tira Peia rockshelter in the Serra da Capivara National Park in Brazil that dated to as early as 22,000 years ago, archaeologist Stuart Fiedel told the *New York Times* that monkeys might have made the tools. Supporters of the claim for the surprisingly early tools responded with incredulity.

It turns out, however, that Fiedel may have been on to something. Susana Carvalho, an archaeologist and primatologist at the University of Oxford, responding to the recent paper in *Nature,* told *Science News* that the notion that some of the earliest stone tools might have been made by monkeys "is not a wild idea anymore." Although Carvalho was referring to the oldest documented stone tools from Africa, the artifacts recovered from the earliest levels of the Toca da Tira Peia rockshelter, described by the excavators as simple pebble tools and flakes, are not all that different from the ancient African tools. Perhaps, in retrospect, Fiedel's suggestion wasn't such a wild idea either.

Monkey the toolmaker

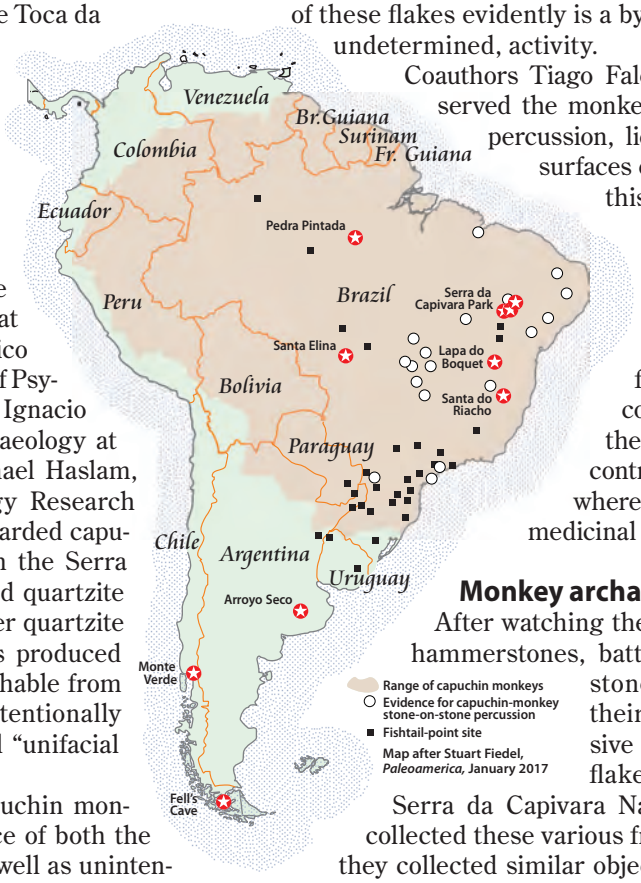
Tomos Proffitt and Lydia Luncz with the Primate Archaeology Research Group at the University of Oxford, Tiago Falótico and Eduardo Ottoni with the Institute of Psychology at the University of São Paulo, Ignacio de la Torre with the Institute of Archaeology at University College London, and Michael Haslam, with the Oxford Primate Archaeology Research Group, reported in *Nature* that wild bearded capuchin monkeys (*Sapajus libidinosus*) in the Serra de Capivara National Park use rounded quartzite cobbles as hammerstones to bash other quartzite cobbles. In the process, the monkeys produced flakes and cores that "are indistinguishable from some archaeological examples of intentionally flaked early hominin stone cores" and "unifacial choppers."

The team repeatedly observed capuchin monkeys "deliberately crushing the surface of both the active and passive hammerstones" as well as unintentionally fracturing the stones during use. They additionally observed a capuchin "place a newly fractured stone flake on top of another stone, and then strike it with a hammer" in a way that resembled bipolar flaking practiced by human flintknappers. It might seem odd that the monkeys "were not observed using the sharp edges of fractured tools to cut or scrape other objects." But the fact that capuchins produce stones with sharp edges without intending to do so and then do not take advantage of the sharp edges when they are produced suggests that the context for the earliest hominin stone-tool production need not have been the production of sharp-edged cutting tools. That may have come later. It also demonstrates that you don't have to be human, or a human ancestor, to make "conchoidally fractured, sharp-edged flakes and cores that have the characteristics and morphology of intentionally produced hominin tools." This has implications potentially even more far-reaching than Goodall's observations of chimpanzee tool use.

Why do monkeys knock rocks together?

Proffitt, Luncz, and their colleagues report that the bearded capuchin monkeys of the Serra da Capivara National Park "use stone tools in more varied activities than any other known non-human primate." These uses include "pounding foods, digging and in sexual displays." They also are "the only wild primates" that engage in stone-on-stone percussion "for the purpose of damaging those stones." The research team hasn't observed the monkeys using the sharp flakes they produce "to cut or scrape other objects," so the production of these flakes evidently is a by-product of some other, so far undetermined, activity.

Coauthors Tiago Falótico and Eduardo Ottoni observed the monkeys, engaged in stone-on-stone percussion, licking or sniffing the crushed surfaces of the battered rocks. Based on this behavior, they propose that the monkeys might be ingesting either powdered quartz or crushed lichens that were growing in the cracks and crevices of the rocks. Silica from the powdered quartz could be an important mineral in their diet that would, for example, contribute to the growth of bones, whereas the lichens might have some medicinal benefit.



