# MAMMOTH TRUMPET

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Center for the Study of the First Americans
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## 45 years of digging

University of Wyoming professor Bob Kelly has excavated in Madagascar, the Andes, Wall Street, the Atacama Desert. Shown here in Wyoming in 2016, he unearths gaming sticks cached on a cliff. Drawing on his formidable experience , he reflects on our past and future. For our profile of this extraordinary scientist and mentor, see **page 14.**

Photo by Madeline Mackie

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# The Chan Hol II Individual

Submerged caves and a stolen skeleton: Did you really need to post that?

Skeletal remains and stalagmite. In this photo taken before the site was looted, the pelvis (partially within the stalagmite) is still aligned with the right femur.

**THIS STORY** sounds like something out of an adventure novel. It involves not only spelunking, but scuba diving, an ancient skeleton, and even unknown adversaries in the form of faceless looters. (I would call them spineless, but they actually stole the spine of a skeleton!)

But maybe we should start from the beginning. . . .

In 2012 photos appeared on social media of human skeletal remains found on the bottom of the submerged Chan Hol Cave near the town of Tulum, in Quintana Roo, Mexico. This is one of a number of sets of remains discovered within the Tulum cave system. Though C-14 dating was attempted, the results were conflicting. The bones appear to have been lying relatively undisturbed—at least they were until later in 2012, when looters pillaged much of the skeleton. Among the remaining bones was a large part of the pelvis. It had rested on the cave floor long enough for a stalagmite to form on top of it, which made that bone impossible for looters to pilfer. The fact that it was cemented in place by a stalagmite also signaled the considerable age of the skeleton. "I immediately realized the importance of the stalagmite," said Wolfgang Stinnesbeck of the Institut für Geowissenschaften, Universität Heidelberg. He insisted that this specimen be collected. When radiocarbon dating failed, Stinnesbeck and his team of experts shifted gears. Instead of dating the bones, they turned to methods for dating the growth of the stalagmite as

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a means of gauging how long the skeleton had been lying on the cave floor.

## A question of age

When it comes to the peopling of the Americas, today's genetic evidence points to a Beringian Spread. (Not something you slap on toast for breakfast, but a migration of people from Siberia across the Bering Land Bridge, which connected current-day Russia with Alaska and provided a pathway for humans and animals into North and South America.) Once on the North American continent, decrees the model that ruled North American anthropology for half a century, a rift appeared between two immense glaciers that spanned Canada, the Ice-Free Corridor, an overland migration route into the southern part of North America and beyond. The corridor has been dated to approximately 12,600


JERÓNIMO AVILÉS

**Diver Arturo González with stalagmite and pelvis after removing them from cave floor.**

CALYBP. The problem with this idea, that the parting of the ice provided human beings with their first foothold in the lower stretches of the American continents, is that sites south of the reaches of the corridor predate its opening.

Currently we know of few osteological remains that potentially predate 11,000 years. But few isn't the same as none. Remains dating older than the corridor have been found in North, Central, and South America. These include two other sets of skeletal remains from the Tulum area. Tooth enamel from one documented by Chatters et al. was C-14 dated to a calibrated age of 12,910–11,750 CALYBP, and Arturo González González radiocarbon dated another set of remains to a calibrated age of 13,721–13,354 CALYBP. Though the Tulum cave system promises great potential for Preceramic-age human remains, Stinnesbeck stresses the need for great caution when it comes to putting that much weight on C-14 dates from the submerged caves near Tulum. Exposure for thousands of years to alternating fresh and salt water depletes collagen in bones and teeth, which makes it difficult to obtain enough for reliable radiocarbon dating. Moreover, fossil carbon can contaminate remaining collagen and thereby corrupt the C-14 dates, typically skewing


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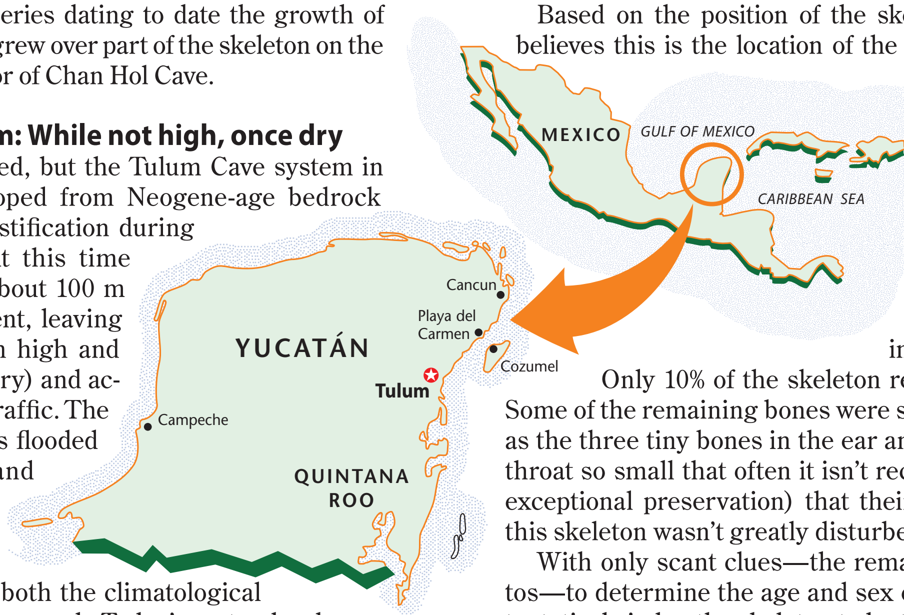
the results toward a false older age. And because bad things tend to come in threes, radiocarbon dating in the tropics has a reputation for being somewhat spotty. For these reasons, the team turned to U-Series dating to date the growth of the stalagmite that grew over part of the skeleton on the once dry cavern floor of Chan Hol Cave.

## The Tulum system: While not high, once dry

Today it's submerged, but the Tulum Cave system in the Yucatán developed from Neogene-age bedrock and underwent karstification during the Pleistocene. At this time the sea level was about 100 m lower than at present, leaving parts of the system high and dry (well, low and dry) and accessible to human traffic. The system of caves was flooded between 13,000 and 7,600 years ago as glaciers melted. This flooding served to preserve both the climatological and archaeological record. Today's water level was reached about 4500 CALYBP. Chan Hol, the specific cave within the Tulum System in which this skeleton was found, lies about 13 m below today's mean sea level. The section of the cave that for so long housed the skeleton is known as the Chan Hol II site. The skeleton is also as known as Chan Hol II, because it's the second one found within this particular cave. This area of the cave, because it was flooded only to a shallow depth, was accessible until the middle Holocene.




## The remains in question—what remains is questionable

The skeleton was brought to the attention of the investigative team by way of a social media post in February 2012. Sadly, they weren't the only persons who took note of the announcement: A month later the site was vandalized, and most of the Chan Hol II individual disappeared. All that was left for scientists to draw clues from was the original photographs, small or fragmented bones that the looters missed or rejected, a few teeth, and the right pelvis, which was protected from greedy fingers by the stalagmite.

From the photos it was determined that the Chan Hol II individual's skeleton had been more than 80% complete and only somewhat disarticulated. The individual appears to have been lying on its back, the ribs surmounting the vertebral column. The right leg was extended, the left leg bent. The right femur was still articulated with the pelvis.

Based on the position of the skeleton, the research team believes this is the location of the individual's death and not a burial. Although intentional burial or other manner of deposit can't be ruled out, no indicators of burial, such as artifacts or other grave goods, were found with the remains or are visible in the photos.

Only 10% of the skeleton remained after the looting. Some of the remaining bones were so small and delicate (such as the three tiny bones in the ear and the hyoid, a bone in the throat so small that often it isn't recovered except in cases of exceptional preservation) that their very presence indicates this skeleton wasn't greatly disturbed after decomposition.

With only scant clues—the remaining bones and the photos—to determine the age and sex of the individual, the team tentatively judge the skeleton to be that of a young adult male.

## Deluded dating from watery depths

The scientists did their best to radiocarbon date the remaining bones, but results were judged unreliable. Thousands of years of lying in alternating salt and fresh water had depleted essential collagen. Stinnesbeck further cautions that the "bioapatite from these skeletons is susceptible to contamination with fossil carbon," which would likely produce a false older date. Any result the team announced would always be suspect.

Far from the Yucatán, as Stinnesbeck in Germany pondered the photographs, we can imagine a cartoon light bulb flashing bright above his head: *Of course! The stalagmite with its captive pelvis!* He quickly got in touch with his colleagues and told them to collect the stalagmite and pelvis.

JERÓNIMO AVILÉS


**Diver González carefully cuts the stalagmite from the cave floor.**

## A unique opportunity

Stalactites and stalagmites, collectively referred to as speleothems, grow from water dripping from the ceiling of a cave. Water containing dissolved $Ca_2^+$ and $HCO_3^-$ ions drips downward and deposits minerals that gradually accrete and create the stalactite on the ceiling and the corresponding stalagmite below it on the floor. Because the entire process requires the persistent dripping of water, speleothems, particularly stalagmites, form only in dry caves. Their growth halts if the cave fills with water.

Stinnesbeck comprehended straightaway that for the stalagmite to encase the bone from dripping water, the cave must have been dry and the skeleton must have been defleshed, which means the individual had died an indeterminate length of time before the stalagmite began to form. Therefore the skeleton dated to at least as old as 4500 CALYBP (when the cave filled with water) plus the age of the stalagmite (how long it took to form).

To calculate the gestation period of the stalactite, the team used U/Th (Uranium/Thorium) methodology, a U-series dating technique that determines the age of calcium-carbonate deposits, for example, in speleothems. Speleothems form in layers somewhat like tree rings. (You know how we archaeologists love our stratified layers.) U/Th dating samples were taken the length of the stalagmite. Since the stalagmite grew linearly upwards, the resulting dates should reflect that: Samples taken from the top should be youngest, and samples should increase in age the lower they were taken from the stalagmite.

Their reasoning proved correct. As the samples neared the bone embedded in the stalagmite, however, the dating went haywire. Dates became *younger* than those above them. After considerable head-scratching, the team determined that Uranium must have leached out of the stone and been absorbed by the porous bone. Yet another obstacle in their path, meant to trip them up.


