MAMMOTH TRUMPET

Volume 32, Number 2 ■ April, 2017

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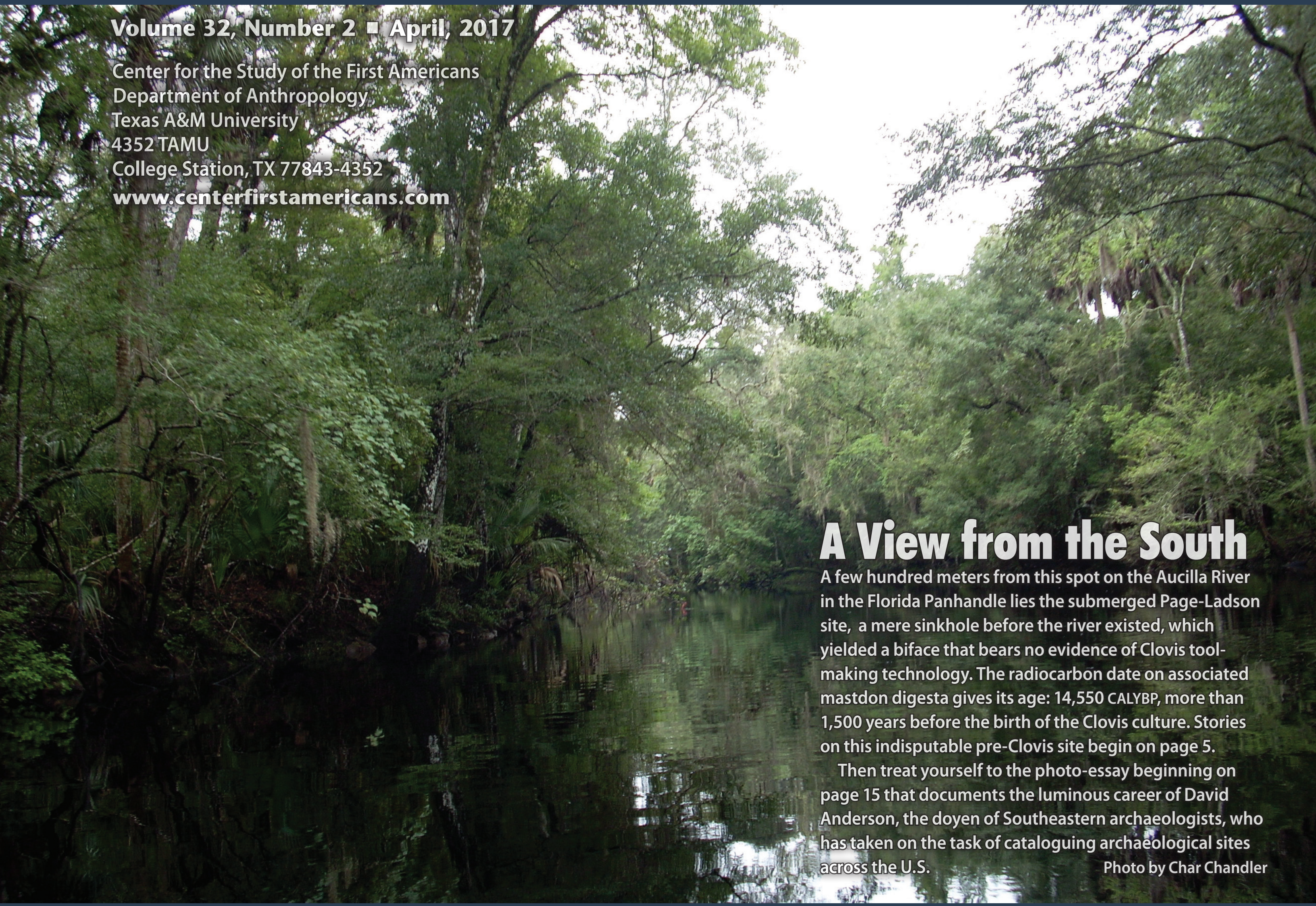

A View from the South

A few hundred meters from this spot on the Aucilla River in the Florida Panhandle lies the submerged Page-Ladson site, a mere sinkhole before the river existed, which yielded a biface that bears no evidence of Clovis tool-making technology. The radiocarbon date on associated mastdon digesta gives its age: 14,550 CALYBP, more than 1,500 years before the birth of the Clovis culture. Stories on this indisputable pre-Clovis site begin on page 5.

Then treat yourself to the photo-essay beginning on page 15 that documents the luminous career of David Anderson, the doyen of Southeastern archaeologists, who has taken on the task of cataloguing archaeological sites across the U.S.

Photo by Char Chandler

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Volume 32, Number 2 — Center for the Study of the First Americans — Department of Anthropology

April, 2017 — Texas A&M University, 4352 TAMU, College Station, TX 77843-4352 — ISSN 8755-6898

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A High-Resolution Timeline for Peopling of the Americas

A NEW ANALYSIS OF DNA from 92 pre-Columbian South Americans provides the clearest picture yet of the timing, route, and process of the Peopling of the Americas. Senior authors Alan Cooper and Wolfgang Haak with the Australian Centre for Ancient DNA at the University of Adelaide and a team of 29 other scientists representing 20 institutions in 7 countries are using this unprecedented library of ancient DNA to answer many of the most fundamental questions about the First Americans—from their initial crossing of Beringia to the catastrophic consequences of the arrival, more than 15,000 years later, of Europeans in this hemisphere.

Cooper and Haak's team sequenced "92 whole mitochondrial genomes from pre-Columbian South American skeletons" dating from between 8,600 and 500 years old. Most of the human remains were recovered from the Central Andes region, including 70 individuals from sites in Peru, 9 from western Bolivia, 6 from northern Chile, 5 from Mexico, and 2 from Argentina. They presented their results in the April 2016 issue of *Scientific Advances.* These data provide an unprecedented genetic window to the earliest chapters of American history.

In order to understand how geneticists can reconstruct history from the letters of the genetic code, you have to know how the so-called molecular clock works. When a group of people divides into two groups, which then move away from each other, their collective gene pools will begin to diverge over time. Random mutations occur in each population at a more or less constant rate, and so when you compare two related populations you can calculate how long ago they separated from each other based on how genetically different they are. The problem lies in

HUACA PUCLLANA RESEARCH, CONSERVATION AND VALORISATION PROJECT

Huaca Pucllana, a great adobe pyramid in the city of Lima, Peru, was a ceremonial and administrative center for the Lima (A.D. 500–700), Wari (A.D. 800–1000), and Ychsma (A.D. 1000–1450) pre-Columbian cultures. DNA from human remains found at Huaca Pucllana was used in the present genetic study.

INSIDE

getting an accurate estimate of that more or less constant rate of mutations. Once you know the rate, you can calibrate the molecular clock.

Owing to the absence of evidence for early sites in eastern Beringia, which includes westernmost Alaska as well as the now submerged eastern portion of the land bridge, and the general scarcity of archaeological evidence for the earliest Americans in the rest of the hemisphere, there are few reliable benchmarks to use for calibration purposes. Another problem noted by Cooper, Haak, and their coauthors is that when studying relatively recent times, we can't apply molecular rates of evolution based on the deep human-chimpanzee time calibration (6–7 million years) to quantify the timing of the peopling of the Americas (which qualifies as recent in this context). This is where those "92 whole mitochondrial genomes from pre-Columbian South American skeletons" come in. That number of data points over that span of time provides a reliable basis for calibrating the molecular clock.

An unexpected amount of genetic diversity

One of the most unexpected discoveries arising from the analysis of these 92 mitochondrial genomes was how diverse they turned out to be. All documented indigenous South Americans fall into seven haplogroups: A2, B2, C1b, C1c, C1d, D1, and D4h3a. The X haplogroup isn't present in South America (**MT 31-4,** "Mitochondrial haplogroup X: Evidence For ancient transatlantic migrations to the Americas?"). A haplogroup is a group of people, living and dead, that can trace their ancestry back to a common ancestor. Haplogroups based on mitochondrial DNA define branches on the maternal side of the family tree. Within those haplogroups are haplotypes, subgroups that share some distinctive segments of genetic code that can be traced to a more recent common maternal ancestor.

Among their sample of pre-Columbian South Americans, Cooper and Haak's team identified 84 distinct haplotypes, none of which "are represented in the existing genealogy of global human mitochondrial diversity." They observe that this remarkable result dramatically illustrates the vital importance of sampling pre-Columbian human remains "to fully measure the past genetic diversity and to reconstruct the process of the peopling of the Americas."

When did the ancestors of Native Americans diverge from Paleo Siberians?

Based on the team's analysis of these 92 genomes, it appears that the ancestors of Siberians and the ancestors of Native Americans went their separate ways sometime between 24,900 and 18,400 years ago. The later date coincides with the height of the Last Glacial Maximum (LGM), which Cooper, Haak, and their coauthors suggest is a likely reason for the separation. The data reported in the new study, however, cannot determine where this separation took place. It could have happened in Siberia or farther east

MAMMOTH TRUMPET

The Mammoth Trumpet (ISSN 8755-6898) is published quarterly by the **Center for the Study of the First Americans,** Department of Anthropology, Texas A&M University, College Station, TX 77843-4352. Phone (979) 845-4046; fax (979) 845-4070; e-mail csfa@tamu.edu. Periodical postage paid at College Station, TX 77843-4352 and at additional mailing offices.

POSTMASTER: Send address changes to:

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–Michael R. Waters, Director

in Beringia, but given the timing, Cooper and Haak's team suggest that "the cold arid conditions" of the LGM drove populations on the Siberian side of Beringia into more congenial southern refugia.

Groups farther to the east, however, wouldn't have had the option of retreating to the south, because there would have been nowhere to go except into the frigid Pacific Ocean. And they couldn't go east, because glacial ice sheets still blocked the way into the Americas. Therefore they would have been forced to make the best of things in eastern Beringia. These isolated groups included the men and women that would become the first Americans.

Cooper, Haak, and their coauthors estimate the population to have been "relatively small, probably not exceeding a few tens of thousands of people." The environment of eastern Beringia was a shrub tundra that would have provided abundant firewood and supported a megafaunal smorgasbord, including mammoths, bison, and horses—ample resources for these hunter-gatherers.

A Beringian standstill?

The genetic data thus support the Beringian Standstill model, but how long was this period of isolation in this large but limited area? Cooper, Haak, and their coauthors claim that their extremely large dataset of ancient mitochondrial genomes makes it possible to estimate precisely the duration of the standstill.