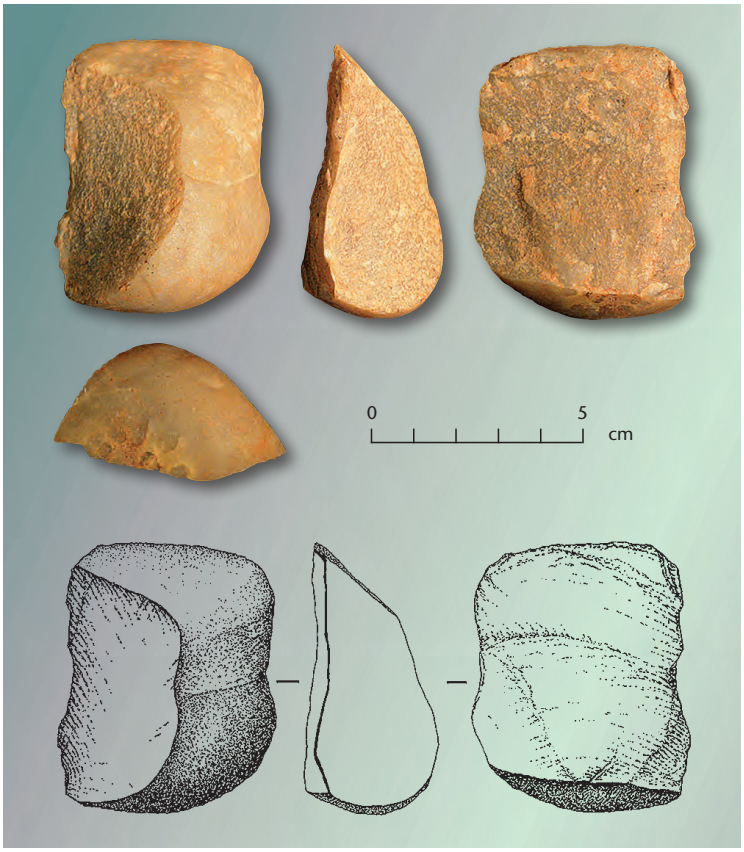
Monkey archaeology

After watching the capuchins create a variety of hammerstones, battered rocks resembling anvilstones that Proffitt, Luncz, and their coauthors refer to as "passive hammers," and sharp-edged flakes at the Oitenta site in the Serra da Capivara National Park, the researchers collected these various fragmented stones. In addition, they collected similar objects from "surface surveys and an archaeological excavation in the same area." The total assemblage of monkey-made stone tools analyzed by the team consisted of "111 capuchin-modified stone artefacts [*sic*]" [perhaps better described as *faux* artifacts; artifacts by definition are only made by humans. –Ed.], including complete and broken hammerstones, passive hammers, flaked hammerstones, and complete and fragmented flakes. One goal of the analysis was to determine to what degree these incidentally produced monkey-modified stones resemble intentionally produced human stone tools.

When is a broken rock a stone tool?

Proffitt, Luncz, and their coauthors first reviewed the hall-

marks of the earliest well-documented stone-tool technology as a basis for considering whether the cobbles and flakes modified by the capuchins actually meet the standard definition of stone tools. These hallmarks include, first, "controlled, conchoidal flaking." This is flaking that takes advantage of the properties of certain types of stone, including quartzite, to break in predictable ways. Second is the "production of sharp cutting edges," which, for most human knapping, is the intended end result. Third, human-modified stone tools exhibit the "repeated removal of multiple flakes from a single core," which suggests an intent to remove flakes in a purposeful sequence rather than an incidental flake removal here and there. Fourth, human flake production involves "clear targeting of core edges," or platforms, not just haphazard bashing of random areas on the cobbles. And, fifth, a set of human-produced stone tools reveals the "adoption of specific flaking patterns." This is another indication that a flintknapper works according to a plan and doesn't simply haphazardly bash rocks together.



TOMOS PROFFITT

A fragment of a cobble, created by stone-on-stone percussion by capuchin monkeys. It mimics a conchoidal fragment produced by human flintknapping.

Surprisingly, the modified stones produced by the capuchin monkeys of the Serra da Capivara National Park possess all these characteristics. The flaked hammerstones "exhibit one or more conchoidal or wedge flake scars" that sometimes are "recurring unidirectional, overlapping flakes resulting from repeated strikes on a fracture plane." The complete flakes "have sharp edges, bulbs of percussion and scars from up to three previous flake removals." Proffitt, Luncz, and their team were able to refit flakes removed from the worked cobbles that "demonstrate this reduction sequence" and concluded that the flaked hammerstones "are indistinguishable from some archaeological examples of intentionally flaked early hominin stone cores" or "unifacial choppers."

In addition, passive hammers, or anvilstones, "typically have a localized area of percussive damage located on a prominent surface." This damage includes "impact points, battering marks . . . and, in some cases, detached flakes or chips." That some cobbles were used first as passive hammers and later as hammerstones indicates that the capuchin tools are "multifunctional, with the monkeys able to repurpose stones from a passive to an active percussive role."