**Photos, like this one of the skull, were used to glean information about the Chan Hol II individual and the site after it was vandalized.**

Setting aside for the time being the spurious dates from samples near the pelvis, the team was confident that dates from samples taken above the bone were accurate. They gave the minimum calibrated age of 11,211 ± 370 CALYBP. The Chan Hol II skeleton is, of course, likely older than this. Below the bone, the dates from samples fell back into line. But the 21-mm section in proximity to the bone itself dated younger than samples taken above the bone.

In that 21-mm anomalous section, the team next attempted to date samples using stable-isotope analysis. The results of this technique, however, were as erratic as the U/Th method. Next the team began looking at other data. When comparing their results with other stable-isotope analysis records of speleothems from America, Latin America, and Asia, they found that all displayed this same discontinuity, a period where dates fell to pieces. This discontinuity common to all speleothem datasets was interpreted as the result of the abrupt climate change of the Younger Dryas. The dating results are stable until the period just prior to the onset of the Younger Dryas (12,900–11,700 CALYBP).

The interval during which the stable-isotope analysis went off the rails, corresponding to that part of the stalactite immediately surrounding around the pelvis, appears to coincide with the Younger Dryas. It's therefore possible to estimate the time of death of the Chan Hol II individual no later than the onset of the Younger Dryas, which pushes its potential age back to before 13,000 CALYBP.

## Rising water

Stinnesbeck and his team overcame serious obstacles in their quest to date the Chan Hol II skeleton, from the complications involved in dating a skeleton long submerged in water in the temperamental tropics, to thievery precipitated by too much information broadcast on social media. (Please post wisely, folks.) Their final learned decision is that the Chan Hol II individual lived and died sometime within the interval 11,211 ± 370 to 13,000 CALYBP, quite possibly closer to 13,000 CALYBP.

Granted, the estimated age of the Chan Hol II skeleton is burdened with an uncertainty of 800 years. Nevertheless it deserves a place among the oldest known skeletons in the Americas. And it isn't the only one to be discovered in the flooded cave systems of the Yucatán Peninsula.

*–K. Hill*

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## Suggested Readings

González, A. G., et al. 2013 The first human settlers on the Yucatán Peninsula: Evidence from drowned caves in the state of Quintana Roo (south Mexico). *Paleoamerican Odyssey.* Center for the Study of the First Americans, Orono: 323–37.

Hering, F., et al. 2018 The Chan Hol cave near Tulum (Quintana Roo, Mexico): Evidence for long-lasting human presence during the early to middle Holocene. *Journal of Quaternary Science* 33(4), 444–54.

Stinnesbeck, S. R., et al. 2018 The Muknal cave near Tulum, Mexico: An early-Holocene funeral site on the Yucatán peninsula." *The Holocene*: 0959683618798124.

Stinnesbeck, W., et al. 2017 The earliest settlers of Mesoamerica date back to the late Pleistocene. *PloS* one 12(8), e0183345.


# Along the Coast or down the Ice-Free Corridor—How Did the First Americans Get Here?

## Part 2

UNIVERSITY OF BUFFALO geologist Alia Lesnek and her team argue that the Pacific coastal corridor "was a viable pathway for the initial colonization" of the Americas. Writing in the May 30 issue of *Science Advances,* they explain that the feasibility of a coastal migration depends on two environmental factors: "The presence or absence of significant physical barriers to migration" and "the biological productivity and availability of food resources" along the route. The predominant physical barrier would have been the Cordilleran Ice Sheet, which for a time during the Late Pleistocene extended from the Rocky Mountains to, in many cases, the continental shelf off the North Pacific coast.

Lesnek and her team report that recent studies of ancient pollen and animal fossils suggest that some locations in southeastern Alaska, including several westernmost islands of the region and portions of the now-submerged continental shelf, remained ice-free during the Last Glacial Maximum. The paucity of detailed studies of the glacial history of southeastern Alaska, however, poses a challenge to arriving at a definitive consensus on the feasibility of coastal migration to the Americas.

To get a better handle on the chronology of glacial retreat and therefore of the opening of the Pacific corridor, Lesnek and her team used Beryllium-10 ($^{10}$Be) dating to determine the last time boulders and bedrock surfaces along the coast were covered by ice or ocean. They obtained 10 new $^{10}$Be dates for locations that were thought to be ice-free refugia since at least 19,000 years ago. These new dates, along with field observations of glacial striations on the bedrock, now determine that they weren't free of ice until around 17,000 years ago.

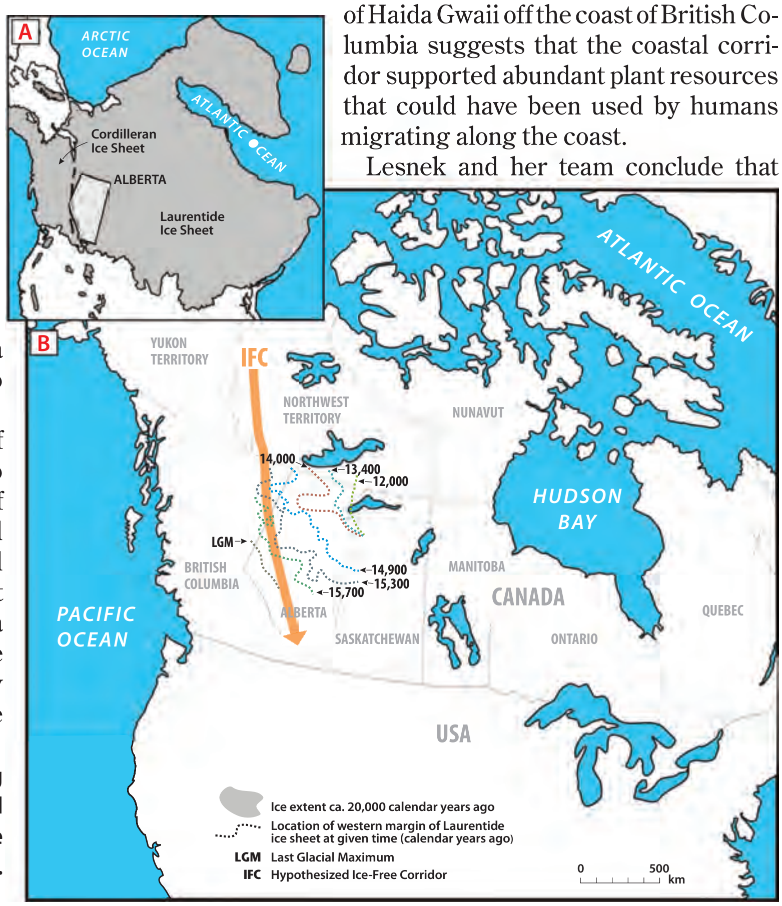
To further refine the glacial history of southeastern Alaska, the team recalibrated 177 previously published radiocarbon dates on fossilized mammal and bird bones obtained from 15 caves in the Alexander Archipelago of southeastern Alaska. Most of these fossils are from Shukáa Káa, formerly known as On Your Knees Cave (**MT 33-2,** "Genetic insights into the First Americans"). Shukáa Káa is especially rich in fossils because it was a carnivore den from before the Last Glacial Maximum into the postglacial period.

The calibrated C-14 dates reveal an exceptional record of nearly continuous fossil preservation from 45,000 years ago to the present. Significant, however, is a marked scarcity of dates in the radiocarbon record between about 20,000 and 15,000 CALYBP and a complete gap between in the period 19,800–17,200 CALYBP. Lesnek and her coauthors interpret this gap as an indication that the entrance to Shukáa Káa and other caves along the coast had been sealed off by the Cordilleran Ice Sheet. This interpretation is supported by their $^{10}$Be dates, which suggest that the Cordilleran Ice Sheet retreated from the islands along the Alaskan coast around 17,000 years ago. Lesnik and her colleagues therefore conclude that the maximum extent of the Cordilleran Ice Sheet occurred between 20,000 and 17,000 CALYBP.

These results demonstrate that although the islands along the southeastern coast of Alaska weren't ice-free and so couldn't have served as plant and wildlife refugia prior to around 17,000 years ago, they became ice-free early enough to accommodate human coastal migration as early as 16,000 years ago. By this time, Lesnek and her colleagues contend, "ice had largely disappeared from the major fjords in and around southeastern Alaska." The question remained, however, whether this region of southeastern Alaska was ecologically viable for human migration at this time.

Lesnek and her colleagues note that a carnivore-modified ringed-seal bone in Shukáa Káa yielded a calibrated radiocarbon date of 17,200 CALYBP, which suggests that "robust terrestrial and marine ecosystems were established soon after deglaciation." Moreover, pine forests became established on Mitkof Island within 1,000 years after it emerged from the Pacific Ocean and deglaciation had relieved the land surface of the weight of glacial ice. They conclude that there was only a short time lag between landscape exposure and regional revegetation. In addition, rising ocean temperatures are documented in the North Pacific between 17,000 and 14,000 years ago, which Lesnek and her colleagues suggest would have increased the availability of food resources in coastal regions by invigorating productive kelp forests. Finally, a study of the postglacial vegetation on the island of Haida Gwaii off the coast of British Columbia suggests that the coastal corridor supported abundant plant resources that could have been used by humans migrating along the coast.

Lesnek and her team conclude that the deglaciation of the islands along the southeastern Alaska coast after 17,000 years ago "ensured that an open, productive corridor . . . was available for human coastal migration" by 16,000 years ago. They acknowledge that to evaluate alternative hypotheses about the routes the First Americans followed in their journey from northeastern Asia ultimately requires archeological evidence of human occupation along potential migration routes. Until more definitive evidence is discovered, however, their results strongly support the hypothesis that the Pacific coastal corridor was a viable pathway for initial colonization.




**Deglaciation chronology for western Canada, constructed using luminescence ages. A, the extent of ice sheets at the Last Glacial Maximum; B, progressive positions of the western margin of the Laurentide Ice sheet between ca. 20,000 and ca. 12,000 CALYBP.**

## Problems to be solved

University of Calgary archaeologist Andrea Freeman argues persuasively that our understanding of the routes by which the First Americans entered the continent is limited both by lack of good data and by a general underestimation of the limitations of the data we have at hand. In her contribution to the book *Stones, Bones, and Profiles: Exploring Archaeological Context, Early American Hunter-Gatherers, and Bison,* edited by Marcel Kornfield and Bruce Huckell, she points out that issues exist with any argument for or against a late-Pleistocene ice-free corridor used by humans and that, as the title of her paper suggests, "the ice-free corridor is still relevant to the peopling of the New World."