Their analysis detects "a sudden burst" of diversification in the mitochondrial DNA family tree of ancient Americans starting 16,000–13,000 years ago. This burst of new diversity coincides with a 60-fold population increase over the same period. Cooper, Haak, and their team argue that this explosion in population size and genetic diversity marks the opening of the more favorable environments of North America to the very first wave of Asian immigrants. Their conclusion: The duration of the Beringian Standstill may have been as short as about 2,400 years, but no longer than about 9,000 years.

Following the coast

Cooper and Haak's team argues that the timing of the entry of the arrival of the First Americans suggests that they must have followed a coastal route into this New World (**MT 14-1,** "Charting the way into the Americas"). The date of 16,000 years ago closely corresponds to the melting of the glaciers along the northwest Pacific coast. Since the inland Ice-Free Corridor didn't open until around 13,000 years ago, the route for the initial entry into the Americas must therefore have been along the "recently emerged northwest Pacific coastal land." And given that people were at Monte Verde in southern Chile by 14,600 years ago (**MT 1-1,** "Life in Ice Age Chile"), the mitochondrial DNA data suggest that these first Americans colonized the entire breadth of the New World, from Alaska to Tierra del Fuego, in only 1,400 years!

After this rapid migration and expansion throughout the Americas of a founding population that included females of every major haplogroup, local groups appear to have rapidly settled into particular geographic regions. Once settled in, they began to limit their interactions with groups in other regions. This is likely what led to the rapid development of the more or less regionally distinctive populations, which we see at a surprisingly early time period (**MT 31-3,** "Kennewick Man's DNA reveals his ancestry").

Genetic diversity in pre-Columbian America

Cooper and Haak's team's conclusion that "none of the 84 haplotypes identified from ancient samples are represented in the existing genealogy of global human mitochondrial diversity" presents us with a puzzle. If pre-Columbian populations were so genetically diverse, why isn't that diversity reflected in post-Columbian populations?

The answer, of course, is that all that

JOHAN REINHARD

The *Doncela* (Maiden) Incan mummy was found at Mount Llullaillaco, Argentina, in 1999. DNA from this mummy and 91 other pre-Columbian humans was used in the genetic study.

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Burial site of the Lima culture (A.D. 500–700) uncovered at the Huaca Pucllana pyramid in Lima, Peru. DNA from human remains found at Huaca Pucllana was used in the present genetic study.

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diversity was somehow lost somewhere along the way. Most of the human remains the team studied came from "large population centers along the western coast of South America, which experienced high extinction rates following European colonization."

After a sophisticated statistical analysis of the genetic data, the team concluded that the best explanation for the massive loss of genetic diversity was "local mass mortality" that followed European colonization. This was principally a consequence of the introduction of European diseases against which indigenous populations lacked natural immunity.

The authors caution, however, that the processes associated with European colonization were likely more complex than we currently understand. Consequently they call for "more complete mitochondrial sequence data from early and modern day populations" to further clarify the factors leading to the catastrophic loss of genetic diversity that followed hard upon European contact.

A genetic history of the Americas

Cooper, Haak, and the 28 other members of their team, through their analyses of an unprecedented number of whole mitochondrial genomes obtained from well-dated pre-Columbian human remains, have produced a remarkably comprehensive history of the peopling of the Americas. Their results offer compelling answers to all the most fundamental questions about this history, including the timing of the initial migration, the route followed by those first arrivals, and the speed of their colonization.

Llamas. Cooper. Fehren-Schmitz. Haak.

Between 24,900 and 18,400 years ago the ancestors of Native Americans separated from their Asian cousins. Trapped between the inhospitable conditions of western Beringia and the glacial ice sheets blocking entrance to North America, they became isolated in eastern Beringia for between 2,400 and 9,000 years. About 16,000 years ago, the LGM came to an end and the ice sheets blocking their way along the western coast of North America melted back, enabling groups to flood southward into the newly discovered lands. Within the short span of 1,400 years, their descendants reached the southern extremes of South America. Very rapidly that relatively diverse and homogeneous population began to differentiate into regional populations with their individual distinctive genetic profiles.

In addition to revealing details of the original discovery of America, this study also gives us new insight into the terrible consequences of that much later and misnamed "discovery" by 15th-century Europeans. In regions where Europeans were present early and in high numbers, there was a commensurate decline of Native American populations due to disease as well as other causes.

There are limitations to this study. For one thing, only mitochondrial DNA was considered, not nuclear DNA, which would have provided a more complete view of the genetic histories of the first Americans. These additional data likely will reveal even more genetic diversity that what we see in the mitochondrial DNA record.

In addition, first author Bastien Llamas, with the Australian Centre for Ancient DNA at the University of Adelaide, told the *Christian Science Monitor* that

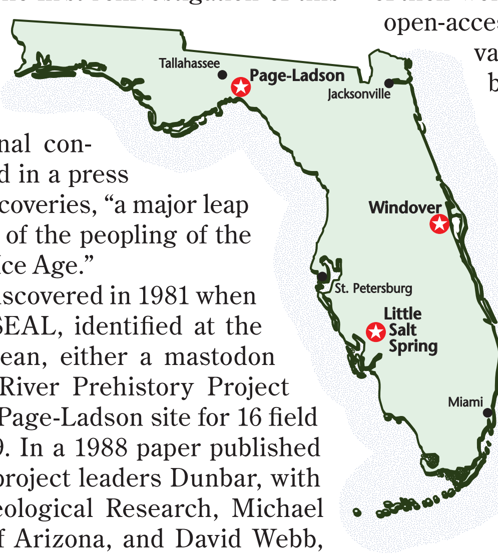
continued on page 9

"An Uncommon Doorway to Our Past"

The Page-Ladson Site

B. FENERTY

NEW DISCOVERIES and the reanalysis of old discoveries made at the Page-Ladson site in the Florida Panhandle shine as unequivocal evidence for the presence of humans in the Americas more than 1,500 years before the Clovis culture. Mike Waters, Director of the Center for the Study of the First Americans, and Florida State University anthropologist Jessi Halligan codirected the first reinvestigation of this important site since the initial work by Jim Dunbar and his team more than a decade ago. Their results corroborate and extend Dunbar's team's original conclusions and are, as Waters said in a press conference to announce the discoveries, "a major leap forward in shaping a new view of the peopling of the Americas at the end of the last Ice Age."



The Page-Ladson site was discovered in 1981 when Buddy Page, a former Navy SEAL, identified at the site the bones of a proboscidean, either a mastodon or a mammoth. The Aucilla River Prehistory Project subsequently investigated the Page-Ladson site for 16 field seasons, 1983–85 and 1987–99. In a 1988 paper published in the *Florida Anthropologist*, project leaders Dunbar, with the Florida Bureau of Archaeological Research, Michael Faught, with the University of Arizona, and David Webb, with the Florida Museum of Natural History, described as the initial goals of this multidisciplinary project "to record, investigate and test the stratigraphic integrity of drowned archaeological and paleontological sites in the Aucilla River in North Florida." In this they succeeded admirably.

In his 2016 book, *Paleoindian Societies of the Coastal Southeast*, Dunbar describes the Aucilla River region as "one of the most important archaeological and paleontological resources in the late Pleistocene Americas." The sites his team explored are for Dunbar "an uncommon doorway to our past."

An oasis in a dry landscape

The Page-Ladson site is located on the Aucilla River about 11.5 km from the Gulf of Mexico. The entire site is now underwater, but during the late Pleistocene, when massive continental ice sheets lowered sea levels, all that existed was a pond at the bottom of a sinkhole. The site preserves the footprints and dung of mastodons that visited the pond during periods when its margins were dry. Paleoenvironmental evidence records the presence of other visitors as well, including opportunistic human hunters.

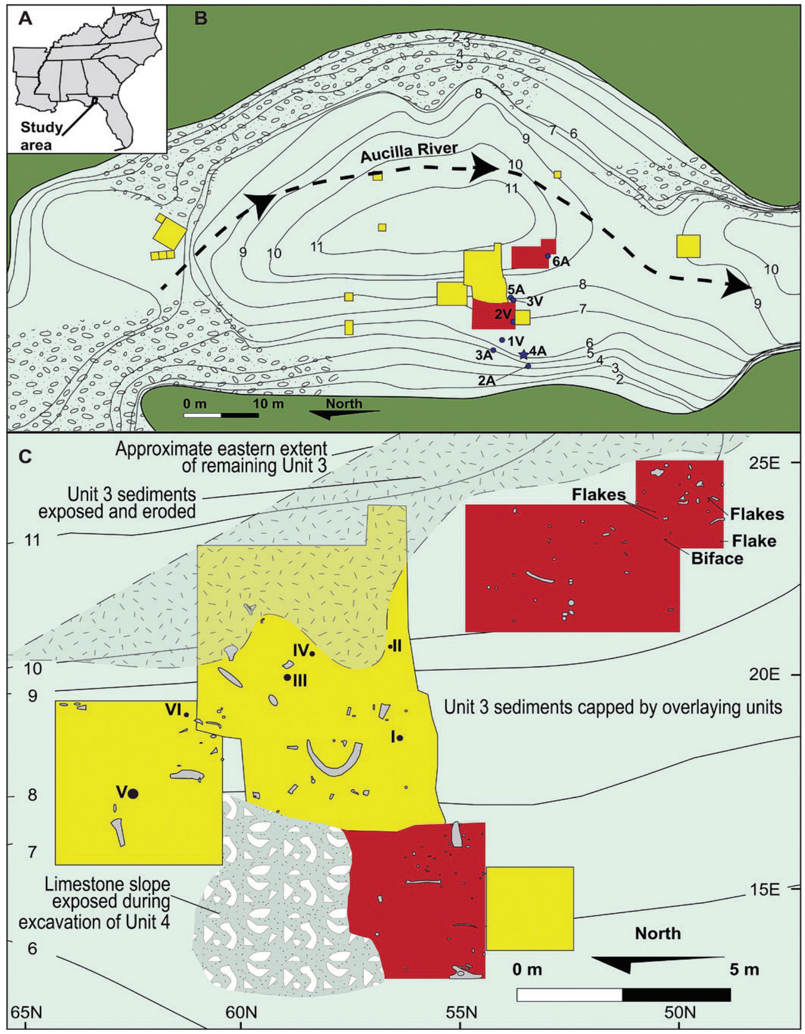
Halligan, Waters, and their team reinvestigated the Page-Ladson site between 2012 and 2014 and presented the results of their work in the 13 May 2016 issue of *Science Advances*, the open-access journal of the American Association for the Advancement of Science. Halligan and Waters are joined by 10 other coauthors from 9 institutions. One of the coauthors is Dunbar, who contributed valuable knowledge and experience of working at the site.