The discovery that capuchin monkeys can produce modified stone objects indistinguishable from those produced by the earliest hominin toolmakers has fascinating implications for our understanding of human evolution. It has long been assumed that creating such stone tools requires a largish brain as well as dexterous

TIAGO FALÓTICO

Tiago Falótico of University of São Paulo (*kneeling far right*), and Michael Haslam and Lydia Luncz, both of Oxford University (*standing far right*), with their team at an excavation in Serra da Capivara National Park in Brazil.

humanlike hands. The capuchin monkey's ability to produce a similar range of tool forms suggests that large brains and opposable thumbs aren't necessary after all. Proffitt, Luncz, and their colleagues therefore caution "that sharp-edged flake production can no longer be implicitly or solely associated with intentional production of cutting flakes." They further point out the need to refine the "criteria commonly used to distinguish intentional hominin lithic assemblages."

The team plans to use the distinctive assemblages of monkey-produced stone pseudo tools to assist "in distinguishing human tools from capuchin artefacts where the range of these primates overlaps" and to "guide future archaeological investigations into the development of capuchin technology."

Ottoni and Falótico told participants of an International Workshop on Primate Archaeology, held at the University of Oxford in June 2016, that they had identified sites yielding "nut cracking hammerstones and anvils" in the Serra de Capivara National Park, which they dated "to around 700 BP, making them the oldest monkey-modified stones currently known outside Africa."

In question, the authenticity of ancient artifacts

Is it possible that 22,000-year-old stone tools from Toca da Tira Peia and much earlier artifacts from Pedra Furada, the yield of decades of research by Niède Guidon and her colleagues, are even older examples of monkey-made tools as Fiedel originally suggested? Proffitt, Luncz, and their colleagues don't address this question. Given that these sites are located within the range of the monkeys studied by the team, however, it seems a question worth asking.

Eric Boëda, Professor of Anthropology at the University of Paris and a specialist in prehistoric lithic technology, doesn't believe the stone artifacts found at Pedra Furada could have been made by monkeys. He told *Mammoth Trumpet* that "the difference between things made by humans and monkeys is very simple" and he claimed that many of the Pedra Furada tools possessed "a lot of different cutting edges that cannot be produced by nature or by monkeys."

Proffitt, Luncz, and their coauthors disagree. They assert that, prior to their discovery that capuchin monkeys could flake stone pseudo tools, if such tools and flakes produced by monkeys had been found in an archaeological site they would have been identified as artifacts made by humans and "potentially interpreted as the result of stone fracture and controlled flake production, and probably attributed to functional needs requiring the use of sharp edges."

David Braun, an archaeologist at George Washington University, was even more emphatic. He told *Science News* that the sharp-edged stones created by the capuchins displayed "remarkable similarity" to the alleged stone tools from Pedra Furada.

One problem with accepting the Pedra Furada stone tools as unquestionably the work of humans is that according to Fabio Parenti, an archaeologist with the Italian Institute of Human Paleontology, the evidence for human occupation at Pedra Furada goes back at least 60,000 years, whereas genetic evidence conclusively suggests that the ancestors of American Indians didn't enter the New World until 16,000 years ago (**MT 32-2,** "A high-resolution timeline for peopling of the Americas"). Mike Waters, Director of the Center for the Study of the First Americans, pointed this out to the *New York Times* back in 2014. If Pedra Furada was occupied by humans that long ago, he reasons, "then whoever lived there never passed on their genetic material to living populations." He adds that "we must think long and hard about these early sites and how they fit into the picture of the peopling of the Americas."

Proffitt feels that the "importance of this capuchin discovery does not relate to the human archaeological lithic material from Serra da Capivara National Park, but instead helps us understand what unintentional stone flaking may look like in the early hominin archaeological record, and may be useful in identifying such behaviors in future earlier archaeological excavations. This has important implications to identifying material related to the emergence of stone tool technology in our species."

Nevertheless, an unintended consequence of the work of Proffitt, Luncz, Falótico, Ottoni, de la Torre, and Haslam is that New World archaeologists, at least in parts of Central and South America, now must take into consideration the possibility that flaked stones that appear to be human-made tools just might not be what they appear to be. Additional studies such as those currently being undertaken by Proffitt, Luncz, and their colleagues are needed to further refine our understanding of the ability of New World monkeys to produce a quasi-archaeological record that could be misinterpreted as evidence for the earliest Paleoamericans. MT

–Brad Lepper

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Suggested Readings

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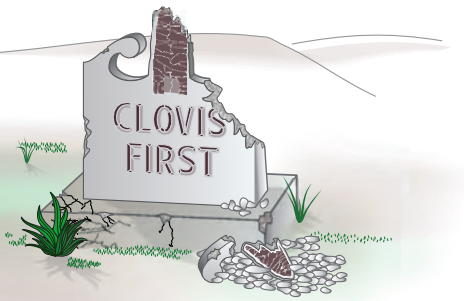
Tom Dillehay

The Clovis-First Iconoclast



LEGENDARY VANDERBILT UNIVERSITY anthropologist Tom D. Dillehay is one of a handful of scientists who are challenging long-accepted theories about the timing and nature of the peopling of the New World. His investigation of Monte Verde, an early settlement in Chile, has required that he grow thick skin to deflect darts and arrows shot at him by skeptics over the past 40 years. But Dillehay soldiers on, reinforcing with new evidence his contention that multiple migrations probably took place along both the Pacific coast and in the interior. Acting on that contention led to his discovery of the earliest accepted settlement in the Americas. The discovery, not surprisingly, has raised the hackles of proponents of the deeply entrenched Clovis-First theory.