**Freeman with skull of steppe bison (*B. priscus*).**

In her review of the geological evidence for the chronology of the advance and retreat of the Laurentide and Cordilleran ice sheets during the late Pleistocene, she identifies five problems with using these data to assess the potential for human movement through the ice-free corridor.

First of all, "Late glacial recessional landforms are interpreted differently by different geologists." Merely deciding whether a given landform is valid evidence for ice retreat can sometimes be problematic.

Second, to attempt to infer the locations of ice margins for particular periods of time "belies the complexity of ice retreat and the origin of glacial ice." The Cordilleran ice-sheet consisted of multiple valley glaciers, whereas the Laurentide ice sheet was a continent-sized monolithic mass of ice. These ice sheets would therefore have advanced and retreated at quite different rates. Freeman points out that "valley glaciers generally lose length more quickly than continental ice," which would result in a generally faster retreat for the Cordilleran ice.

Third, the Laurentide and Cordilleran ice sheets didn't reach their maximum extent at the same time, again owing to the difference in their composition and geometry. Since certain types of ice advance more quickly across the landscape than others, this disparity in their rate of advance would have influenced when ice achieved its maximum amplitude on the landscape.

Fourth, the two ice sheets didn't separate uniformly from north to south. In other words, the ice-free corridor didn't just swing open like a door. The evidence reviewed by Freeman suggests the southern section opened by around 16,000 RCYBP, followed by the northern portion at around 15,000 RCYBP, and the central section sometime in the period 15,000–14,000 RCYBP.

Fifth, the environmental suitability of the corridor for human hunter-gatherers shouldn't be defined by the presence of a prairie landscape supporting herds of mammoth, horse, and bison. Indeed, Freeman rejects "an overall obsession with proboscidean remains when it comes to understanding the peopling of the continent." Mountain goats, she points out, may have provided prey for hunters in the ice-free corridor. Their diet consists of the first species of plants to inhabit the corridor, and they are able to occupy steep alpine slopes year-round. Long before mammoths and bison were present, humans could have subsisted in the corridor on mountain goats and other smaller animals.

Freeman concedes the want of evidence for a pre-Clovis or even a Clovis occupation of the ice-free corridor, just as there is little evidence supporting an earlier-than-Clovis presence on the coast. And she recognizes the formidable challenge in finding these sites in the corridor, since much evidence has likely been obliterated by erosion or overlain by thick layers of sediments deposited by floods produced by melting glaciers.

Freeman concludes that the five problems she identifies "must be resolved in order to better understand the possibilities that exist for an early landscape and how the first prehistoric groups present in Alberta and British Columbia may have used that landscape."

## Along the coast or between the glaciers?

Most archaeologists and geologists agree that the First Americans came to the New World along either of two principal routes, the Ice-Free Corridor or the Pacific Coastal Corridor. Further, they generally accept that massive glaciers and, as the glaciers melted, the barren landscapes left in their wake posed temporary barriers to people moving along either corridor. Therefore, investigations into the timing of ice retreat and the appearance of animals that could have provided food for people moving through those corridors are fundamental to debate about the feasibility of the vying potential routes. In the next article, we'll review a paper that questions the assumption that glaciers and barren landscapes were ever insurmountable obstacles to the movement of humans already capable of making a living in northeastern Siberia.

JASON BRINER

**Lesnek doing field work in Alaska, summer 2015.**

**In part 1 of this series, we considered the latest arguments for and against the two routes accepted as the most likely used by the First Americans, the Ice-Free Corridor and the Pacific Coastal Corridor. Fundamental to the debate is the question, Which path was first open and habitable? But what if that question is based on a false premise? What if neither route was ever truly blocked? How would that affect our understanding of how the first Americans came to the New World?**

## There were no barriers

Robert Dawe, archaeologist with the Royal Alberta Museum, and Marcel Kornfeld with the Paleoindian Research Lab at the University of Wyoming review the arguments for the relative merits of the Ice-Free Corridor, or the Alberta Corridor, versus the coastal route of entry for the First Americans in a paper in 2017 in the journal *Quaternary International*. They make a convincing case that "the concept of the ice-free corridor is irrelevant for Clovis First as well as pre-Clovis peopling models" because the Laurentide and Cordilleran ice sheets never coalesced long enough or over a large enough area to constitute a significant barrier to human movement. They further submit that we shouldn't think of the Cordilleran "ice sheet" as an ice sheet anyway. Dawe and Kornfeld argue that instead of thinking of the Cordilleran as a vast impenetrable continental ice sheet, we should view it as a series of ice fields, each with radiating and intersecting labyrinths of cirques and valley glaciers and countless *nunataks*. The best-known examples of nunataks are tops of mountains or hills that protrude from the surrounding ice like islands in the sea. Nunataks would have served as refugia, reservoirs for plants and animals that rapidly expanded into deglaciated landscapes. They could also have served as rest stops for humans migrating along these "icy corridors."

**Kornfeld excavating a Goshen-age bison scapula at Hell Gap, August 2015.** LOUIS ANICH

## Icy Corridors model for the entry route

Dawe and Kornfeld don't accept as the initial route of entry for the First Americans the proposed Ice-Free Corridor through the interior of North America that only opened around 14,500 years ago and only became habitable for humans about 13,000 CALYBP.

**A glacier extruding from the Columbia icefields near Jasper, Alberta. Dawe and Kornfeld contend that such an expanse of ice, intimidating though it appears to us, wasn't an insuperable barrier to the First Americans.** ROBERT DAWE

They also reject the Pacific coastal route as a route of entry for the first Americans because of "slim evidence of the movement of pre-Clovis people not only along the Alaska and British Columbia coast, but also along the 12,000 km of shoreline from there to Monte Verde." They don't find persuasive the argument that this evidence has been submerged by rising sea levels following the melting of the continental ice sheets. For this to be a valid argument, they insist, coastal migrants would have had to restrict their activities entirely to the narrow band of coastline that was subsequently submerged. They dismiss this as highly unlikely, since "such behavior is not readily explicable in a highly mobile human population entering a vast uninhabited region."

Dawe and Kornfeld propose a third option, Icy Corridors. In this model, glacial conditions, far from forming an impassable barrier, may have expedited movement south by creating "a viable network of transportation routes." They concede that the glaciated landscape may indeed have been cold and forbidding, but they urge us to remember that the people using this route came from a cold and inhospitable place.

## Icy Corridors instead of an Ice-Free Corridor

The northern portion of the Icy Corridors region stretched from the Mackenzie Mountains in the Canadian Northwest Territories to the Laird River basin in northern British Columbia. The valley glaciers flowing out of the Mackenzie Mountains to the northwest and southeast were apparently never part of the Cordilleran ice sheet, and significant portions of this region were ice-free throughout the Late Pleistocene. Indeed, the Mackenzie Mountains supported a "genetically discrete population of mountain sheep throughout the Wisconsin." Although it has been claimed that much of this region was covered by ice or flooded by proglacial lakes until around 11,500 CALYBP, Dawe and Kornfeld argue that neither ice nor proglacial lakes would have constituted a barrier to humans in the region. They submit that valley glaciers provided a better travel conduit than deglaciated valley floors occupied by rivers and that proglacial lakes, particularly when frozen, posed no obstacles to humans accustomed to traveling in the north.

The central portion of the corridor extends from the Laird River to the Peace River basin, which runs across the middle of British Columbia. Dawe and Kornfeld contend that the maximum extent of the eastern Cordilleran glaciers and the Laurentide ice sheet in this region may have occurred at different times and so may never have formed a continuous ice mass. Moreover, even if the ice did coalesce, portions of the corridor were open by at least 16,000 CALYBP. So it wouldn't have constituted a barrier for the earliest well-documented people in the Americas.

The southern portion of the corridor extends from the Peace River basin southward to northern Montana. Even though it appears that the Cordilleran glaciers and the Laurentide ice sheet may have merged in the northern part of this section, even here, Dawe and Kornfeld point out that "the west flank of the corridor was a veritable sea of nunataks, each a potential micro-refugium of plants and animals." Dawe and Kornfeld characterize the refugia pockets as "a veritable picnic" for human migrants that could have included lemmings, ground squirrels, marmots, and hares, and potentially sheep and goats. Migratory waterfowl may have been abundant during particular seasons. Therefore, a "resident population of megafauna . . . need not have been a precondition for traversing the corridor."

**Potter (*1*) and Reuther (*2*) at the Upward Sun River site in Alaska, 2011.**

## Glaciers as highways, not barriers

Dawe and Kornfeld state flatly that "although formidable features, the perception of glaciers and ice fields as obstacles to movement is erroneous." They support this statement by observing that both the coastal Tlingit and interior Athapascans are known to have regularly traversed the Elias Glacier, the third largest ice cap in the world, in a period of as little as three months. They suggest that the Elias Glacier is analogous to the late-Pleistocene Cordilleran ice sheet: Not featureless and uninhabitable vast plains of ice, instead both are characterized by numerous nunataks, rocky islands poking up out of the ice. These prominent landscape features both aided way-finding and, as already mentioned, may have functioned as micro-refugia of plants and animals—think of rest stops on a turnpike. After about 13,000 CALYBP, "the corridor was not just viable, but was actually utilized habitat for herds of bison, horse, and camel."

Dawe and Kornfeld believe that the "standard approaches to the peopling problem suffer from a paradigm that requires not just an ice-free, but a habitable corridor." They believe that the criterion of traversability should replace habitability and refer again to the St. Elias range, which, although non-habitable, has nevertheless been frequently traversed by recent native peoples. For Dawe and Kornfeld, this fact dispels the notion that glaciers were insurmountable barriers to First Americans.

## The First Americans, pre-Clovis or Clovis-First?

In the Clovis-First model for the first human movement into North America, Clovis people arrived from Siberia through Alaska, and then, once the Ice-Free Corridor (IFC) opened a way into the interior of the continent, dispersed southward. Dawe and Kornfeld assert, however, that "from our perspective an IFC was not a precondition for people to come through the region, hence the route was available well before the Clovis time."