Practicing precise archaeology underwater

Because the site is now submerged in the Aucilla River, the archaeologists needed to employ special methods to excavate it with the same careful precision they devote to sites on dry land. Doing archaeology underwater, says Waters, is "twice as expensive, at least, and three times as complicated" as doing it on land.

Halligan describes how she and her team conducted the excavation: "Teams of two divers would carefully remove all sediments in controlled levels by trowel and by hand vacuuming these sediments to the surface with a water dredge." The divers excavated the site in 5- or 10-

Page-Ladson site map. **A,** location of the site in northwestern Florida. **B,** map of underwater excavations made by Halligan and Waters team (red), showing the entire sinkhole and previous excavation areas (yellow). Contours are in meters below datum. **C,** detailed map displaying the location of bones (gray) drawn to scale, and artifacts (black) recovered from geological units 3a–3c and 4a–4b.



cm levels, and all the excavated sediment was sieved through nested ¼- and 1⁄16-inch floating screens. Underwater lasers calibrated the depth of excavation. Their methods, says Halligan, "allowed us to be very precise in our excavation and to see items as we exposed them in place."

In "Supplementary Materials" accompanying the *Science Advances* article, the authors provide a glimpse of their meticulous methods in describing one of the team's key discoveries. Upon arriving at the excavation block, the divers "removed their fins . . . and tied them off to the stake placed for this purpose. The dredge hose was routed around the outside of the excavation block to come in from the north side of the excavation unit in order to make sure no materials were being knocked in from the walls of the unit. Both divers were within the excavation block entirely to make sure that their bodies could not knock any items in. . . . They carefully cleaned all loose debris from the top of the unit before beginning excavation by trowel."

Their diligence paid off when they uncovered an artifact, a small fragment of a reworked bifacially flaked knife lying on a mound of digesta. The divers "carefully inspected the area for any evidence of disturbance (which was not observed), collected copious amounts of video and still photography of the artifact in context . . . and collected radiocarbon samples of the digesta from which the flat-lying biface was recovered."

Found: pre-Clovis artifacts

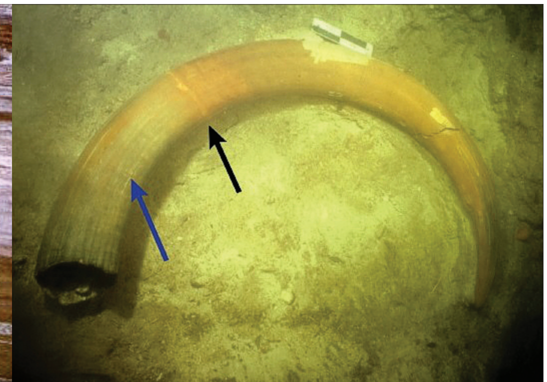
Waters and Halligan's team recovered from pre-Clovis units 3, 4a, and 4b a total of "six unequivocal stone artifacts, all made of local coastal plain chert." The artifacts from the deepest layer, 3c, included the knife found with digesta, and a flake. The digesta are organic materials from feces or possibly from the stomach or intestine, probably of a mastodon. (Bison and camel bones have also been recovered in these deposits.) The flake was excavated at the same depth as the biface, but about 1 m away. Seven samples of organic material associated with the biface returned calibrated radiocarbon dates of around 14,550 CALYBP. Two fragments of wood found in association with the flake produced similar dates of around 14,500 CALYBP.

To eliminate the possibility that these might be younger artifacts that intruded into an older layer, the team also obtained a vertical series of 15 radiocarbon dates from 1.1 m of sediment overlying the biface and another nine dates down to 0.6 m below it. The sequence of dates confirmed the excavators' observations: The bifacial knife fragment "was lying in undisturbed sediments." Its undisturbed nature was confirmed by the presence of a thin unbroken layer of shell-rich sediment in the lower portion of Unit 4. This layer has been radiocarbon dated to around 14,400 CALYBP. If the biface fragment or flake had intruded into the pre-Clovis layer from a level associated with Clovis or an even more recent period, the team would have observed breaks in the shell layer. Therefore they confidently conclude that the artifacts have been sealed beneath this shell layer for at least 14,400 years.

Halligan and her coauthors write that "the small artifact assemblage recovered from the pre-Clovis occupation at Page-Ladson is consistent with the small number of artifacts found at other pre-Clovis and some Clovis butchering and scavenging sites." The crucial difference is the technology, which sets Page-Ladson apart from Clovis. Waters notes that the bifacial knife, in particular, "appears to have been made on a flake and doesn't have any of the characteristics of Clovis technology—of the type of flaking that you find on Clovis and that seems to be true of all pre-Clovis sites."

A butchered mastodon?

The recent excavations directed by Halligan and Waters didn't recover any animal bones with direct evidence of human butchering. One of Dunbar's most important discoveries at the Page-Ladson site, however, was a mastodon tusk found submerged in 1993. It bears several deep parallel grooves, which his team interpreted as cutmarks made by stone tools. The tusk was radiocarbon dated at 14,400 CALYBP, making it pre-Clovis. The evidence wasn't widely accepted at the time, partly because it's difficult to ascertain what made the marks and whether they were made at the time the animal died, or centuries or even millennia later. Of course, another reason Dunbar's claim was largely ignored is that many archaeologists at the time adhered to the Clovis-First model, which postulated Clovis as the earliest occupation of North America.



▲Underwater photo of mastodon tusk in situ. The black arrow indicates the gingival margin (the depth to which the tusk was embedded in the tusk socket); the blue arrow indicates where a patch mold was applied by David Webb shortly after the tusk was found in 1993 to make a cast of striations in the cementum. The scale is 20 cm.

▲Cutmarks on Page-Ladson mastodon tusk (UF 150701), photographed prior to desiccation fracturing of cementum layer, are oriented perpendicular to random longitudinal ridges and grooves that form on the surface as the cementum dries and checks.

Waters and Halligan's team thought it was worth a second look at the possible cutmarks, so as part of their reinvestigation of the Page-Ladson site they enlisted the help of Daniel Fisher, a paleontologist at the Museum of Paleontology at the University of Michigan and an expert at interpreting ancient bones and the various kinds of marks made on their surfaces by natural processes and by humans. His examination of the tusk confirmed that the grooves are indeed cutmarks made by stone tools when the tusk was extracted from its socket in the mastodon's skull.

Why would the pre-Clovis people go to the work to remove the tusk? First of all, Fisher tells us, the pulp cavity of a tusk contains about 15 lbs of highly nutritious tissue. Perhaps even more important, says Fisher, was the ivory, useful stock for making tools. After detaching the tusk Paleoindian toolmakers might have intentionally submerged it in the pond to preserve the ivory for later use.

Halligan (*left*) and lab technicians with the partially reassembled tusk after its recovery.

Making the case for a pre-Clovis occupation

The evidence from Page-Ladson indicates that, along the margins of a small pond at the edge of a sinkhole, around 14,500 years ago people butchered a mastodon, which they had either killed or scavenged. When pre-Clovis people occupied the site it was, according to Halligan, “a pretty isolated pond, which means that people either would have had to understand how the landscape worked very, very well, or they would have been following the big game like mastodons from water hole to water hole, which meant that of course they would have to understand how these large mammals worked very, very well.” Either scenario suggests that the people weren't newcomers to this landscape.

The evidence for these conclusions is meager. Waters and Halligan's team recovered only six flint artifacts and reevaluated a single piece of a mastodon tusk with cutmarks. Is this evidence sufficient to prove there was a pre-Clovis occupation at Page-Ladson?

The answer from Waters is a resounding *yes!* “The gold standard necessary to demonstrate unequivocally that a site predates Clovis,” he says, “has always been, one, clear evidence of human activity, usually in the form of stone tools. Second, these tools must occur in a solid geological context. And third, these artifacts must be dated using a reliable dating technique. At Page-Ladson, we meet all three criteria.” At Page-Ladson were found unequivocal lithic artifacts, including a bifacial knife and utilized flakes, associated with mastodon remains, including a tusk with tool marks. The artifacts were sealed in undisturbed geological deposits at the base of a 4-m-thick stratified sequence. Moreover, "71 new radiocarbon dates show the artifacts date to 14,500 years ago and that the stratigraphy at the site is undisturbed."

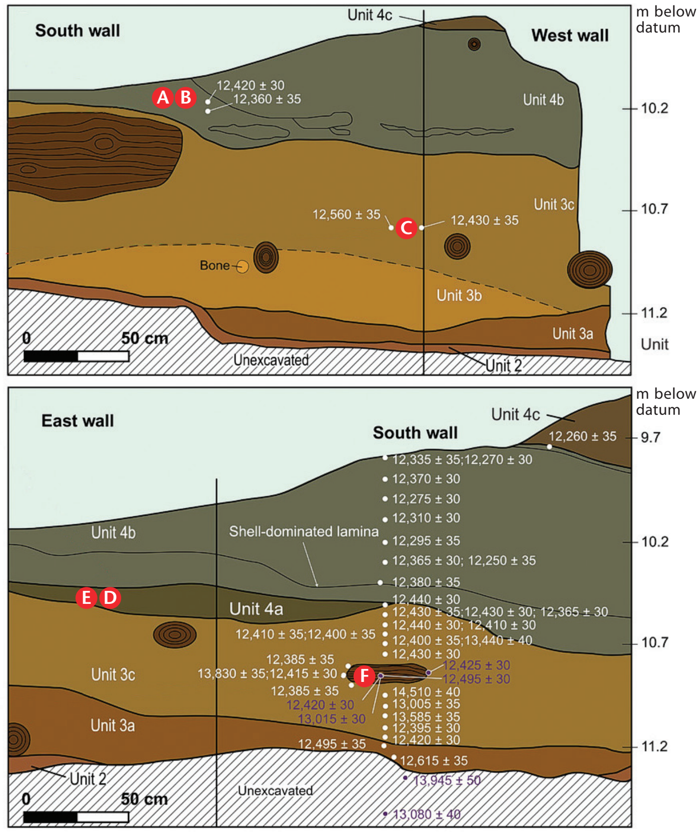
The continuing pursuit of pre-Clovis

For Waters, the focus of research has now shifted from the narrow question, Was there a pre-Clovis occupation at Page-Ladson? to the bigger question, Where did this technology eventually morph into Clovis? And why was that technology developed?

Concerning the next steps in the Page-Ladson investigation, Waters says that they "should go back and dig more of Unit 3, because one thing we don't have in this pre-Clovis assemblage is a diagnostic projectile point." It's a daunting mission, though, which he admits is "like looking for a needle in a haystack."