"I grew up doing archaeology as a teen," Dillehay tells us, "participating in the excavation of Caddo Coral Snake Mound in east Texas." He spent time with avocational archaeologists (and a few professionals—Kreiger, Story, Jelks) in the Dallas–Fort Worth area during his high school years and did surface collecting at sites in Texas, Oklahoma, and New Mexico. "My grandfather and his friends had land out west where I did lots of surface-collecting, finding some Clovis, Folsom, and other point types," he recalls. "In fact, I was a big Clovis fan growing up."

In graduate school, Dillehay worked at cultural resource management in Texas, New Mexico, Oklahoma, and Louisiana, surveying and excavating at Paleo, Archaic, Pueblo, and Woodland sites. He was a teaching assistant in Dee Ann Story field schools and spent time in northern Mexico working on lithics with Jerry Epstein at the University of Texas.

ALL PHOTOS: TOM DILLEHAY

Dillehay doing fieldwork in the desert of north Peru, 2016.

Between 1972 and 1975, he worked on his doctorate in Peru. "I worked mainly on Inca sites for my dissertation, the primary site being Huancayo Alto, but there were others on the western slopes of the Andes," Dillehay says. "I also went into the field several times with French archaeologist Frederic Engel, surveying and testing late-Pleistocene and early-Archaic sites in the Peruvian desert."

Monte Verde discovery—kicking over the hornet's nest

Dillehay had already amassed experience in multiple places and time periods by the time the Monte Verde site in south-central Chile popped up on his radar. A veterinary student who visited the area in late 1975 originally recognized the importance of the site, discovered when severe erosion due to logging exposed bones along Chinchihuapi Creek. Instead of a "cow bone" the local peasants thought they had discovered, it proved to be a bone from a gomphothere, an early proboscidean not

belonging to the family Elephantidae (**MT 30-3,** "El Fin del Mundo: News from the end of the world . . . as we know it?").

Monte Verde is an open-air Pleistocene site located 36 miles from the Pacific Ocean. A freak of nature accounts for its exceptional preservation: Not long after the site was originally occupied, the creek flooded and formed a peat-filled gallery bog, which inhibited the normal decay of organic materials and preserved perishable artifacts for millennia.

The Monte Verde site complex. MV-I site is on the high terrace in foreground (brown grass). MV-II is on the brown-grass terrace in the background. Chinchihuapi Creek lies between.

In 1975, before completing his Ph.D. from the University of Texas in 1976, Dillehay accepted a teaching job first at the Catholic University in Santiago and then at the Southern University of Chile in Valdivia. In 1977 he began excavating the nearby Monte Verde site and soon discovered evidence of its extreme antiquity and unusual degree of organic preservation. His early reports, which pushed back the arrival of people in the Americas by more than a thousand years, ignited a firestorm of skepticism.

"From my front-row seat at the unfolding Monte Verde debate, I was struck by Tom's cool under fire," says colleague David Meltzer of SMU. "It cannot be easy to be subject to that level of criticism, especially while you're still trying to get the evidence out for all to see. But give him credit: He addressed his critics, built an impressive case for Monte Verde, and produced two substantial monographs of lasting value. Oh, and along the way he changed how we think about the peopling of the Americas. Impressive!"

An extensive inventory of human-related matter

Studies at Monte Verde II, dated around 14,500 CALYBP, have played an important role in the dating and nature of the peopling of South America by revealing new evidence that points to an earlier human presence on the continent than was previously thought. Multiple spatially discontinuous, low-density occurrences of in situ stone artifacts, faunal remains, and burned areas at other localities in the Monte Verde complex suggest horizons of transitory human activity radiocarbon dated between ca. 15,000 and possibly as early as 18,000 CALYBP. New evidence discovered in recent years suggests a wider diversity of tool types, landscape use, and site size that led Dillehay and his colleagues to postulate that people might have been in South America before 15,000 years ago, that they were highly mobile and seasonally adapted to a wide variety of environments including cold non-glacial areas.

Dillehay with part of excavation crew near Monte Verde, 2016.

Dillehay's early work at Monte Verde revealed at least one valid human site (MV-II) dated ca. 14,500 CALYBP, whose residents had adapted to a temperate rainforest climate, and a cultural horizon (MV-I), possibly much older, buried in the south terrace of Chinchihuapi Creek, which formed about 15,000 CALYBP. The MV-II horizon is associated with the remains of a long tent-like dwelling, the foundation of another structure, hearths, human footprints, economic plants and wood, and artifacts of reed, bone, and stone. Dillehay's excavations at Monte Verde II gradually unveiled a very early Andean settlement of people who lived along the banks of a creek, hunting and gathering and exchanging with others in the Andes and along the Pacific coast.