Dawe and Kornfeld believe that "by about 14,000 cal BP, if not earlier, a resident human population occupied eastern Beringia." The technology of these groups was "a markedly terrestrial-adapted one." Some of the earliest stemmed-point assemblages "closely resemble and may be ancestral to the Paleoindian stemmed points of the Great Basin and Plains." They cite as examples Sluiceway and Mesa points, contracting-stemmed lanceolate points, which are at least as old as fluted points in Alaska, and they observe that "these bifacial stemmed points closely resemble and may be ancestral to the Paleoindian stemmed points of the Great Basin and Plains." They recognize the enormous difficulties involved with identifying a pre-Clovis occupation, since the geological processes associated with deglaciation throughout this region will have destroyed or obscured much evidence. Moreover, unlike searching for Clovis sites, locating pre-Clovis sites has the added handicap that we don't know what we should be looking for or where to look. No solid evidence has been found to suggest that the earliest Clovis in Alberta was a late arrival. Indeed, without evidence for any obvious precursor south of the ice sheets, Dawe and Kornfeld conclude that the antecedents of the Clovis technology have their roots in eastern Beringia or in the corridor region itself.

## A myriad of pathways

Dawe and Kornfeld also dismiss the Bering Land Bridge as a

*continued on page 13*

# Beringian Child's Genome Reveals the Founding Population of the First Americans

**THE DEATHS OF TWO INFANTS** about 11,500 years ago in eastern Beringia give us crucial insights into the story of the First Americans (**MT 26-4, "**Child of Beringia"). DNA recovered from the bones of one of these children has revealed that she was the child of a population that is ancestral to all Native Americans. Her lineage thus holds the key to understanding when and where the Native American story began.

The two children were buried in a shallow pit dug into the floor of a small circular dwelling at the Upward Sun River site (USR), located along the Tanana River in southeastern Alaska. The pit was apparently a cooking hearth before it was used as a burial chamber. We know this because burnt bones of fish and small mammals were found in the ashy deposits beneath the human remains. The burial appears to have been the final use of the hearth before the house was abandoned.

Ben Potter and his team from the University of Alaska Fairbanks excavated the burials only after consulting with representatives of the Healy Lake Traditional Council and the Tanana Chiefs Conference, and close consultation with these indigenous groups has continued throughout the study of the children's DNA.

## Burial companions, but not sisters

The older of the two children, a female who probably died shortly after birth, is known to scientists as USR1 and to the indigenous Tanana Athapascans of the region as *Xach'itee'aanenh t'eede gaay,* or "sunrise child-girl." The younger child, USR2, known as *Yelkaanenh t'eede gay,* or "dawn twilight child-girl," was a late-term fetus.

Excavating into lower sediments at Upward Sun River, 2014.

Eighteen scientists from four different countries contributed to this research, which was directed by Eske Willerslev of the Centre for GeoGenetics at the Natural History Museum of Denmark. Their results were published in the January 2018 issue of journal *Nature*.

Ancient DNA previously had been recovered from both USR1 and USR2, but it was sufficient only to identify the mitochondrial haplogroups each belonged to. USR1 belonged to C1, whereas USR2 belonged to B2. Haplogroups B and C are two of the five founding haplogroups of Native Americans, so there are no surprises here. But since mitochondria are inherited solely from the mother, we know that these two children had different mothers—and the two mothers weren't sisters, or at least not sisters with the same mother.

Willerslev and his team succeeded in recovering "whole-genome sequence data" from USR1, though not from USR2. Having access to the whole genome provides the opportunity to delve much deeper into the genetic history of USR1. The team hoped to discover "the number, source(s) and structure of the initial founding population(s) and the timing and location of their subsequent divergence." Thus, whole-genome-sequence data are key to answering the most fundamental questions in the study of the first Americans.

Willerslev and his colleagues compared USR1's genome with a set of previously recovered ancient genomes as well as with genomes from "a panel of 167 worldwide populations." After comparing USR1's genome with this sample, the team determined that this infant is "more closely related to present-day Native Americans than to any other tested population." She is also closely related to Siberian and East Asian populations.

Detailed analysis showed that although USR1 is closely related to all tested Native American groups, her genome "did not cluster with any specific Native American group." This suggested that USR1 "belonged to a previously unknown Native American population," which Willerslev and his team have named the "Ancient Beringians." Though the team wasn't able to recover the same high-resolution genetic information for USR2, they recovered enough data to establish that the two infants "were close relatives."

# Milestone Events in the Native American Family

Because *Xach'itee'aanenh t'eede gaay* (Upward Sun River 1 USR1) is so ancient, she lies very nearly at the base of the Native American family tree. As a result, her genome makes it possible to reconstruct a population history for all Native Americans.

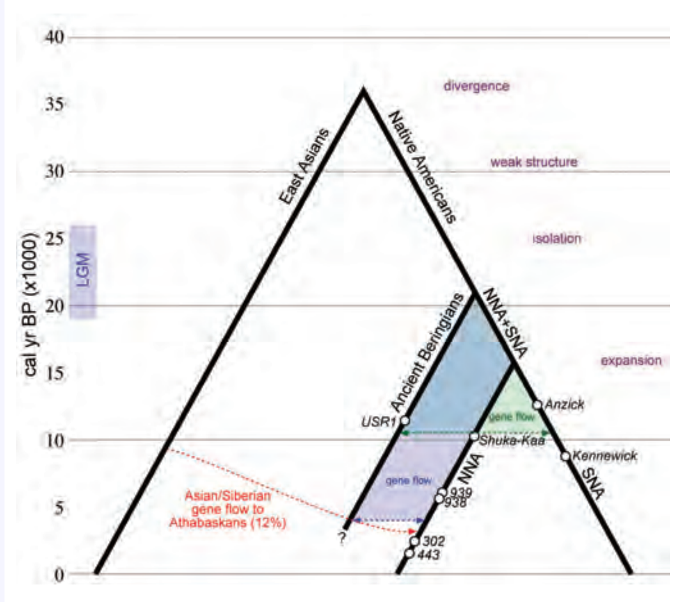
A single founding population of Native Americans began diverging from East Asians about 36,000 years ago, with strong gene flow until 25,000 years ago. This separation is associated with the onset of the LGM, perhaps facilitating fragmentation of Northeast Asian populations.

About 40% of Native American genes derived from another source, termed Ancient North Eurasians, probably around 25–20,000 years ago. This strongly suggests that Native American ancestors were still in Asia, probably near Lake Baikal, during this time.

The so-called Beringian Standstill Model relates to isolation of the Native American groups from East Asian cousins between ~25–20,000 years ago and 15,300–14,300 years ago, after which time we see evidence of lineage diversification and population increase associated with migration into Eastern Beringia and the Americas.

Around 20,000 years ago, Native Americans split into 2 groups: (1) Ancient Beringians and (2) all other Native groups. They were likely in Northeast Asia at this time.

The second population split later into 2 other groups about 15,000 years ago (either in NE Asia or Beringia), into a Northern lineage (that includes Athabaskans and Algonkians), and a Southern lineage that includes most other groups in North and South America. We term these NNA and SNA. This split may be associated with the Southern lineage moving through the Ice-Free Corridor, leading to widespread Clovis culture throughout North America, and the Northern lineage moving through the Northwest Pacific coast.




There are now a number of individuals anchoring the time and place of each of the three lineages: Anzick, Kennewick on the Southern line, and Shuka Kaa and some BC individuals on the Northern line.

Once Ancient Beringians separated, there was a bit of gene flow with this Southern group—but that ceased about 10,000 years ago, while there was further gene flow with the Northern group until about 5000 years ago.

Finally, NNA (but not SNA) received gene flow from a Siberian population in the Holocene.

*–Ben Potter*
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Genetic data published in *Nature,* 2018
(see "Suggested Readings")

## Ancestral to *all* Native Americans, North and South

To determine whether ancient Beringians constituted the "source population" for all contemporary Native Americans, Willerslev and his team exhaustively compared the USR1 genome with data from Siberians and East Asians. They found that USR1 and all other tested present-day Native Americans form a clade, or related group, that is distinctively different from Siberians and East Asians. They also found that USR1 and present-day Native Americans are "equally related to the ancient north Eurasian population represented by the 24-thousand-year-old Malt'ta individual" (**MT 29-2,** "Ancient Siberian boy reveals complex origins of First Americans"), thus confirming that USR1 and contemporary Native Americans came from the same "ancestral source," which the team described as a group with "a mixture of East Asian– and Mal'ta-related ancestry." Additional analysis established that USR1 was related equally to both the previously identified Northern and Southern branches of the Native American family, which diverged between 17,500 and 14,600 CALYBP.

**Excavation overview, end of 2013 season.**

Willerslev and his colleagues argue that their data and analyses indicate that the ancestors of USR1 and Native Americans began to diverge from Siberians between 36,000 and 24,500 CALYBP and that this divergence likely took place somewhere in northeastern Asia because there is as yet "no evidence of people in Beringia or northwest North America at this period." These two groups exchanged "a high level of gene flow" until the onset of the Last Glacial Maximum (LGM) around 25,000 CALYBP, a period of "harsh climate conditions" that appears to have isolated the Native American founding population from Siberians (**MT 33-2,** "Bluefish Caves").

Willerslev and his colleagues offer two scenarios for what happened next. In Scenario 1, by 20,900 CALYBP the Ancient Beringians diverged from the population that would become the Northern and Southern Native Americans while still in northeastern Asia. In Scenario 2, that divergence took place in eastern Beringia. They acknowledge that "scenario 1 best fits the archaeological and paleoecological evidence," since there are no documented archaeological sites in eastern Beringia that date to this period. (Known sites in the region date to no earlier than 15,000 CALYBP.) Moreover, it seems unlikely that groups living in Siberia would expand northward into Beringia during the bitterly cold LGM.