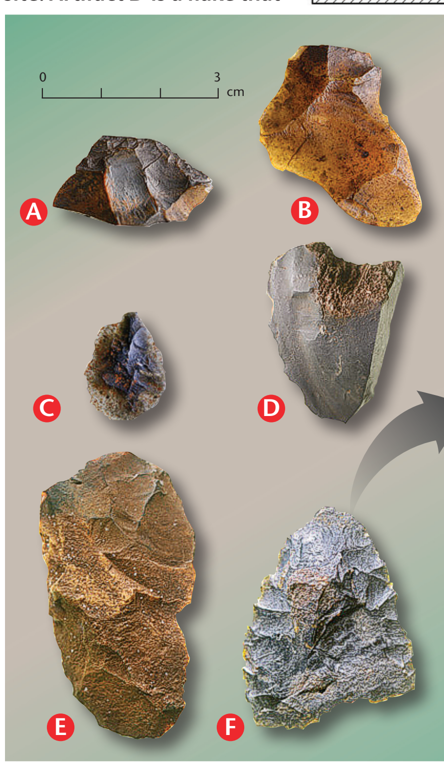
Dunbar thinks he has already identified diagnostic pre-Clovis points at Page-Ladson. In disturbed contexts his team has found a number of points that he believes are pre-Clovis. He compares these points, which he has named Page-Ladson points, to the Miller point found in a pre-Clovis level at Meadowcroft Rockshelter in Pennsylvania and to similar points found at the Cactus Hill site in Virginia. Only time will tell whether these Page-Ladson points are indeed the diagnostic pre-Clovis projectile point Waters is looking for.

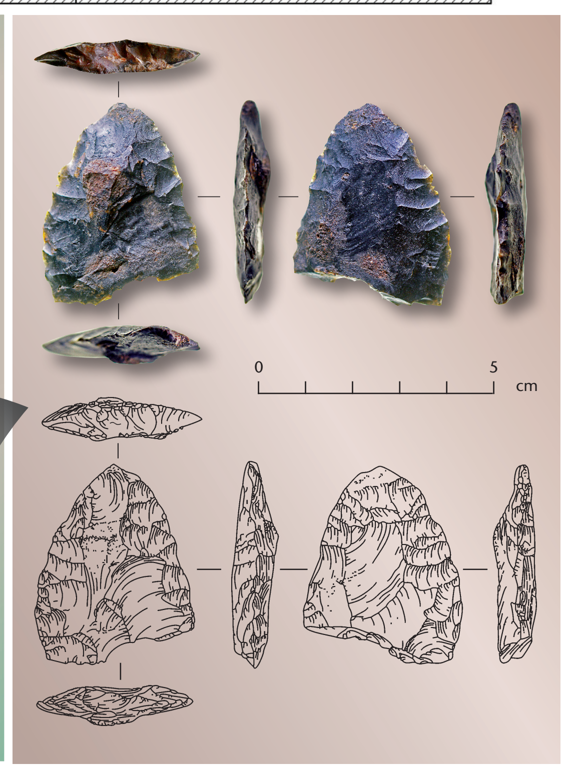
Page-Ladson offers one answer to the question of why pre-Clovis sites have been so hard to find. According to Halligan, Waters, and their coauthors, "Much of the earliest record of human habitation of the American Southeast lies submerged and buried in unique depositional settings like those found on the Aucilla River." They predict that underwater investigations, "if undertaken with intensity and focus, should reveal a rich and abundant pre-Clovis record for the American Southeast."



Stratigraphy of excavation units, pre-Clovis artifacts, and radiocarbon ages at the Page-Ladson site. Artifact D is a flake that shows evidence of use wear; E is a biface. Note that although biface F appears to lie in the middle of a tree (dark brown), the tree is only present in the south wall profile and doesn't extend into the excavation unit where the biface was found.

Biface F in situ on digesta.





DRAWINGS BY J. L. KEENE

Waters offers additional insights as to why such sites are so hard to find: "The record of human habitation in the Americas between 14,000 and 15,000 years ago is sparse, but it is real. Clearly humans were exploring and settling the Americas at this time. The rarity of these early sites is likely due to low population densities resulting in few archaeological sites and low site visibility due to deep burial, and in some cases, such as at Page-Ladson, this evidence is submerged. This will make finding these sites difficult, but very important when we do find them."

The discoveries at the Page-Ladson site contribute enormously to our understanding of the peopling of the Americas.

Not only are we better able to tell the story of the First Americans, we're better equipped to find new sites that will add further chapters to the story.

–Brad Lepper

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TAMU graduate student Morgan Smith and CSFA Director Waters examine the pre-Clovis biface found on mastodon digesta.

Suggested Readings

Dunbar, J. S. 2016 *Paleoindian Societies of the Coastal Southeast.* University Press of Florida, Gainesville.

Halligan, J. J., M. R. Waters, A. Perrotti, I. J. Owens, J. M. Feinberg, M. D. Bourne, B. Fenerty, B. Winsborough, D. Carlson, D. C. Fisher, T. W. Stafford, Jr. and J. S. Dunbar 2016 Pre-Clovis occupation 14,550 years ago at the Page-Ladson site, Florida, and the peopling of the Americas. *Science Advances* vol. 2, no. 5; http://advances.sciencemag.org/content/2/5/e1600375

A High-Resolution Timeline

continued from page 4

since the vast majority of the ancient human remains the team studied were from only three South American countries—Bolivia, Chile, and Peru—"there may have been some kind of bias in our sampling," and that therefore "the conclusions that we have drawn from this dataset may change in the future when we gather more data. It's an ongoing story."

Llamas gratefully acknowledges the contribution to the study of anthropologist Lars Fehren-Schmitz of University of California, Santa Cruz, who, says Llamas, "actually did as much as I did in that study."

Certainly our understanding of the peopling of the Americas will be refined as we obtain additional archaeological, paleoenvironmental, and genetic data. Nevertheless the work of Cooper, Haak, Fehren-Schmitz, Llamas, and the rest of their team provides a solid foundation upon which that future research can build.

–Brad Lepper

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Suggested Readings

Botkin-Kowacki, E. 2016 DNA research suggests mysterious collapse of Native American ancestors. *Christian Science Monitor*; http://www.csmonitor.com/Science/2016/0402/dna-research-suggests-large-scale-collapse-of-Native-American-ancestors

Llamas, B., L. Fehren-Schmitz, G. Valverde, J. Soubrier, S. Mallick, N. Rohland, S. Nordenfelt, C. Valdiosera, S. M. Richards, A. Rohrlach, M. I. Barreto Romero, I. Flores Espinoza, E. Tomasto Cagigao, L. Watson Jiménez, K. Makowski, I. Santiago Leboreiro Reyna, J. Mansilla Lory, J. A. Ballivián Torrez, M. A. Rivera, R. L. Burger, M. Constanza Ceruti, J. Reinhard, R. S. Wells, G. Politis, C. M. Santoro, V. G. Standen, C. Smith, D. Reich, S. Y. W. Ho, A. Cooper, and W. Haak 2016 Ancient mitochondrial DNA provides high-resolution time scale of the peopling of the Americas. *Science Advances* vol. 2, no. 4, e1501385; DOI: 10.1126/sciadv.1501385.

SUBMERGED at Page-Ladson

FOR MOST PEOPLE, it probably seems insane to voluntarily spend a day at work adrift in the black, tannin-stained waters of a 30-ft-deep sinkhole, sustained only by the faintest hope of discovering a piece of a puzzle—a piece of a puzzle that is meaningless or, even worse, garbage to the untrained eye.

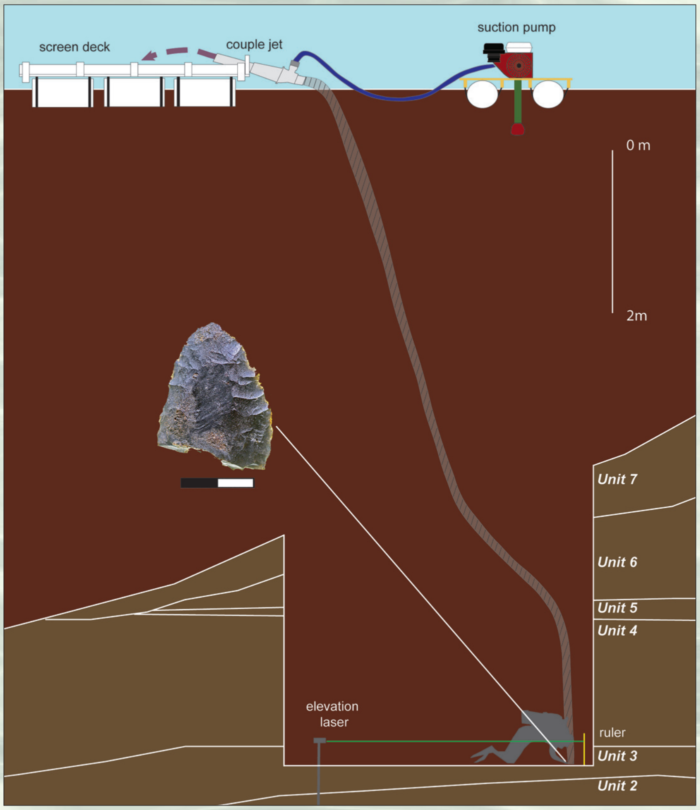
While working in the Aucilla river, you can really only see the things immediately in front of you. People laboring 6 ft away are only dimly perceived if their lights flash in your direction. Further, the water temperature is only about 70°–72°F, extremely cold after a couple of hours. Nevertheless, there's a peace to be found in the bottom of the river. All the external world is absorbed by the darkness of the river, and you find yourself giving your absolute focus to the 2 square feet lighted by you and your dig partner. For two hours, your only job is to watch and trowel toward the dredge head, making sure to note all changes in the dirt matrix before it's lifted by the sucking vacuum maw of the water dredge to the screens floating 30 ft over your head on the water's surface.

One of you may be holding the 1,000-watt Snooper light that turns the whole unit a reddish orange while the other digs or carefully plots and photographs a find or the location of a soil or dating sample. You might both be troweling, holding the dredge hose between you, using the underwater flashlights attached to your helmets for illumination. You may turn off all your lights, allowing the green beam of the underwater laser to shine uninterrupted to determine if you've finished your 5-cm level in this 1-by-1-m square. You often forget that you're wearing SCUBA gear and that you're breathing air pumped down to you from a barge on the surface. At times you may think this is not unlike the experience of an astronaut, drifting in near-orbit darkness in a world consisting of the technical task at hand and life-support systems.