Lithic artifacts recovered included edge-trimmed pebble flakes, stones for slings, grooved stones for bolas, bifacial projectile points, flaked debitage, and grinding stones. Preliminary investigation of this site revealed a few burned areas and fragments of scorched animal bone directly associated with a few pebble flakes. The MV-I site, dated to ca. 33,000 CALYBP, encompassed three clay-lined burned areas, possibly culturally produced, and 26 stones, of which at least 6 suggest human modifications.

Not an enjoyable milieu for working

"Although the Chilean government constructed a road to the Monte Verde site in the late 1980s, during the 6 field seasons in the '70s and '80s we transported field equipment and food for 2 months on 4-team ox carts through bogs to reach the site," Dillehay explains. "The excavation crews of the last four seasons usually totaled about 30 people plus specialists arriving to sample portions of the site. During those field seasons we lived in tents at the site, cooked our food, and received periodic visits from the military, which thought we were leftists hiding out and organizing protests against the government.

"Let's not forget that Chile lived under a hard military dictatorship during this period and that many academicians in the humanities and social sciences were jailed, exiled, or *desaparecido* (disappeared, presumed killed by members of the military or police). At the time, when I was in my twenties, I was contracted by the Interamerican Development Bank to create and develop anthropology programs in the south, which I was doing when Monte Verde came along.

"These were difficult years when we lived under military *toque de queda* (curfew) from 10:00 pm to 6:00 am in the cities. In fact, to carry out fieldwork anywhere, we first had to check in with the military and show where we were working and when we would return to the university. It was even difficult to obtain chemicals (PEG, for instance) to preserve the organic remains, mainly wood, at Monte Verde because the military thought we were using them to make bombs."

Return to Monte Verde . . . with fingers crossed

Dillehay wasn't sure he wanted to return to Monte Verde after the long and exhausting controversy his original discoveries provoked. Consequently, he declined when the Chilean government invited him to survey the full extent of Monte Verde. He finally returned, reluctantly, in 2013, hoping in a few weeks to dig 50 small test trenches across a 20,000-m^2 area . . . and then hightail it out of Dodge before sundown. The dig rewarded him with significant evidence including stone artifacts, some of them manufactured from materials transported from outside the area.

Preceramic mound at Huaca Prieta, 7800–4000 CALYBP. Late-Pleistocene and early-Holocene cultural deposits (ca. 14,500–8000 CALYBP) lie on an older terrace below the mound.

"The principal goal in undertaking new research at Monte Verde was to conduct a preliminary, discontinuous geoarchaeological reconnaissance of the Monte Verde area to determine the wider horizontal and deeper vertical extent of the site for the National Council of Monuments in Chile," Dillehay writes in an article published in 2015 in *PLoS ONE*. "It was not intended to be a full-scale excavation to resolve previous research questions."

The National Council of Monuments (CMN) Plan

The subsurface testing and excavation plan was designed by CMN to fulfill three specific objectives:

- To explore previously unknown geoarchaeological deposits in sites MV-I, MV-II, CH-I and CH-II within the larger Monte Verde complex (along Chinchihaupi Creek);
- to investigate the long time span between sites MV-I and MV-II;
- to further assess the geological setting of the sites by applying sedimentological, microstratigraphic, geophysical, optically stimulated luminescence dating, and macro- and microbotanical analysis.

The result was the discovery of 12 small discrete burned features directly associated with fragments of burned and intact faunal remains, manuport spherical stones, and knapped flakes dated to at least ca. 18,000 and 14,500 CALYBP. The features, which were scattered widely across the study area, suggest a fleeting human presence over a few millennia and underscore the difficulty of searching for archaeological evidence in this kind of setting.

Specialists in Dillehay's research team, which included geomorphologists, sedimentologists, geoarchaeologists, and volcanologists, were acutely aware of possible processes that could have modified the stratigraphy, context, and structure of archaeological materials in this sandur environment. They accordingly exercised caution in seeking to detect taphonomic disturbances that might have been caused by natural agents or other processes. They discovered no mixed stratigraphic levels, no subsequent natural retouch, no patina due to water or wind on the edges of artifacts, and no frost shattering of bone remains.

Dillehay's exquisite caution and painstaking attention to detail haven't gone unnoticed by the scientific community. "Tom Dillehay is an extraordinarily productive scholar of great breadth, insatiable curiosity, and perfected skill at collaborative research," says Michael Collins of Texas State University. "He is one of my most admired colleagues."

High praise for Dillehay comes from long-time colleague and companion Mario Pino, Director of the School of Geology at Universidad Austral de Chile. "I met Tom in 1977 in his laboratory in Valdivia in front of the *gomphotherium* bones of Monte Verde," he remembers. "In these tens of years we have developed a relationship more than friends, as brothers, who share, among many other things, a large dose of black humor. I have been a close witness not only of its scientific development but also of the human consequences originated by the Clovis police. All related Tom to Monte Verde, but for me his work as an archaeologist and anthropologist with the Mapuche culture is really exceptional. It is very impressive to work with him in the field (in Peru, in Monte Verde, in the Araucanía area) and to observe how, from the data in an excavation, he is able to go on to build great hypotheses and theories, and how well it relates to simple local people, and how those people respect and admire it."