**Upward Sun River Component 3 bifaces, 2007–2013.**

On the other hand, Willerslev and his team argue that "Scenario 2 is genetically most parsimonious." Clear evidence argues for "continuous gene flow between the Ancient Beringians" and the population that would later diverge into the Northern and Southern Native Americans. Therefore these groups must have lived close enough to one another to have exchanged mating partners and were isolated from their Asian and Siberian cousins by distance and the environmental barriers of extreme cold and scarce resources after about 25,000 CALYBP.

Scenario 2 is consistent with the Beringian Standstill hypothesis, which argues that the ancestral Native American population were sequestered in an isolated refugium in eastern Beringia, cut off from contact with their ancestors by the harsh climate of Siberia during the LGM, and were prevented from moving eastward by the barrier of ice created when the Laurentide and Cordilleran ice sheets coalesced. This refugium thus became the cradle from which emerged the distinctive Native American genetic variants.

Around 15,000 CALYBP the Northern and Southern Native Americans diverged into separate populations. This is consistent with both scenarios 1 and 2. Willerslev and his colleagues suggest this split occurred south of the continental ice sheets. They further note that no members of the Southern Native American family have so far been "documented in regions that were once north of the Pleistocene glaciers" and that those members of the Northern Native American family that have been documented in the most northerly regions of North America, such as the Athapascans, "are likely to be descendants of a population that moved north" sometime after 11,500 CALYBP.

## The Beringian Standstill hypothesis gets a boost

*Willerslev* told NOVA, in the February 2018 PBS documentary, "First Face of America," that "the Upward Sun sample is extremely important, in the sense that it's the oldest skeleton found in Alaska. And when we did the genome of Upward Sun, it became even more interesting, because it turns out to be basal to all Native Americans." Jennifer Raff, a coauthor of the 2015 study of the mitochondrial genomes of the Upward Sun burials published in the *Proceedings of the National Academy of Sciences,* contributed a column to *The Guardian* about Willerslev's team's work, which concludes that "the Upward Sun River child's genome is very significant. It strongly confirms the Beringian Incubation/Standstill model." But she cautions that "we ought to temper our excitement . . . with the recognition

## Suggested Readings

Moreno-Mayar, J. V., B. A. Potter, L. Vinner, M. Steinrücken, S. Rasmussen, J. Terhorst, J. A. Kamm, A. Albrechtsen, A-S. Malaspinas, M. Sikora, J. D. Reuther, J. D. Irish, R. S. Malhi, L. Orlando, Y. S. Song, R. Nielsen, D. J. Meltzer, and E. Willerslev 2018 Terminal Pleistocene Alaskan genome reveals first founding population of Native Americans. *Nature* 553:203–07.

Potter, B. A., J. D. Irish, J. D. Reuther, and H. J. McKinney 2014 New insights into Eastern Beringian mortuary behavior: A terminal Pleistocene double infant burial at Upward Sun River. *Proceedings of the National Academy of Sciences* 111(48):17060–65.

Potter, B. A., J. D. Irish, J. D. Reuther, C. Gelvin-Reymiller, and V. T. Holliday 2011 A Terminal Pleistocene child cremation and residential structure from Eastern Beringia. *Science* 331:1058–62.

Raff, J. 2018 What the ancient DNA discovery tells us about Native American ancestry. *The Guardian* 3 January 2018; https://www.theguardian.com/science/2018/jan/03/what-the-ancient-dna-discovery-tells-us-about-native-american-ancestry

Tackney, J. C., B. A. Potter, J. Raff, M. Powers, W. S. Watkins, D. Warner, J. D. Reuther, J. D. Irish, and D. H. O'Rourke 2015 Two contemporaneous mitogenomes from terminal Pleistocene burials in eastern Beringia.

that a nuclear genome from a single individual might not represent the full range of genetic diversity within a population."

Nevertheless, Willerslev and his coauthors argue that "the USR1 results provide direct genomic evidence that all Native Americans can be traced back to the same source population from a single Late Pleistocene founding event" and that descendants of that population, which they have called the Ancient Beringians, were present in eastern Beringia until at least 11,500 CALYBP.

Educator Shane Doyle, a member of the Crow tribe, shared his thoughts on the research with NOVA. "What happened," he insists, "was the ancestors of tribal people all were able to come to a confluence at the Bering, about 25,000 years or more ago, and . . . produced a new group of people, and that is who American Indian people are." He further emphasizes that "there's not Native American DNA on the other side of the Bering Strait. Nowhere else in the world is there Native American DNA, except for the Americas. And so that was one of the most profound things that came from the study."

Regardless of the need for further research and the possibility that additional ancient DNA studies surely will refine our understanding of the process of the peopling of the Americas, the study of the Upward Sun River burials has given us a remarkably complete picture of the ancestry of one unfortunate child whose family were members of a population that would eventually give rise to all the indigenous peoples of North and South America. Equally important, the results of this work strongly corroborate the Beringian Standstill hypothesis, which today stands as our best model for how the genetic diversity of Native Americans developed.

*–Brad Lepper*

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# Corridors

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necessary precondition for a successful human migration into the Americas. Since the Bering Strait is frozen every winter and ancient people had serviceable watercraft long before the earliest evidence for people in the Americas, humans could have crossed from northeastern Asia into northwestern North America any time.

Dawe and Kornfeld wish to see an end to quibbling over when the Ice-Free Corridor opened and when it was re-colonized by plants and animals and so became habitable for human occupation. They argue that "the concept of the ice-free corridor is irrelevant for Clovis First as well as pre-Clovis peopling models." The so-called corridor, they insist, was never a narrow passage "between huge multi-kilometer thick continental ice sheets." Instead, it was simply an icy landscape with "a myriad of pathways humans may have travelled from eastern Beringia south to the unglaciated Plains and Rocky Mountains."

## Which Corridor, Ice-Free or Pacific Coastal? It's not an either/or question

At a press conference held in August 2018 to announce the publication of the results of a review of the current genetic, archaeological, and paleoecological evidence relating to peopling of the Americas, Ben Potter expressed his opinion that we don't yet know the answers to many of the questions relating to the routes and timing of the earliest movements of people into the New World:

> I think the issue of 'I don't know' is for many people not a good answer. And so an answer that might be incomplete or conflicting could be preferred over an answer of 'I don't know.' As scientists I think all three of us here [the coauthors present at the press conference] are very happy with 'I don't know' because it pushes us forward to address the questions with new data and new analyses.

Ultimately, as Alia Lesnek and her team observed, archaeological discoveries will provide the answers to the questions of when and where people first found their ways to America. Andrea Freeman recognized that the challenge of finding the earliest sites in the Ice-Free Corridor is likely to be great owing to the fact that many of the traces of those first travelers will have been either washed away or buried beneath thick layers of sediment. Until that evidence is uncovered, however, we'll have to be content with not knowing which route was followed by the very first Americans. And as Potter points out, that's just fine—for now.

*–Brad Lepper*

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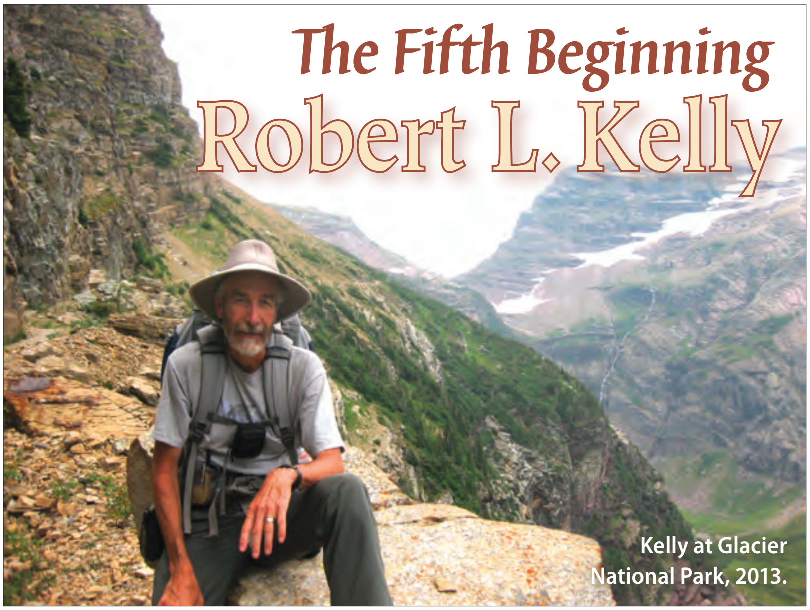
# The Fifth Beginning
# Robert L. Kelly


Kelly at Glacier National Park, 2013.

CRAIG LEE

**DURING RENOWNED WYOMING** archaeologist Robert L. Kelly's 45 years of digging in the soil to unearth archaeological evidence of the lives of early peoples, his agile mind was also digging through what is known about our 6 million years of human existence and organizing it into a pattern of development that's both global in scope and optimistic in nature. "I dig," Kelly says, "because of a deep need to understand human history."

If there was a time when Kelly wanted to be a cowboy, fireman, or astronaut, he doesn't remember it. "I can't actually recall wanting to be anything but an archaeologist," he tells us, "and I filled my childhood bedroom with arrowheads, bones, and fossils." He poked through caves and walked the fields, fascinated by anything old. At an early age his mother gave him a copy of Leonard Wooley's 1962 book, *The Young Archaeologist*; it still holds a place of prominence on his desk at the University of Wyoming.

## A lucky break for a 16-year-old

A school guidance counselor showed Kelly a brochure for Educational Expeditions International when he was just 16. Known as Earthwatch today, EEI matches high school volunteers with field scientists for the summer. Kelly applied for and received a scholarship to work with David Hurst Thomas, an archaeologist at the American Museum of Natural History, who was excavating a cave in central Nevada. After that summer, Kelly continued to work with Thomas for years, until he began his own doctoral field research in western Nevada. Over the years they have coauthored two college archaeology textbooks.


Kelly on survey at the Wall ranch in Wyoming, 2015.

TODD SUROVELL

"Bob Kelly became a meticulous excavator the hard way," Thomas tells us. "He started out with us at Gatecliff Shelter, where, at the ripe old age of 16, he spent his first field night crammed into the back of a pickup truck stuck in the high desert. Despite my best coaching wisdom to the contrary, Bob was a Paleoindian preform from the get-go. His senior thesis at Cornell was a shoreline survey loaded with fluted and stemmed points at Pleistocene Lake Tonopah (Nevada), and his ongoing excavations at Alm Shelter continue this passion in grand style."