You become completely accustomed to communicating with your partner through a series of emphatic hand signals and short notes written by pencil on Mylar sheets (which is where you also record your excavation notes). This small portion of the world becomes all that exists while you and your partner search for some of the best-preserved evidence of the First Americans that exists anywhere in the New World.

Today a river, once high and dry

I started diving in the Aucilla River in 2007 as a CSFA Ph.D. student looking for a topic for my doctoral dissertation. I had come to Texas A&M to look for sites that had been submerged by the rapid sea-level rise that occurred at the end of the Pleistocene. After all, more than 450 ft of sea-level rise occurred from 21,000 to 5,000 years ago; this rise covered huge swaths of land that would have been available for the early people in the New World, and I wanted to understand more about them. I well knew that most of the evidence of their lives on the now-submerged landscape had probably been erased by the submergence process, but work done in Florida by a number of intrepid pioneers of underwater archaeology like Mike Faught, Andy Hemmings, and Jim Dunbar demonstrated that there were preserved sites offshore and in river channels of the Big Bend. However, the relative integrity of these sites wasn't well understood, so for my dissertation I undertook a geoarchaeological investigation of two underwater sinkhole sites and the terrestrial landscape between them.



Underwater excavating at the Page-Ladson site. The suction pump creates suction by the venturi effect at the intake of the hydraulic water dredge, which sucks up sediments through the 4-inch hose and discharges them into screens floating on the surface.

I dug small shovel test pits and auger pits on land and took cores from the underwater sites. I excavated 1-by-1-m units underwater and collected samples of the surface artifacts in the sites. After numerous trips from Texas to Florida, I had enough data to enable me to distinguish some trends I was seeing in the archaeological deposits in the rivers. Many people had suggested the cultural materials had been redeposited in the river by fluvial activities, but the original excavators were sure that some of the materials from the Aucilla River had been discovered in situ, or where people had left them behind when they abandoned the sites. I became convinced that they were correct. This led me and Mike Waters to a renewed interest in the Page-Ladson site, where we returned, in collaboration with Jim Dunbar, in 2012.

A tough row to hoe

My half decade of experience on the river helped me become familiar with (some of) the trials of underwater archaeology, although every year I encounter new challenges. Underwater archaeology is easily ten times as expensive as its terrestrial counterpart for several reasons. First, and most obviously, underwater archaeology requires people to work underwater, which requires SCUBA gear, motors to supply air, safety measures including surface support staff for divers (usually almost equal in number to the divers), and pairs of divers to work together to complete the same task.

Halligan with the pre-Clovis biface recovered from the Page-Ladson site.

Second is the mechanics of excavation. At terrestrial sites, the number of excavators is limited only by the ability to pay for labor. In underwater archaeology, on the other hand, each underwater team needs its own pump to run its own water dredge to its own screen, and each screen needs its own person to examine the spoil and manage the pump. In theory, the river could be covered with a flotilla of pumps and screens, each managed by a team of divers, surface support, and screeners, but this rapidly becomes impractical and unmanageable with more than three pumps running. For each team, screeners need to be hustled out of the sun and fed; dive teams need to be warmed from their underwater hypothermia and fed; pumps, generators, and SCUBA air systems need to be cleaned, maintained, and fueled. Most importantly, finds need to be logged and described and excavation notes need to be completed.

During the working day on the river, anywhere from 2 to 10 small engines are running, creating a cacophony on the river bank, so an observer notices that even when on the surface the divers talk as much with their hands as they do with their voices while making notes of their completed dives and filling out the labels for the artifacts or bones they recovered during their excavations. This is the routine when everything is working properly. On an average day, a small amount of time is lost to malfunctioning equipment or weather delays. On an unfortunate day, hours are spent repairing critical support paraphernalia or huddled under awnings on shore watching lightning flash during dramatic summer storms.

Most people would probably wonder why underwater archaeology is worth it. There are lots of bones and stones in the world. Why spend all that time and money? Why get a Ph.D., then spend the summer fixing small engines (or in my case, failing to fix them)? Why take the risk of diving into the dark waters filled with 'gators and snakes and trees that loom out of the darkness and are just as frightening in their unexpectedness? For me and my crew, the answer is easy: preservation.

The rewards make it all worthwhile

When in the bottom of the Aucilla, we are truly able to touch the Pleistocene. Fragments of mastodons, mammoths, sloths, horses, tapirs, and other exotic and extinct fauna abound. Less common, but more exciting for us, are the stone and bone tools made by people who have been dead for more than ten millennia. We know this, because we occasionally are lucky enough and patient enough to find these artifacts located in undisturbed sediments that were deposited in these sinkholes when sea levels were lower and the sinkholes were isolated ponds. In many cases these artifacts had been deposited in the mud on the sinkhole margin and buried by later sediments. Often these muds preserved organic plant remains that dropped around the artifact, carbon-rich vegetal remains that are so valuable for radiocarbon dating. In the lowest cultural layer at Page-Ladson, for instance, the stratum is composed of a mixture of sand and dispersed mastodon digesta (or feces), which comprises straw-like fragments of plants. Each one of those pieces of digesta is directly dateable, and we collected a number of them around the stone knife discovered in 2013. This is the ironclad evidence that empowers us to state unambiguously that the artifact was left behind more 14,500 years ago.

I can never quite overcome the sense of wonder I felt when first seeing the artifact that had been sitting on the bottom of a river for millennia in a bed of sand, cypress twigs, acacia thorns, grape seeds, and gourd seeds until members of my crew uncovered it. This one small knife changed our understanding of New World archaeology by making it clear that people had been in the Southeast for 1,500 years longer than we previously knew. Darkness, complicated logistics, and regular small-engine repair are a small price to pay in balance.

–Jessi Halligan

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THE OPPOSITE OF OVERKILL

Sporormiella Evidence at the Page-Ladson Site

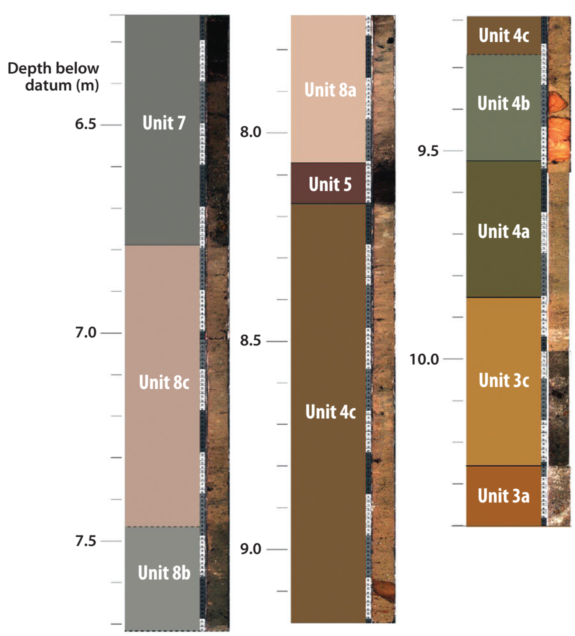
THE TINIEST OF EVIDENCE can sometimes provide answers to decades-old questions, knocking established paradigms off kilter in the process. A textbook case confirms this: Biological remains completely invisible to the naked eye, recovered from a riverine sinkhole in Florida, refute the long-held belief that humans and megafauna didn't mix.

The Page-Ladson site has been the object of archaeological interest since 1981, when diver Buddy Page discovered the remains of what proved to be a mastodon during a dive into a sinkhole on the Aucilla River in the Florida Panhandle. Given its rich archaeological and paleontological materials, Page-Ladson soon became a primary focus of the Aucilla River Prehistory Project (ARRP) (see "The Page-Ladson Site: "An Uncommon Doorway to Our Past," page 5). Between 1983 and 1999, the ARRP conducted 16 seasons of fieldwork there. Among their findings were a sparse collection of stone tools that seemed to date to well before the Clovis era, along with a mastodon tusk scored with distinctive parallel grooves made by stone tools, evidence that humans deliberately removed it from the animal. Long recognized as a significant site in the pre-Clovis canon even before pre-Clovis was accepted by a significant segment of the scientific community, the Page-Ladson site has been on the radar of First Americans researchers for decades—and now is widely accepted as prima facie evidence of pre-Clovis. The ARRP work proved it. Recent research by the Center for the Study of the First Americans clinches the argument.

The holy grail found in a Florida sinkhole

The CSFA crew, led by Director Mike Waters and Jessi Halligan of the University of Florida, recovered just six stone artifacts during their extensive investigations, including an exquisite knife fragment that dates to approximately 14,550 CALYBP. The 71 radiocarbon ages they also collected definitively proved, among other things, that the knife was in situ rather than intrusive from a younger layer. Several things about the knife stand out: It doesn't resemble later Clovis technology at all, and it was found lying on a pile of digesta—apparently mastodon dung. That's significant, because much of the work of another CSFA team member, Angelina Perrotti, focused on microscopic spores associated with such dung. By pinning down the spore abundance of the fungus *Sporormiella*, which colonizes the dung of herbivores, Perrotti has poked a hole in the old overkill theory, which argues that human predation was a key factor in the extinction of megafauna almost as soon as humans appeared on the North American scene. Her work confirms that large herbivores lingered for thousands of years after humans arrived in Florida.

Only 12,600 years ago does the *Sporormiella* signal fade away in Page-Ladson sediments, thereby marking the collapse of the last megafauna populations. We know that humans were definitely in the area by 14,550 years ago and probably sooner because the people who visited the site at that time were familiar with the locations of useful resources like toolstone quarries and secluded sites like Page-Ladson itself. To acquire specialized knowledge like that takes hunter-gatherers decades, if not centuries. Meanwhile, evidence continues to pile up for at least a sparse occupation of the Americas by 15,000–16,000 CALYBP at sites like Buttermilk Creek in Texas, Meadowcroft Shelter in Pennsylvania, and Paisley Caves in Oregon. And although it's impossible to say whether the people who butchered the animal at Page-Ladson actually hunted it down, scavenged its carcass, or killed it after it became mired at the sinkhole, they definitely processed it. The tusk alone, in addition to its value as an ivory source, would have yielded more than 15 pounds of protein-rich meat from its base.



Close-up composite of Core 4A displaying unit designations.