The government of Chile, together with UNESCO, recently announced plans to build a museum in the Chilean tourist city of Puerto Montt (a tourist hub for cruise ships that draws about 800,000 visitors a year from around the world) featur-

ing Dillehay's discoveries at Monte Verde. The Museo Monte Verde will also feature exhibits of other ethnographic research from Dillehay's career and will serve as a research station for scholars working in the region.

Verifying the geochronology of Monte Verde

Using C-14 and OSL dating, the team obtained nine radiocarbon dates from single pieces of charcoal and from animal-bone fragments. Calibrated radiocarbon dates derived from the deeper stratum, from the top of its upper level to its base, varied from ca. 15,000 to 45,000 years ago. A fragment of animal skin in a peat ball from the deeper level of MV-I dated at 43,500 CALYBP, but Dillehay believes that data from the deeper levels are still far too meager and inconclusive to determine whether they represent human activity or indeterminate natural features.

Samples for OSL dating, intended to confirm the chronology of the stratigraphic units of Monte Verde sites, were taken from deposits mainly composed of sand, varying from poorly and moderately well sorted medium grains to very coarse subangular grains, with occasional lenses of small gravel. The OSL dates confirm the prior radiocarbon dating, calibrated at ca. 14,500 CALYBP, of cultural materials in the single-component occupation of the MV-II site.

Analyzing lithic assemblages

Lithic samples discovered during the 2013 season of Monte Verde fieldwork included 39 stones of both local and exotic materials that showed percussion flaking. The mixed toolstone provenience—65.7% is from local sources, 34.3% is from remote sources—signifies that toolmakers didn't depend solely on local quarries. The occupants didn't necessarily have intimate knowledge of distant toolstone sources, however. Dillehay believes toolstone was likely an exchange commodity.

Unifacial tools, ca. 14,500 CALYBP, from pre-mound deposits at Huaca Prieta, Peru.

Four lithic-artifact assemblages, their origins widely spaced in time, were found distributed across the investigation area. Although the artifacts resemble ones previously found, present evidence suggests that this locality embraces a complex and prolonged cultural history.

"The earliest possible lithics probably date to around or before 25,000 years ago," says Dillehay. Evidence of indisputable human-derived percussion flaking appears in all four assemblages. The principal toolstones are local basalts and andesites, but exotic serpentine, unsourced limestones, and white quartzite were also knapped. Among the artifacts from the 2013 season as well as from previously reported MV-II discoveries, exotic materials suggest a high degree of long-distance mobility or exchange.

Dillehay sums up: "Our recent work confirms the discrete and dispersed nature of these materials in the older, deeper levels of MV-I and the very remote possibility that people were in the area earlier than we have documented here."

Vegetation records in the study area suggest that climate warming occurred between ca. 20,000 and 18,400 CALYBP, with interspersed short cooling events followed by warmer pulses. Numerous tephra lenses and ash-coated artifacts found at sites suggest that volcanic eruptions throughout all periods may have influenced the movement of people.

Pacific coastal arrival?

Dillehay believes human presence in the Monte Verde area in the period he conservatively estimates at 16,000–14,500 CALYBP is likely related to Pacific coastal occupations and to possible migration routes through deglaciated passes in the Andes to the Argentine steppes. Exotic lithic materials and plant species found from both areas, especially from coastal beaches and estuaries, promote the likelihood that Monte Verde was a way station for people passing through from distant origins after ca. 14,500 CALYBP.

"The chronology and nature of the peopling of the New World are the focus of great deliberation between multiple schools of thought," Dillehay explains. "For the moment, the majority of anatomical, archaeological, and genetic evidence gives credence to the view that people are relatively recent arrivals to the Americas, probably sometime between 20,000 and 15,000 years ago. The current evidence presented here for the Monte Verde area best fits this scenario; however, this may change as more data are gathered and assessed. The early archaeological record of the Americas continues to be remarkably unpredictable and intriguingly complex."

"I met Tom a long time ago at an archaeological congress in Altos de Vilches when he was doing his Ph.D. research in Peru," Gustavo Politis, an Argentinian colleague, tells us. "Later he was my supervisor for more than a year during my post-doc fellowship in Lexington, Kentucky, and we became good friends. He was a great guide, always providing useful advice and passing on his enthusiasm. Moreover, he was so dedicated to work and to developing serious research that he became a model to follow. I still keep track of his research and publications, and I recognize the tremendous contributions to archaeology and anthropology he has made during his career. I was really impressed with his book *Monuments, Empires, and Resistance: The Araucanian Polity and Ritual Narratives* (2007), which is an outstanding contribution."

Seaweed in the medicine cabinet

The substantial body of evidence compiled by Dillehay and his colleagues at Monte Verde is directly linked to people living in the area today. Ten species of seaweed were found at Monte

Verde II, a windfall made possible by the remarkable preservation of organic matter. Some seaweed had been compressed into cakes, to be chewed as quids like tobacco. Others had clearly been cooked.

"All ten seaweed species recovered at Monte Verde II are excellent sources of iodine, iron, zinc, protein, and a wide range of trace elements, particularly cobalt, copper, boron and manganese," Dillehay writes in a report to the journal *Science*. "At least two of the species are still used medicinally by local indigenous people to treat chest and intestinal ailments."