Abandoning high school a year early over the objections of his high school principal, Kelly enrolled at Cornell University and earned a B.A. in anthropology in 1978. He went on to receive an M.A. at the University of New Mexico and a Ph.D. from the University of Michigan in 1985. His research focuses on hunter-gatherers, stone-tool technology, and archaeological theory.

Kelly's years as a working archaeologist cover an enormous range of field projects—from New York City, where he excavated on Wall Street, to St. Catherines Island in Georgia, Maine, Kentucky, Montana and Wyoming for ice-patch archaeology, and to the foothills of the Andes Mountains in Chile on the edge of the Atacama Desert. He's especially proud of his ethnographic fieldwork in Madagascar with seasonal hunter-gatherers (he candidly observes that "few archaeologists do such work"). He has examined 13,000-year-old Paleoindian campsites, 19th-century trash middens, human burials, pueblos, and caves. Drawn to the simple lifestyle of hunter-gatherers, Kelly came to admire their ingenuity and ability to survive on what nature provides while leaving only a small footprint.

Studying hunter-gatherers led Kelly to speculate about what early human life was like. Since humanity has spent 99% of its existence foraging, it must have been a tremendously successful adaptation. He wondered what led early peoples to such technological "advances" as agriculture, cities, armies, slavery, and ruling classes when life in small, egalitarian, nomadic groups worked so well for so long. But Kelly believes that "archaeology is not just about the dead; it's also about the living. And it's not just about the past; it's also about the future."

"Bob Kelly played a big role in my decision to go to the University of Wyoming, and also in my decision to pursue a Ph.D. in the first place," says Spencer Pelton, Senior Archaeologist, Transcon Environmental, Inc. "Discovering his 'big picture' approach to archaeology really opened my mind to the field's larger potential for understanding human behavior, and it ultimately inspired me to continue my education at a time when I was debating between CRM and academic paths. It has been a huge privilege to work with Bob the past five years through all the long, pensive dissertation meetings, dry cave backfillings, latrine diggings, wheelbarrow naps, and late field nights. He put up with far more shenanigans than he needed to, and for that I am forever grateful."

## The Fifth Beginning

Most archaeologists will tell you they study the past in order to predict the future, but at some point Kelly recognized that the reason he wanted to understand prehistory was to help create the future. His book, *The Fifth Beginning,* is the result.

"Our attitude toward the future has gone downhill since World War I hit," Kelly says. "Some days it seems as though there's no reason, none at all, to be hopeful. But I choose to remain hopeful, because if I don't—if *we* don't—then surely the world will go to hell. I'm frankly not an optimistic person, but I am a practical one. So I choose the attitude that will lead to the result we all seek."

Even a quick glance at the ancient world proves economist Herbert Stein's Law: If something can't go on forever, it won't. Fifteen thousand years ago nearly everyone was a hunter-gatherer; today almost no one is. Our ancestors couldn't have envisioned our sophisticated technology or global economy; immense changes have occurred in the past 15,000 years. Although evolution's job is to ensure the continuation of the genetic material of a species, the process creates creatures that are remarkably different from those it started with. Everyone in our society today is the result of our ancestors' trying to be the best hunter-gatherers they could be.

"In trying to be one thing," Kelly explains, "organisms reach a tipping point and become something completely different. This is what evolutionary theorists label emergent phenomena." In *The Fifth Beginning,* Kelly argues that humans have passed through four such tipping points over the past six million years. He calls these events beginnings because they mark periods when the basic character of human existence changed and our species began a new life.


UNIVERSITY OF CALIFORNIA PRESS

Cut from the same bolt of cloth as narratives by scientists like Jared Diamond and Richard Dawkins, Kelly's marvelous book traces the history and explores the future of *Homo sapiens* on our fragile planet.

## The beginning of technology

Archaeologists are adept at spotting artifacts manufactured by humans, even when they are nothing more than small dirty fragments. The earliest known stone tools (simple flakes detached from a larger stone), about 3.3 million years old, were discovered in Kenya. These, Kelly suggests, are the beginning of technology, objects that set humans on a path that would lead us to alter our environment.

Bipedalism enabled early hominins to make and transport stone tools, which are often found associated with the bones of possible game animals. Although they may originally have been used to butcher scavenged animals, eventually early hominins became serious hunters. The tools enabled them to win hard-to-acquire foods at an energetic gain, and Kelly points out that acquiring food efficiently is job one for any organism. If a species fails at that task, it's doomed.

Technology was part of an adaptive complex that included bipedalism, changes in diet, and the use of fire. Nothing that followed in human history would have been possible without technology. Stone-tool technology, once developed, remained static between 3.3 and 1.5 million years ago, but the use of stone tools made hominins more successful than their niche's competitors. Users of stone tools raised more offspring and passed on their genetic material, turning our ancestors from arboreal fruit- and leaf-eating, non-toolmaking primates into something entirely different.

## The beginning of culture

"It's our capacity for culture, to see the world differently, that sets humans apart from other primates," Kelly says. "At some point between 200,000 and 50,000 years ago, hominins became cultural beings, humans as we know them."

These early humans became capable of religious thought, learned to tell stories and use metaphors and analogies, and created rudimentary science, art, music and poetry. Like all anthropologists, Kelly believes all human populations have the same capacity for culture. In this case, culture refers to all human creative activity. Central to its development is the ability to recognize and use symbols (a symbol is defined as a visual, auditory, or tactile expression that stands for something with which the symbol has no necessary link). Symbols make a

TODD SUROVELL

**Kelly describes this photo as "a grimy shot of me after backfilling a site last year."**

difference because the capacity for culture means that humans understand the world as a symbolic construction.

"Language is a precondition for culture," Kelly says, "so we need to know when our ancestors began talking. Since words don't fossilize, that's a difficult question." Written language (Egyptian hieroglyphics and cuneiform writing) appeared only about 5,000 years ago, but the physical position of the larynx allowed humans to make a wide variety of sounds soon after bipedalism appeared. Some experiments suggest that language and tool manufacture may have coevolved. "Somewhere in Africa," Kelly tells us, "perhaps in a cave along the continent's southern coast, probably between 200,000 and 50,000 years ago, the second beginning, the emergence of culture, occurred."

## The beginning of agriculture

A global human migration driven by slow population growth continued, until by 10,000 B.C. nearly the entire world was colonized by hunter-gatherers. *Homo sapiens* led the way, and movement was an essential part of the hunting-and-gathering lifestyle, but when there was little unoccupied space left, they were forced to adjust. They weighed the costs and benefits of the available possibilities and opted for the choice that would yield the largest amount of food for the least amount of work. Foraging for wild plants eventually led some hunter-gatherers to domesticate some wild species, and to swap foraging for agriculture.

RACHEL RECKIN

Kelly camping at 10,000 ft while on ice-patch survey in Glacier National Park.

The domestication of plants and animals marks the third beginning. Wheat and barley, millet, rice, maize, and squash made their appearances near human communities around 12,000 to 11,000 years ago. Peas and lentils, tomatoes, fruit trees, grapes, bananas, and yams soon followed.

Dogs have been sharing human living space for at least 13,000 years. Cattle, sheep, pigs, goats, horses, llamas, and turkeys also proved useful to early humans. After tens of thousands of years as hunter-gatherers, many ancient peoples became agriculturalists, leading to today's critical dependence on agricultural to feed the Earth's 7½ billion people.

During the Pleistocene, foraging groups were rarely organized into communities. People could move as individuals or families because no official boundaries existed. Kelly emphasizes that nomadic hunter-gatherers didn't own land; what they owned was the right to grant permission for others to use the land's resources. Population growth was slow, about .04% a year, but began to increase when hunter-gatherers became agriculturists. More food translated into more children.

Climate change and improving plant genetics made agriculture a feasible option in some places, and hunter-gatherers seized it. "Almost overnight in geologic time," Kelly states, "hunter-gatherers became agriculturalists and established sedentary villages."

## The beginning of the state

During the last 10,000 years, more changes occurred than in the previous six million years. It's the time when cities, swords, gold and silver coinage, temples and palaces, roads, bridges, jewelry, spices, chariots, money, and slavery developed. States formed. Anthropologists describe states as societies that have at least three levels of political hierarchy—a ruling class, a bureaucratic class, and laborers.

As societies grew larger, agriculturalists learned to increase production—not simply to support a growing population, but also to relieve some people of the task of producing food. This freed laborers and the state's elite to work at other tasks and brought about the age of Egyptian pyramids, Roman aqueducts, and other colossal feats of architecture.

Once states were born, science and art developed rapidly, as did the study of mathematics, necessary for calculating dimensions in architecture and engineering. Rulers supported court artisans. Trade increased, limited only by available means of transportation. Writing systems were developed. Although early societies were dominated by the kinship principle, the kinship link between the rulers and the ruled was severed when states developed. And together with these cultural leaps came another human invention—war.

## Another beginning on the horizon?

Kelly's ruminations about beginnings led him to suspect that a fifth beginning is currently underway, although it's harder to see because we are in the middle of it. Vast changes are taking place in today's world. For the first time in human history, the majority of the world's population resides in cities instead of rural areas. The planet currently has 28 megacities, each with a population of over 10 million.

Today's world is exploding with trash, in massive landfills and in the ocean. Tree rings and other data sources record a 21st-century rise in atmospheric $CO_2$, the highest in over 800,000 years. The oceans grow increasingly acidic. These changes in the human signature on Earth suggest to archaeologists a period of radical change.

Is there a light at the end of the tunnel that isn't an oncoming train? "Yes," Kelly believes. "In each of the past four beginnings, humanity devised new levels of cooperation. This beginning is no different. Archaeologists imagine the past, but all of us must now imagine the future. That's not easy, but we must do it, for there are two things that make the fifth beginning different from previous ones. First, humans now have the capacity to change the world, and second, we have history to educate us. The only open question is whether we use our capacity and knowledge to take charge of our future."