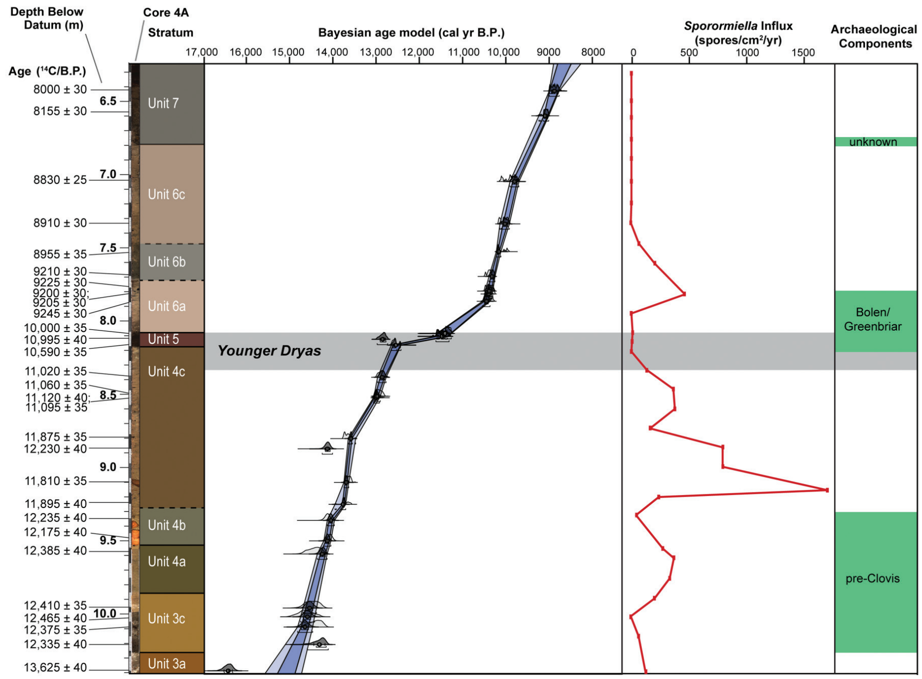
Pollen detectives

Angelina Perrotti, a Ph.D. candidate in the Department of Anthropology at Texas A&M University, was introduced to archaeological palynology while earning her B.A. in Anthropology at Washington State University. On deciding to pursue the science as her career, she chose as her mentor TAMU professor Vaughn M. Bryant, Jr., a world-renowned authority on palynology, who has spent his career studying pollen in various contexts. On occasion he has even assisted police departments in solving crimes using these minuscule clues. "After taking a few classes here at TAMU about the peopling of the Americas," Perrotti remembers, "I became very interested in using palynology to better understand the process of the first migrations of people to North America." She leaped at the opportunity to analyze a sediment core from Page-Ladson, for *Sporormiella* analysis is a key part of her dissertation research. She tells us that "the remainder of my dissertation research involves a pollen study of the same sediment core from Page-Ladson, as well as a dung fungi study from another site in the Aucilla River, and a site in South Carolina."

Sporormiella is a genus of coprophilous fungus—in plain language, that means it loves feces. In even plainer language, it lives on the poop of plant-eating animals; the more poop, the more *Sporormiella*. It's very common today and thrives in the manure of animals as diverse as birds, rodents, rabbits, livestock, and elephants. If *Sporormiella* existed at the time of the dinosaurs, its spores no doubt are present in great abundance in sedimentary rocks of the era. (Note to any paleontology grad students reading this: A raft of Ph.D. dissertations await you if you can successfully isolate spores from the rocks. It's been done for other pollen and spores, so why not *Sporormiella*?)

Sporormiella has been isolated from Pleistocene sediments in numerous locations throughout the world. Its potential as a microproxy for gauging the numbers of large herbivores was recognized as early as the mid-1980s by Owen Davis of the University of Arizona, but his studies were neglected until 1996, when David Burney of Fordham University in New York City documented a correlation between abundant *Sporormiella* and the presence of large herbivores in prehistoric Madagascar. In 2009, a team led by Jacquelyn Gill and Jack Williams of the University of Madison, Wisconsin, used *Sporormiella* to demonstrate the rapid decline of North American mastodons and mammoths after 14,800 CALYBP at lake sites in Indiana and New York (**MT 25-1,** "Decoding the woolly mammoth, part III: Timing extinction by proxy"). Their decline in Northern states therefore approximately coincides with the period when humans were present at Page-Ladson.

Perrotti's discovery that *Sporormiella* frequencies remained high at Page-Ladson until more than 1,500 years later demonstrates that humans and megaherbivores coexisted in Florida at least during that period. *Sporormiella* peaked at about 13,700 CALYBP, then gradually dropped off and finally disappeared into the background about 12,600 CALYBP.



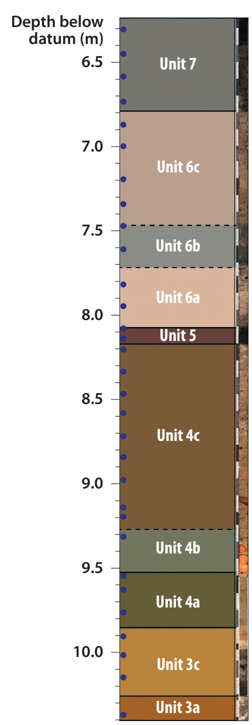
ALL IMAGES: ANGELINA PERROTTI

Core 4A from Page-Ladson showing uncalibrated radiocarbon ages of subsamples. Bayesian-age model of radiocarbon ages was computed from OxCal version 4.2.4 (30–32). *Sporormiella* influx curve was calculated from spore concentrations, age model, and sedimentation rates. Archaeological components discovered at the Page-Ladson site were plotted by geological association.

Why *Sporormiella*?

One of the reasons Perrotti selected such an unusual way of determining how long megafauna lingered at Page-Ladson was simple expediency. The faunal record in the Aucilla River is sparse in sediments above Unit 3. The spores of dung fungi therefore serve as a better proxy than faunal remains for the presence of animals. "This proxy is quite well established," Perrotti tells us, "so it seemed a good fit for Page-Ladson." Furthermore, the site itself is ideal for palynology studies because it has an intact sedimentary sequence that contains sediments deposited throughout the late Pleistocene and early Holocene. "Many ponds and lakes in this region became desiccated at some point in the early Holocene because of warm, arid climatic conditions," she says. "This desiccation not only resulted in erosion of sediments or a cessation of deposition, but also damaged palynomorphs [pollen, spores, and similar biological remains], which can be sensitive to oxidation [exposure to oxygen]. Therefore, the continuous deposition and good preservation of the sediments at Page-Ladson made it a good candidate for a study like this."

Although *Sporormiella* is considered common, it rarely constitutes more than about 2% of the pollen/spore content of a sediment, even of sediments as-

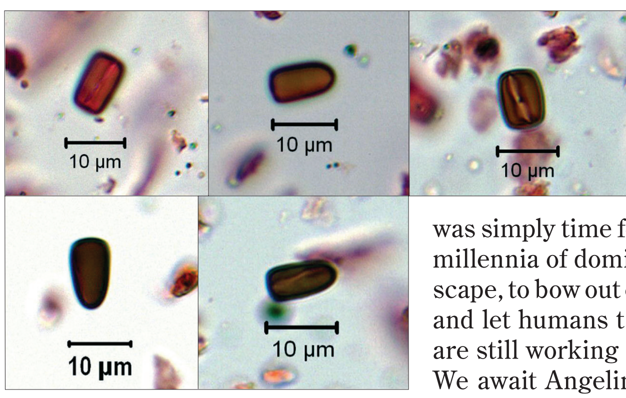


Location of *Sporormiella* samples from Core 4A. Subsamples for palynological analysis were carefully removed from the core at 10-cm intervals.

Perrotti in the laboratory.

sociated with substantial numbers of megaherbivores. An abundant presence of *Sporormiella* suggests a healthy megafaunal population. To correlate *Sporormiella* levels with the size of a herbivore population can be complicated, however, by a large population of smaller animals like rabbits, whose feces may also host a high percentage of the *Sporormiella* that end up in pond sediments. Although the volume of feces they produce is much less than that of the average elephant, their greater numbers and the greater relative surface area of their feces—numerous rounded or elongated pellets as opposed to a single large mass—may support more *Sporormiella*. Perrotti concedes that "there's some debate over the relative effect of dung production on the formation of a *Sporormiella* record." On the other hand, populations of rabbits and other small animals didn't collapse at the end of the Pleistocene the way megafaunal populations did; indeed, most small-animal species survive to this day in large numbers, whereas *Sporormiella* percentages didn't rise again above 2% until livestock were brought to North America about 500 years ago.

Unusual conditions conceivably contributed to the concentration of the dung fungus in the older Pleistocene pond strata at Page-Ladson, but no evidence has been found, here or elsewhere, that this occurred. In the first place, Page-Ladson escaped the dry spell suffered by similar sites during the Holocene. Moreover, a century of well-documented palynological research (much of it Bryant's work) demonstrates that the relative quantity of pollen and spores found in a stratum accurately reflects the mix of plants and fungi in the local region, once the data are adjusted for factors like the amount of pollen or spores produced by specific species. Perrotti is nonetheless acutely aware that alternative explanations may warrant consideration, for example, "a drastic change in environmental conditions such as temperature, relative humidity, or water activity in the soil could drastically alter *Sporormiella* reproduction. However, at this time, other climate proxies such as pollen do not suggest that end-Pleistocene *Sporormiella* decline is a result of environmental changes."



Images of fossil *Sporormiella* from Core 4A. The cells from the *Sporormiella* ascospore are quite morphologically distinct: Medial cells are barrel shaped, proximal cells are bullet shaped. They are thick walled, which means they are generally well preserved. The S-shaped aperture seen in some of the photos varies in the degree of curvature between different *Sporormiella* species.

An interesting difference between Page-Ladson's *Sporormiella* profile and others previously reported is that the *Sporormiella* peak lasted long after humans first occupied the area. Perrotti notes that "both faunal and spore studies around the world have suggested that extinctions occur after the area is colonized by humans. . . . Interestingly, the *Sporormiella* and cultural records at Page-Ladson suggest that large herbivores and humans would have coexisted at the site for about 2,000 years." In Florida, humans and the big herbivores shared the region for an unusually long time, until proboscideans and their fellow megafauna eventually gave way to the faunal mix we see today.

Perrotti hasn't completed her work at Page-Ladson. Recently she completed a pollen analysis of the same core she initially analyzed for *Sporormiella* to view the spectrum of the local vegetation regime. She's also analyzed a second Page-Ladson core for dung fungus. "The results should be submitted for publication soon, after a final analysis of the data I've collected," she reveals. "I can tell you, however, that the general *Sporormiella* patterns observed within the initially analyzed core are confirmed within the second core from the site. I also have plans to perform a spore analysis at another site in the Aucilla River."