One of the large platform mounds (dated A.D. 1200–1700) that hark back to the Mapuche and Araucanian tradition. Dillehay has worked on these mounds over the past 30 years.

Dillehay: How South America was peopled

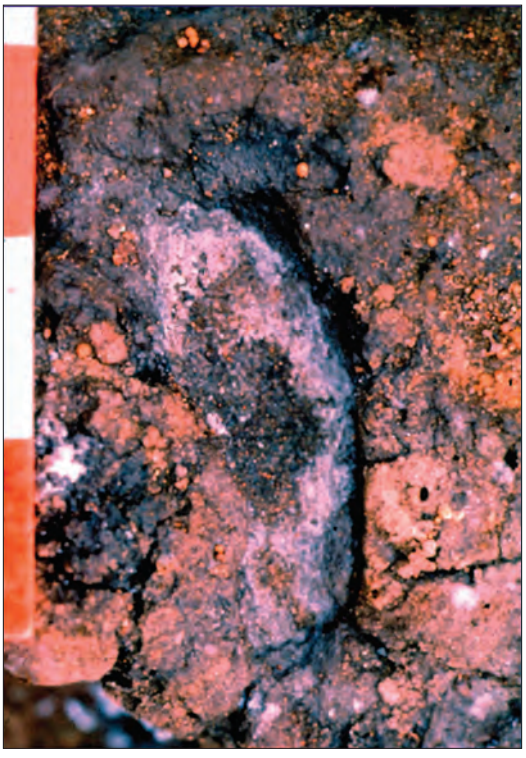
To understand the first peopling of any continent, Dillehay argues, we must first understand human dispersion and adaptation. Until recently, the earliest archaeological record of South America was viewed as a bequest of big-game hunters from North America who introduced their Clovis lithic technology and became the founding population of the southern continent. Many South American scholars now reject this model. Their reason is the calendar.

The Clovis culture, which flourished in the period 13,110–12,660 CALYBP (11,050–10,800 RCYBP), spanned the breadth of North America and extended from Canada in the north to the Sonora Desert of Mexico in the south. Dillehay confidently dates human occupation of Monte Verde to at least 14,500 CALYBP, and possibly earlier. Even in the most rapid advance imaginable, Clovis migrants couldn't have reached Tierra del Fuego and other southernmost sites in South America within the narrow window of time available. It's worth noting that other, confirmed South American sites render the idea of Clovis colonization even more bizarre. Charcoal from a hearth at the Cerro Tres Tetas site in southern Argentina, for example, returned radiocarbon dates of 10,900 and 11,100 RCYBP (**MT 25-4,** "Paleo South America: Long time, no see"). South American archaeologists don't need to tip their hats to anyone.

In Dillehay's peopling model of South America, humans might have been confined to productive open terrain or patchy forests in lowland environments and might not have occupied high altitudes until the onset of deglaciation 17,000–15,000 years ago. Late-Pleistocene settlements in South America show a steady shift away from broad uniformity, characterized by widely diverse technologies, loose territoriality, and generalized foraging economies, and toward distinct regional traditions.

"From a global perspective, what makes South America interesting is that cultural complexity developed early, possibly within only a few millennia after the initial arrival of humans," Dillehay writes in an article in *Evolutionary Anthropology*. He finds that late-Pleistocene occupations in South America in many ways differ markedly from those of North America. A unifacial tool industry, exemplified by the Itaparica and Monte Verde cultures, sets South America apart from the Northern Hemisphere. With glaciation confined to high altitudes and low latitudes, diverse cultures developed in South America, including precursors of an agricultural subsistence.

The exceptional preservation of organic material at Monte Verde II raises doubts about what may be missing at poorly preserved sites and questions interpretations based almost exclusively on assemblages of stone tools and faunal skeletal remains. Unfortunately, direct evidence of the physical and genetic make-up of early South Americans is absent. Perhaps only a single reliable human skeleton from the late Pleistocene has been excavated, which makes South America the only continent where what we know of early inhabitants is based almost exclusively on artifacts and not human skeletal remains.



One of three human footprints preserved at Monte Verde II.

"The most plausible scenario to explain the current archaeological evidence," Dillehay states, "is a founding migration of people moving rapidly from North America to South America along the Pacific coastline shortly before the invention and spread of the Clovis culture." We can't presume, he cautions, that what happened in North America also happened in Central and South America. He allows that the two continents share some cultural and behavioral continuities and similarities. After all, he muses,

it beggars the imagination to suppose that the south was inhabited from a direction other than the north. Nevertheless, we can be certain that the people who entered via Beringia were somewhat different behaviorally and cognitively from colonists who finally made their way to Tierra del Fuego—and along the way produced greater different cultural variation than many archaeologists are willing to admit. "Can you imagine," he asks us, "trying to explain all the Old World based on a single model out of Africa?"