### Mentor extraordinaire

"Dr. Kelly is a model advisor, graduate supervisor, and teacher," says former student Brigid Grund, a recent doctoral graduate of University of Wyoming. "His interactions and collaborations with students are genuine and simultaneously professional. He is the kind of person that asks to read students' papers (unrelated to his advisory role), simply because he is interested. In short, Bob is a magnificent professor, advisor, career coach, and all-around human being. The impact he has on me as an archaeologist, as a student, and as a person far exceeds any official responsibilities he might have in those areas. Bob is everything an inspiring and distinguished mentor could possibly be."

"Bob Kelly is one of the preeminent hunter-gatherer archaeologists working today," says Wyoming colleague Todd Surovell. "I consider his book on variation in hunter-gatherer lifeways to be the greatest contribution to the anthropology of foraging peoples ever written. Bob was a hero of mine in graduate school and continues to be so after working as his colleague for 15 years. Whether writing about New World colonization, hunter-gatherer archaeology, or lithic technology, he is a synthetic thinker who prefers to focus on the forest rather than the trees. His academic stature is immense and continues to grow. Despite all this accomplishment, he remains a remarkably humble and kind person."

**Vintage Bob Kelly: At the Triple-T Rockshelter in central Nevada, 1973, not far from the Gatecliff Rockshelter, which was also being excavated at the time.**

### A life of abundant accomplishments

Kelly has written over 100 articles, books, and reviews, and has served in a number of leadership capacities, including a total of nine years as department head for both the University of Wyoming and the University of Louisville. He has served as director of the Frison Institute of Archaeology and Anthropology, and as editor of *American Antiquity.* He is also a past president of the Society for American Archaeology and has lectured in the UK, France, the Netherlands, Germany, Finland, Argentina, Australia, Russia, Taiwan, China, and Japan. Kelly is currently directing a 6-year project sponsored by National Science Foundation to create an archaeological radiocarbon database for the U.S. Whew! Makes one wonder when he had time to eat and sleep.

### His view of the future of Paleoindian archaeology

"We should *not* pursue the question of archaeology's future *only* by excavating allegedly pre-Clovis sites and then arguing about whether a meager assemblage is or is not pre-Clovis," Kelly says. "The reason is that that approach will only produce a final answer after we have excavated the entire New World. Instead, we have to rely on arguments based on probability; for example, given the distribution of radiocarbon dates in North America, what's the likelihood that colonization occurred at 13,000, 13,500, 14,000 . . . years ago? What's the likelihood that we can locate evidence of a failed migration? (On the one hand, we found L'Anse aux Meadows—a failed Viking settlement in eastern Canada with architectural walls; on the other hand, we can't find Lewis and Clark's camps—and they left maps!)

"We need better investigation of the Ice-Free Corridor and Northwest coast; and we need to devote attention to Baja California, because if the coastal migration hypothesis is correct, Baja is one of the better places to look for it, since fresh water would constrain occupation there (even in the Pleistocene) and narrow the haystack down for us [**MT 17-2,** "The Baja connection"]. Finally, as I have been saying for years, we don't know the age of Clovis. We have very few dated sites, and a statistical analysis by one of my students, Mary Prasciunas, and my colleague Todd Surovell shows that the current sample of dates almost certainly came from a broader date range than the sample currently represents, and possibly a much longer range, up to perhaps 1,500 years. [In **MT 22-3, -4,** "Clovis dethroned: A new perspective on the First Americans," CSFA Director Mike Waters and geochronologist Tom Stafford specify the radiocarbon and calibrated dates of known Clovis sites.] Add to this the fact that Clovis is not at all well dated west of the Rocky Mountains. In other words, our sample of Clovis dates is small and geographically biased. We can't talk about pre-Clovis if we don't know the age of Clovis—and we don't know the date range of Clovis with certainty (but it is almost certainly older than current dates suggest)."

As for his own immediate future, "I'll be working on First American studies from the perspective of data synthesis, and continuing to work with colleagues on the La Prele Clovis mammoth kill site in Wyoming." MT

*–Martha Deeringer*

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Robert L. Kelly
e-mail: RLKELLY@uwyo.edu

## Suggested Readings

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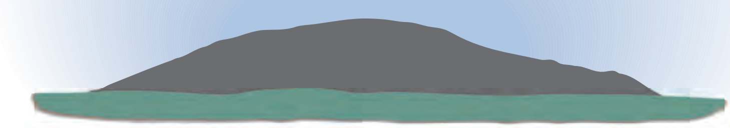
# HUACA PRIETA



# An Ancient Maritime Economy
## Part I

**ON THE PACIFIC COAST** about 700 km north of Lima, an enormous earthen mound called Huaca Prieta dominates the beach. At first glance, the northern Peruvian coast, mainly desert, seems a desolate place unlikely to attract inhabitants, but Huaca Prieta has been uniquely favored by Nature.

The Humboldt Current from Antarctica hugs the shoreline. Farther offshore, the continental shelf drops off. The site lies on the southern point of a relict Pleistocene terrace, which presides over estuarine wetlands and the delta plain of the Chicama River, fed year-round by snowmelt from the Andes Mountains to the east. Abundant marine life of many varieties drew occupants, who created an ancient civilization based on a strong maritime economy. Humans first occupied the site around 14,500 years ago, thousands of years earlier, it turns out, than was thought before Junius Bird first excavated the mound.

### Earliest excavations led by Junius Bird

The distinguishing feature of Huaca Prieta is the enormous mound measuring 162 x 78 x 32 m—about the size of a spacious 10-story apartment building. When Bird excavated at Huaca Prieta in 1944–46 (**MT 23-4, 24-1, -2,** "In the footsteps of Junius Bird"), he was exploring under the egis of the Museum of Natural History in New York. Bird inferred that the site, which initially yielded radiocarbon dates between 5300 and 1900 CALYBP, was occupied by sedentary people who lived in pit houses and exploited marine resources, based on the presence of small stone structures and abundant remains of marine animals

Bird's research defined the existence of a Preceramic culture on the coast of Peru and established the role of textiles as an important medium of cultural expression in ancient Andean culture. Today the Huaca Prieta collection at the Museum displays lithic artifacts, textiles, early ceramics, pyro-engraved gourds, shells, sculpted mud figures, and faunal and botanical remains. The human remains and artifacts reveal a complex culture that practiced burial rituals and produced stylized art.


### Tom Dillehay returns to Huaca Prieta

Inspired by Bird's initial excavations and hoping to fill gaps in the archaeological record, Tom Dillehay, Rebecca Webb Wilson University Distinguished Professor of Anthropology, Religion, and Culture and Professor of Anthropology at Vanderbilt University (**MT 33-3,** "Tom Dillehay: The Clovis-First iconoclast"), along with the late Peruvian archaeologist Duccio Bonavia, led archaeological excavations at Huaca Prieta beginning in 2007.

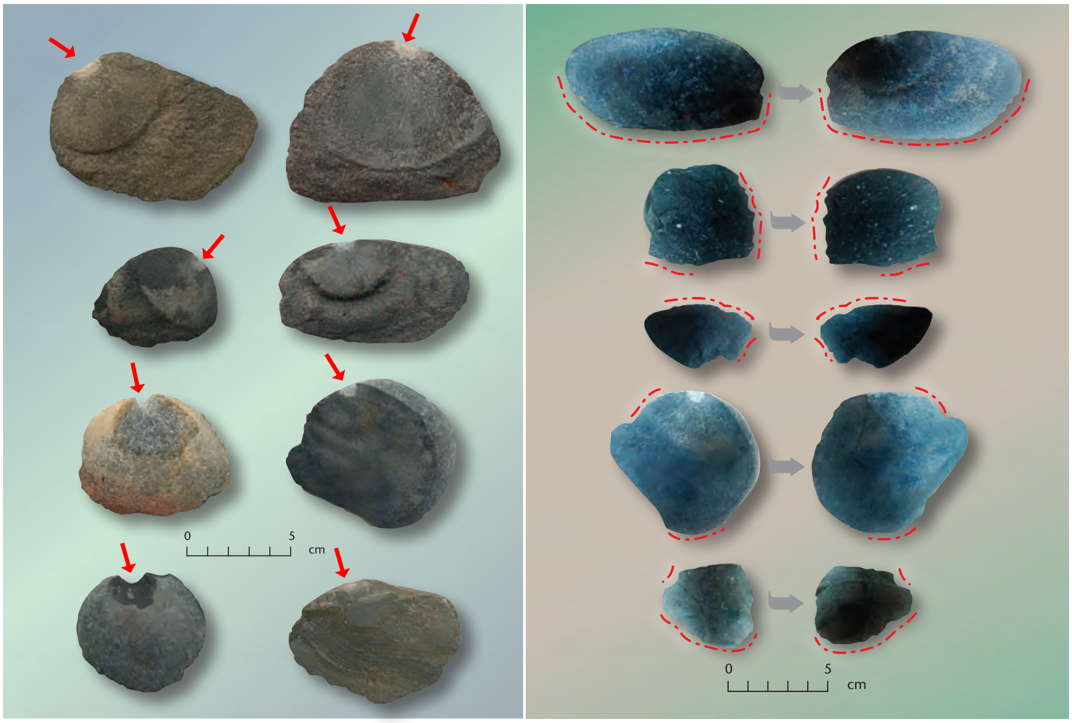
Huaca Prieta is a famous archaeological site. It was the second site in the world, after the Egyptian pyramids, chosen for radiocarbon dating, thanks to Willard Libby, the American physical chemist who won the Nobel Prize in 1960 for his role in developing this invaluable archaeological technology. Until Dillehay's work at Huaca Prieta, the importance of Bird's pioneering work was constrained by a paucity of radiocarbon dates and incomplete study of the environment, stratigraphy, and chronology of Huaca Prieta and other nearby Preceramic sites.

To date, Dillehay's team has excavated more than 2,000 $m^3$ in old and new areas of Huaca Prieta, explored other occupation floors on the relict Sangamon terrace, surveyed Preceramic settlements along the coast of the Chicama River valley, and reconstructed the paleoecology of the area.

"I knew the area Junius Bird excavated dated to 5,500 years ago," Dillehay remembers, "but that was only the northern end of the site. On the southern end is the older stuff, where the mound started being built as it moved north, and below it was late-Pleistocene stuff." The mound building was directional because the first people were maritime hunters and gatherers who dwelled right on the point of the Sangamon terrace. The Chicama River at that time skirted the edge of it, so the occupants were living by the river. As the population expanded, they moved progressively north, up and away from the river.