Over and out in Florida

Whether the megafauna extinction in North America was caused by human predation, a celestial impact event, disease, degraded vegetation incapable of supporting large animals, or a mix of all the above remains uncertain. Maybe it was simply time for the megafauna, after tens of millennia of dominating the icy American landscape, to bow out of the Grand Scheme of Things and let humans take center stage. The experts are still working to fit the pieces in that puzzle. We await Angelina Perrotti's other analyses of Page-Ladson strata with great anticipation. Perhaps she will find the missing piece that finally completes the picture. MT

–Floyd Largent

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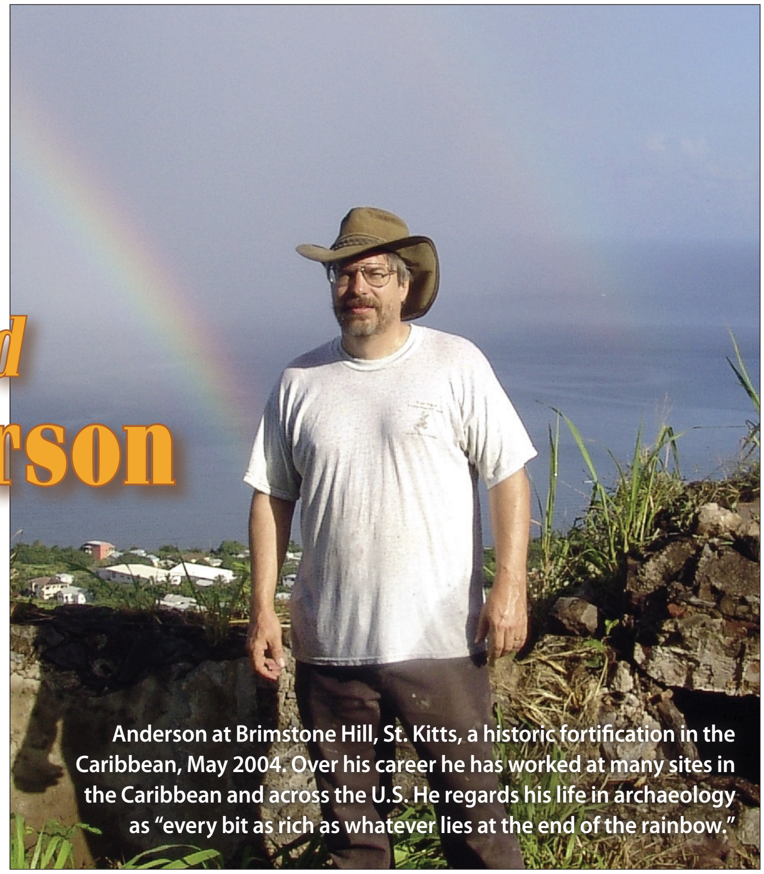
An Organized Mind
David G. Anderson

NO ONE WILL EVER ACCUSE David Anderson of shying away from the daunting task of managing and integrating data in today's Information Age. Anderson, Professor of Anthropology at the University of Tennessee, Knoxville, has navigated the choppy waters of cultural resource management since the early days of his career, when an introductory anthropology class he took in his sophomore year at Case Western Reserve University launched him in a new educational direction. He was intrigued by the focus of anthropology on questions relating to human existence and the ways early people organized themselves into groups and cultures.

Born in St. Louis, Missouri, in 1949, Anderson graduated from high school in Milledgeville, Georgia, in 1967, and set off for Case Western Reserve University in Ohio, where he earned a B.A. in Anthropology in 1972. Along the way he came to recognize the vital importance of maintaining and improving America's cultural resources management (CRM) program, the system in place to protect the cultural heritage of indigenous peoples and share the wealth of data. With his B.A. in hand, Anderson volunteered for fieldwork in southwestern New Mexico for several months, then for two years worked in a machine shop and construction as a certified welder. He volunteered on other projects before he landed his first full-time job in archaeology at the South Carolina Institute of Archaeology and Anthropology (SCIAA) in February 1974. At SCIAA, Anderson began to amass his impressive knowledge of Southeastern archaeology by assisting, first, historic archaeologist Leland Ferguson, then Al Goodyear, a newly minted Ph.D. just starting his long career in South Carolina archaeology.



Anderson at Brimstone Hill, St. Kitts, a historic fortification in the Caribbean, May 2004. Over his career he has worked at many sites in the Caribbean and across the U.S. He regards his life in archaeology as "every bit as rich as whatever lies at the end of the rainbow."

GERALD SCHROEDL

"I have known David professionally and personally since 1974," says Al Goodyear of SCIAA, for years the PI at the Topper Clovis site in South Carolina. "I was his best man at his wedding. As long as I've known him he has been interested in developing databases in archaeology starting here in South Carolina. For fellow Paleoamerican scholars, his PIDBA database naturally assumes great importance for working in North America."

Anderson completed his M.A. while an assistant with the Arkansas Archaeological Survey. He worked with materials from Toltec Mounds Archaeological State Park and the Zebree Homestead site, an early Mississippian-period village. It was his opportunity to begin exciting research on the emergence of the Mississippian culture.

"David asked me to teach him photography while in the field at the Zebree site," says colleague Dan Morse. "He wrote up some aspects of the site excavation for his M.A. thesis at Arkansas. I handed him a 35-mm camera and a roll of black-and-white film, showed him how to load the film, and told him to take pictures and then criticize the results. He became a good photographer."

UNIVERSITY OF TENNESSEE

Anderson, volunteer Susan Hollyday, and co-PI Shane Miller celebrating the discovery of deeply stratified deposits at a site along the Cumberland River near Nashville in 2010. Dozens of radiocarbon dates obtained during the work helped securely date several major Archaic and Early Woodland assemblages.

More than facts and figures

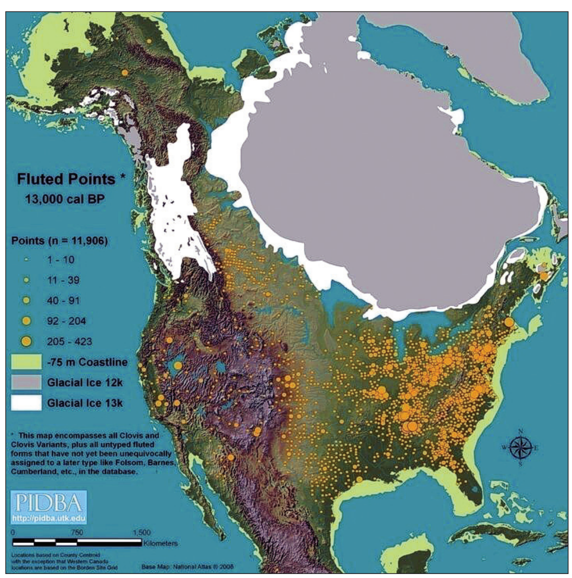
Anderson recognized that CRM projects offered interesting research opportunities, often with generous funding in place. He pursued these opportunities with a mission to conduct the best possible research and to write about his discoveries in revealing and informative ways that illuminated the unique qualities of the inhabitants of early cultures. Beyond descriptions of artifacts and campsites, Anderson's reports included valuable information about human interaction and behavior in the ancient past. "The expansion of our lineage across the planet has always fascinated me," Anderson says, "and the initial human settlement of the Americas is one of the most impressive and dramatic parts of the story."

Anderson, with John Cornelison and an NPS team, excavated from 1999 to 2004 at an eroding Early Mississippian mound at the Shiloh Indian Mound group 30 m above the Tennessee River. A detailed report that summarizes research conducted by many specialists is available online.

SOUTHEAST ARCHEOLOGICAL CENTER, NATIONAL PARK SERVICE

In 1977, Commonwealth Associates, Inc. in Michigan hired Anderson to direct progressively larger survey and excavation projects in the Southeast and Southwest. During a project in 1979 excavating three sites along Mattassee Lake, a tributary of the Santee River in central South Carolina, he met Jenalee Muse, who was working on a nearby historic excavation. The two started dating, and were married in 1981. They are still an inseparable couple 35 years later.

While in Michigan Anderson completed his Ph.D. coursework from 1983 to 1986 at the University of Michigan, and then returned to CRM, this time with Garrow and Associates, a company in Atlanta, Georgia, where he led major survey and reporting work along the L'Anguille River in Arkansas, at Fort Polk in Louisiana, and in the Russell Reservoir on the upper Savannah River in Georgia and South Carolina. In 1988 he joined the National Park Service and continued there until leaving to complete his dissertation. A Department of Energy fellowship led him to the Savannah River Site (SRS) near Williston, South Carolina, where he and his family still reside in a plantation house they restored. Anderson had done an initial archaeological survey of SRS in 1974–75. His extensive research at the 328-square-mile SRS and at archaeological sites along the length of the Savannah River provided the meat for his 1990 dissertation, "Political Change in Chiefdom Societies: Cycling in the Late Prehistoric Southeastern United States," which was awarded the Society for American Archaeology dissertation prize in 1991.



Fluted points in PIDBA (all reported Clovis and Clovis Variants, plus points designated as "fluted" but not assigned to a specific type). Data are presented using county, parish, or other political unit centroids in eastern Canada, Mexico, and the United States; in western Canada Borden grid cell centers are used. Coordinate data are posted online with the artifact data for each county.

STEPHEN J. YERKA AND J. CHRISTOPHER GILLAM

The Savannah River chiefdoms

Anderson's dissertation focused on chiefdom cycling, the process by which complex chiefdoms emerge, expand, and fragment in a regional landscape of simple chiefdoms. "Why complex societies emerge and collapse has always fascinated me," he says, "as it has people all the way back to antiquity." His research, summarized in a 1994 book *The Savannah River Chiefdoms*, still stands as a major synthesis, and has generated appreciable attention, commentary, and new thinking on the subject of Mississippian social dynamics.

The Savannah River valley was occupied continuously from the Paleoindian period to the Mississippian period. Toward the end of this time, simple and complex chiefdoms arose and declined in the Savannah River valley and other river valleys. Occasionally large areas were left unpopulated for hundreds of years. Over 500 Mississippian sites and 14 mound centers along the Savannah River have yielded well-defined occupational histories that form a solid foundation for examining political change over time.

Chiefdom cycling was caused by an extensive array of factors including climate change and social competition. Anderson's research discovered such varied causal mechanisms as social ranking, sanctifying ideologies and authority structures, warfare, competition within the chiefdom for power and prestige, increased demand for processing information, and subsistence uncertainty. "What I call cycling," Anderson explains, "refers to a fluctuation in administrative or decision-making levels within designated upper and lower limits. More specifically, it encompasses the social transformations that occur when administrative or decision-making levels within chiefdom-level societies fluctuate between one and two levels above the local community over a regional scale, making the political landscape something like blinking Christmas tree lights." Working with colleagues at Michigan like Henry Wright, who originally coined the term "cycling," and Richard Ford, who advised him throughout his dissertation research, Anderson finished up his doctorate in 1990. Along the way he got interested in Paleoindian archaeology in a big way.