A career to look back on with satisfaction

Occasionally during his varied career, Tom Dillehay extracted himself from the depths of the Pleistocene to study more modern Chilean cultures. One such fascinating foray involved *parlementos*, political negotiations or attempted treaties between the Spanish Crown and the Araucanians in south-central Chile from the late 1600s to the early 1800s, described in his fascinating book *Monuments, Empires and Resistance.* He also teamed with Alan Kolata to study the prehistory and paleoecology of the lower Jequetepeque Valley in northern Peru.

Dillehay's 45 years of scientific study encompass the fields of Archaeology, Ethnography and Social Anthropology, Ethnohistory, and Methodology. Since receiving his Ph.D. in 1976, he has carried out numerous archaeological and anthropological projects in the United States, Peru, Chile, Argentina, and other South American countries. He has published 20 books and more than 200 journal articles and spoken to countless audiences about his discoveries. A Distinguished Professor in the Department of Anthropology at Vanderbilt University, he has received numerous international and national awards for his research, books, and teaching, and is a Member of the American Academy of Arts and Sciences. He was named the Rebecca Webb Wilson Distinguished Professor of Anthropology, Religion and Culture at Vanderbilt in 2011, and he's a Kentucky Colonel—and a professor or visiting professor at 17 universities in Latin America.

The government of Chile has granted Dillehay citizenship, the highest recognition any country can award a foreigner, for his academic and research contributions to Chile and Latin America in general.

"I am interested in long-term social cultural processes," Dillehay says, "thus a career given to early, middle and late cultural sequences in various areas. I am convinced that we must examine behavior transformations via changing processes along both a diachronic and synchronic spectrum. I am currently working with UNESCO and the Chilean government to establish the Museo Monte Verde, and I continue exploring new sites in the Monte Verde area, but most of my work continues with projects in north Peru, where I have been working every year since 1972 and also with earthen mounds in the Mapuche area."

Says colleague Jim Adovasio, "I have known Tom for virtually the entirety of his professional career. While I was still at Pitt, he visited to talk about Monte Verde well before most of the world knew about it. I knew then that his work at that seminal site would be a 'game changer.' It was and he still is!!!"

– Martha Deeringer

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Suggested Readings

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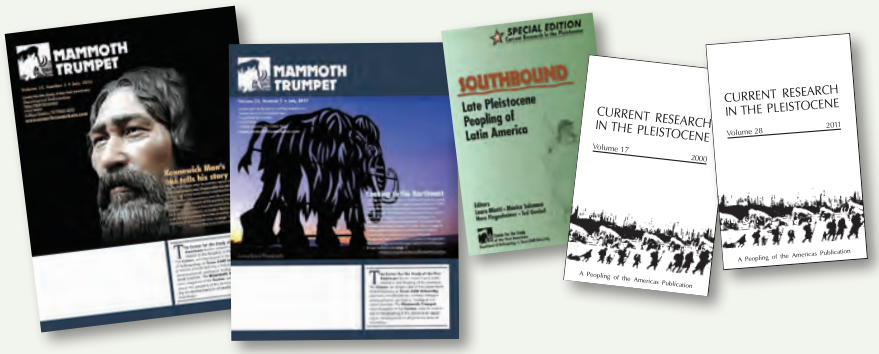

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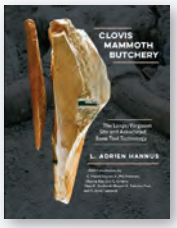

Clovis Mammoth Butchery: The Lange/Ferguson Site and Associated Bone Tool Technology, L. Adrien Hannus. 2018. 288 pages. Hardback (ISBN 978-1-62349-592-3).
Reg. price $60.00
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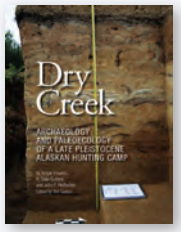

Dry Creek: Archaeology and Paleoecology of a Late Pleistocene Alaskan Hunting Camp, W. Roger Powers, R. Dale Guthrie, and John F. Hoffecker; edited by Ted Goebel. 2017. 344 pages. Hardback (ISBN 978-1-62349-538-1).
Reg. price $50.00
CSFA members $40.00

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
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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).
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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).
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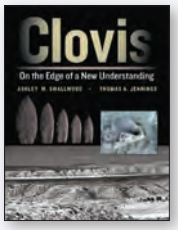

Clovis: On the Edge of a New Understanding, Ashley M. Smallwood and Thomas A. Jennings, editors. 2014. 376 pages. Hardback or e-book (ISBN 978-1-62349-201-4).
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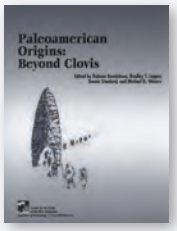

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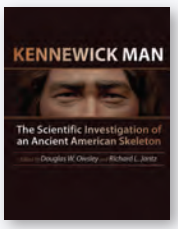

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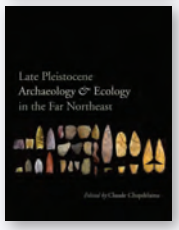

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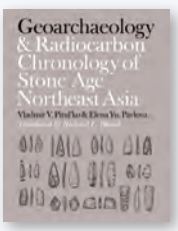

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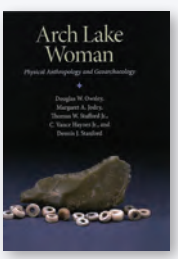

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