### Probing deeper into and below the mound

Dillehay initially wanted to focus on the mound itself, but his team soon began investigating the landform beneath it. The team kept digging deeper and deeper into the earth until "the only obstacle was dealing with the depth of the site," Dillehay




ALL PHOTOS UNLESS NOTED: TOM D. DILLEHAY

admits. "The deeper you go, you can't open up big areas. It's too dangerous. I had one worker who fell about 40 feet and broke his hip."

The deepest pit, which took 5 years to excavate, plunges 30 m. Stratigraphic layers reveal evidence for human occupation in hearth fires, animal bones, plant remains, and simple stone tools. Radiocarbon dating of two pieces of wood charcoal from hearths places the upper range of dates at 15,155–15,182 CALYBP, and a wild bean seed was dated at 15,217 CALYBP. Breaking the 15,000-year barrier is significant because the prevailing model for the peopling of the Americas preaches that massive glaciers made travel from Asia to the Americas impossible before 15,000 years ago. Dillehay's research further suggests that some early migrants possibly moved along the coast in an exploratory manner, hopscotching from one refugium to the next.

It's evident to Dillehay that early colonizers had detailed knowledge of different maritime and terrestrial environments, which must have been gathered only after considerable time invested in exploring, observing, and experimenting in trial-and-error fashion. Huaca Prieta was abandoned 3,800 years ago, which means it was used, on and off, for more than 11,000 years. It served as a sacred mortuary site for burials from the Ceramic and colonial periods to the modern day. "We actually excavated part of a body that had bluejeans on," says Dillehay, "so the site has really been continually *used* for more than 14,000 years."

**Lithic artifacts, pre-14,000 CALYBP, from Huaca Prieta: (*left*) arrows indicate percussion marks; (*right*) hash marks indicate use wear on margins.**

## What's on the menu?

The Vanderbilt University professor once said in a TED talk that archaeology is the study of human behavior observed through the use of material goods. "We play with people's trash," he told his audience. Dillehay's team has literally dug through the trash heaps—middens—of the earliest inhabitants at Huaca Prieta. They discovered that occupants survived on local plants as well as marine resources. The first occupants of the site, however, were maritime foragers. Interestingly, Dillehay didn't find fishing lines, nets, or harpoons. He suspects people didn't need them because storm surges would have sent seawater flooding inland, leaving behind pools full of stranded sea creatures ready to be scooped up—as local people continue to do today.


**Mat fragment from early-Holocene level (pre-10,000 CALYBP) at Huaca Prieta.**

Digging down 30 m also provided a glimpse into the Pleistocene diet. At a depth of about 27 m, Dillehay's team first found

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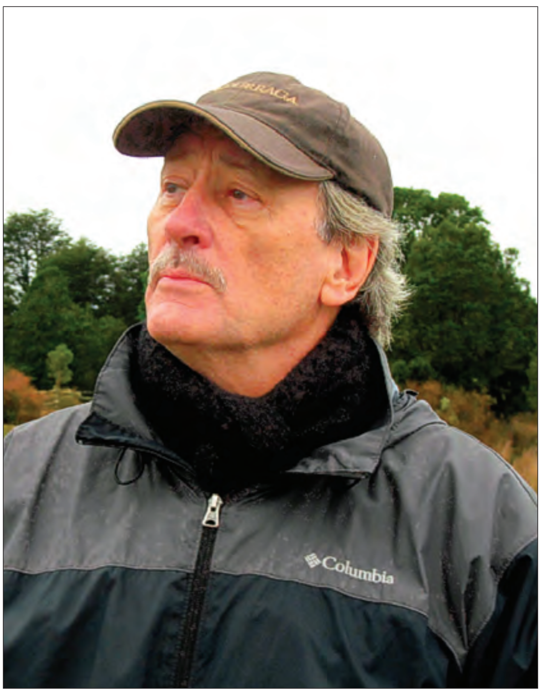
what they expected, the remains of sea lions. "Even today, on that particular beach, sea lions come there to die or to mate," Dillehay tells us. "I've seen people go out there and club them to death, then cook and eat them. There's also shellfish, which is easy to collect. When you get high tide, the estuaries fill up and small sharks come in to feed on the fish. These fishing and collecting techniques have been around for 14 or 15 thousand years." You don't need sophisticated techniques at all, Dillehay explains. Today people in Peru take a basalt cobble, knock off a flake to create a serrated edge, and use it to scrape scales off a fish before cooking it. "It works a lot better than a steel knife," he says. "It grabs the scales and pulls them right off. It's a simple pebble-tool technology still in use today."

**Huaca Prieta, habitation and a site for mortuary and ritual use, 14,500–3800 CALYBP.**

## Not strictly a seafood diet

Plants were part of the diet even 14,500 to 10,500 years ago. "People were collecting edible bullrush and reeds from the wetlands to eat. There was also pods of the algarrobo, a mesquite-like tree," Dillehay says, "and at about 10,500 years ago we start getting squash, avocado, and chili peppers. Gradually, over time, you see that what was once a 98% maritime economy shifting into agriculture. Near the end, you can't say the maritime economy ever went away. It was more like a dual economy by the time you get to 4,000 years ago."

Larisa DeSantis, Assistant Professor of Earth and Environmental Sciences at Vanderbilt University, analyzes the teeth of Huaca Prieta human remains for stable-isotope data, which detect ratios of certain elements like nitrogen or carbon and thereby reveal the kind of food in an individual's diet. Paleontologists use this technology to chart changes in the ecosystem from the teeth of megaherbivores (**MT 23-2,** "Chemical studies reveal the lost world of Pleistocene America"). She also analyzes dental microwear, studying 3-D models of abrasion marks left by foods eaten. Her studies show that the diet of many occupants of the Huaca Prieta area, especially at the nearby mound of Paredones, shifted from principally marine animal to increasing reliance on crops: As corn became the mainstay of a diet, the amount of carbon stored in tooth enamel and bones increased.



JORJE GUZMAN

**Dilehay at Huaca Prieta, July 2018.**

The diet of many occupants shifted, but not all. "There were people eating almost exclusively corn and veggies like chili peppers and beans," Dillehay explains. "Then there were other people eating almost exclusively seafood. So, although they lived a few hundred meters apart, these people weren't just specialized producers but eaters as well. So it's kind of like today, your vegans versus your beef-eaters."

## Work for ecology sleuths

It's fitting that Huaca Prieta is the only large Preceramic mound that sits right on the ocean because, as Dillehay points out, "Peru probably has the world's most abundant and richest maritime economy always, even today. So it's appropriate this site developed according to what was important ecologically." This area is also a desert environment, where low humidity and stable warm temperatures serve to preserve organic materials remarkably well (**MT 31-1,** "The archaeology of Mars-on-Earth"). "The downside, if there is a downside," archaeologist Dillehay confides, "is that you've got to study everything you excavate now, which is one of the reasons the study was highly interdisciplinary." He admits that one of the challenges in excavating Huaca Prieta was putting together his multi-talented team of about 50 specialists. MT

*–Katy Dycus*

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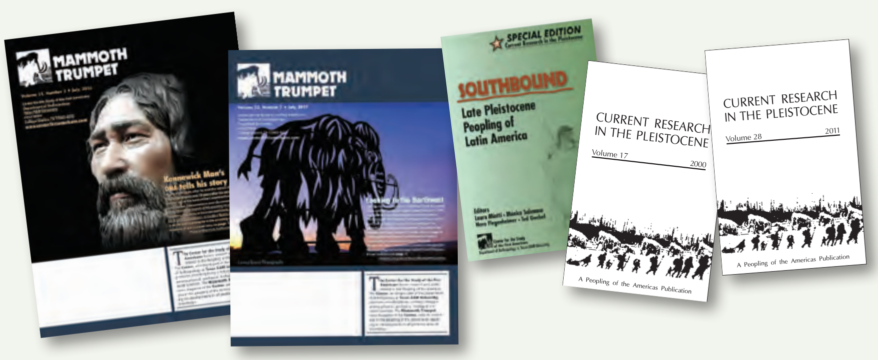


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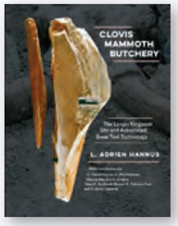


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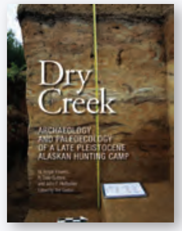


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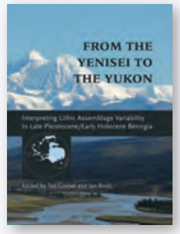


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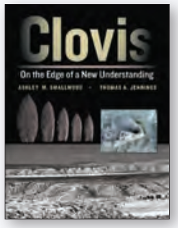


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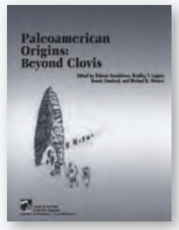


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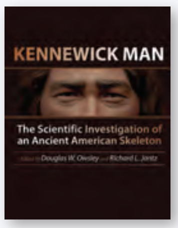


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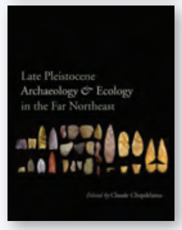


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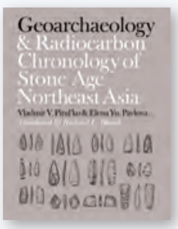


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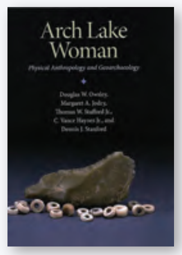


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|---|---|---|---|
| | | | |
| | | | |
| | | | |

**Payment**

☐ Check ☐ VISA ☐ MC ☐ AmEx ☐ Discover

Credit card no. ______________________

Expires ____ ____ (M/M, Y/Y) 3-digit verification code ______ (on back of card)

Signature ______________________

**Ship to (please print clearly):**

Name ______________________

Address ______________________

City ______________ State ____ Zip ______

e-mail ______________ phone ______________

**Shipping & handling:** U.S., $6+$1 each add. book
Foreign, $11+$3 each add. book

**Subtotal**

**Texas residents add 8.25% sales tax**

**Total**

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