The Paleoindian Database of the Americas

In the late 1980s, while taking a break from writing his doctoral dissertation on the rise and fall of Mississippian societies, Anderson began to conceive of a system for digitally organizing the masses of Paleoindian artifact data discovered by archaeologists and making the information available to scientists worldwide.

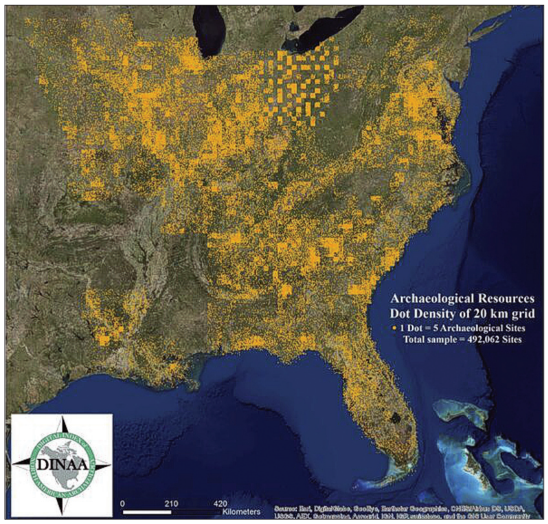
In collaboration with professional archaeologists, avocational archaeologists pursuing local artifact surveys, and undergraduate and graduate students, Anderson and colleagues like Mike Faught and Shane Miller have compiled locational data on over 30,000 artifacts, and attribute and image data on over 10,000 projectile points. The fledgling dataset was first distributed on floppy disks, then as it expanded on CDs, and by the late 1990s on the Internet. Today attributes and locational and image data on Paleoindian materials from across North America are available on the PIDBA website to anyone interested in documenting patterns of land and raw-material use, variability in artifact forms, and demographic trends within the Paleoindian period. Compiling and maintaining the database demands immense dedication by many individuals. Anderson is quick to acknowledge that this is a team effort, not the work of a single person.

☞ **Visit PIDBA at http://pidba.utk.edu/main.htm**

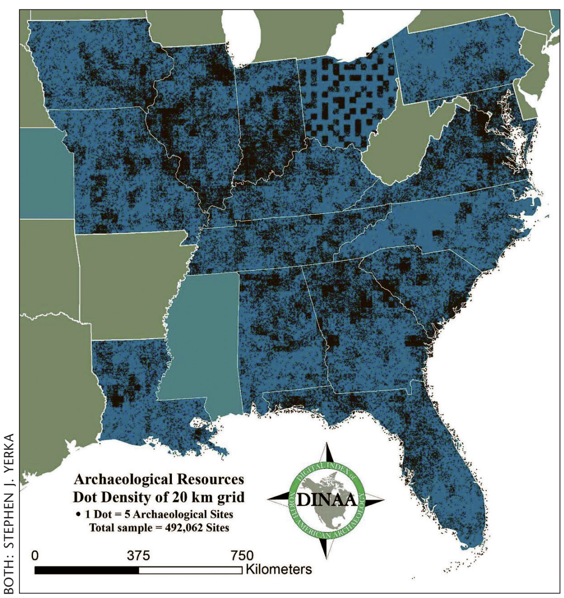
The Digital Index of North American Archaeology

The successful launch and continued growth of PIDBA spawned another herculean project, which is just getting underway. The Digital Index of North American Archaeology (DINAA) encompasses a much larger array of information. In this effort the goal is to link to essentially any information that can be found online about an archaeological site, which is listed using the site number as a lowest common denominator.

"There are an estimated 2½ to 3 million archaeological sites in the U.S. alone," Anderson says, "so it is a challenging project in terms of managing and integrating data. I am one of five PIs on the DINAA project, along with Eric and Sarah Kansa, Josh Wells, and Steve Yerka. Linking state site files is something I've been thinking about for decades, but only in recent years have we had the capability of doing it, and my younger colleagues have the technical skills to pull it off."



◀ **The half-million sites linked to date in DINAA.**



BOTH: STEPHEN J. YERKA

◀ **DINAA partnerships as of November 2016 showing the distribution at low resolution of sites within states that have reported data thus far. In these DINAA maps dots refer not to exact site locations, but to groups of five sites randomly distributed within a 20-by-20-km grid cell. Ohio data are at county-level resolution.**

DINAA is a multi-institutional undertaking. The project got under way in September 2012 with funding from the National Science Foundation and a plan to create interoperability models for archaeological site data in the United States. Researchers from universities and the public and private sectors are developing protocols to integrate archaeological information from large areas of North America into a unified database, which is being made available to scholars, resource managers, and the public. Although most states collect and compile data on archaeological sites, only rarely have such data been compiled and examined on a large geographic scale and made available for use by domestic and international researchers as a distributed linked network.

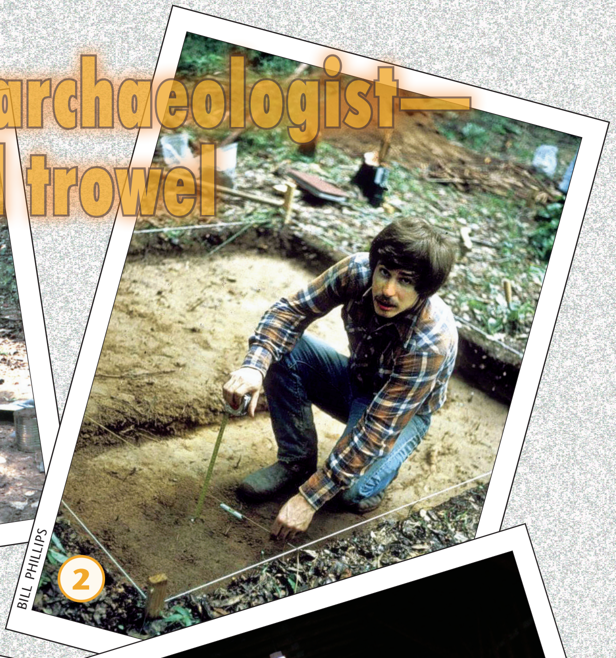
Neither PIDBA nor DINAA discloses precise locational or other sensitive data; researchers are instead directed to the primary sources that retain control of such information.

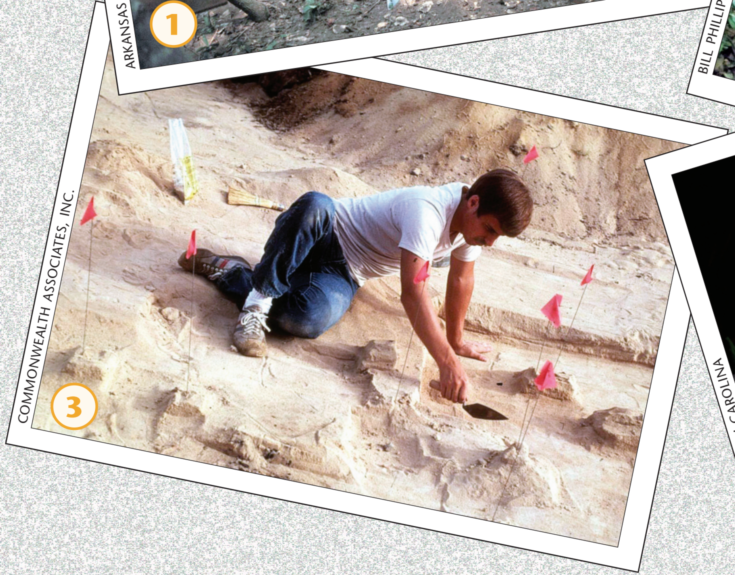
☞ **Visit DINAA at http://ux.opencontext.org/archaeology-site-data/**

The late-Pleistocene human settlement of North America

The questions of when and by which migration routes North America was settled continue to spur friendly debate among archaeologists. Anderson, working with colleagues like Chris Gillam and Thad Bissett, is convinced that physiographic features (major river valleys, mountain ranges, deserts, pluvial

Tools of a seasoned archaeologist—shovel, backhoe, and trowel





1 Anderson in 1975 excavating a test pit at Zebree, a Late Woodland/Initial Mississippian site in northeast Arkansas examined in 1968–1976 by Dan and Phyllis Morse and a large multidisciplinary team. The site is one of the earliest Mississippian assemblages found in the central Mississippi Valley.

2 Checking unit level depth in one of three stratified Archaic and Woodland blocks opened along Mattassee Lake along the Santee River in South Carolina in 1979. The work helped define the cultural sequence for that part of South Carolina.

3 In advance of highway construction, Anderson in 1978 excavating a Middle Archaic Morrow Mountain biface cache discovered in sandy deposits at site 38LX5 near Columbia, South Carolina, by a local volunteer. Avocationals have helped recover maximum information on many projects in Anderson's career.

4 Says Anderson, "Good colleagues and mentors make for good archaeology." After dinner and before a public address at the Topper site May 2015 (*left–right*) Shane Miller, Anderson, Al Goodyear, and Dan and Phyllis Morse.

and periglacial lakes, and ice-sheet margins) would have profoundly influenced the spread of early explorers and settlers. Anderson believes that "sometime after about 20,000 years ago, and probably after 17,000 years ago based on genetic evidence and the major warming that occurred about 14,800 years BP, early settlers would have made their way into the Americas from East/Northeast Asia, probably using watercraft and island hopping through the Beringian and Northwest coastal archipelagos, as well as overland across Beringia and down the coast and through the ice-free corridor when they were passable."

A belief that Anderson espouses, and one that is gaining widespread acceptance among Paleoindian scholars, is that people were present in the Americas before the appearance of the Clovis culture. He cites as evidence the Monte Verde site in Chile, the Broken Mammoth and Swan Point sites in Alaska, Meadowcroft Rockshelter in Pennsylvania, the

5 Anderson at the Topper site May 2015 removing the first fill from the initial 1-by-1-m unit of a large Late Woodland block filled with features with pottery, small arrowheads, and corn. In the background is an old 2-by-2-m unit that had penetrated to the Clovis level, in the process revealing a dense Woodland occupation.

6 Anderson at the stratified Paleoindian- to Mississippian-period Rucker's Bottom site along the upper Savannah River in Georgia. He used the backhoe-loader to track a Mississippian fortification ditch, open geoarchaeological trenches, and haul fill to a water-screening operation along the river.

7 The 2012 University of Tennessee field crew, local volunteers, and park staff at the Bells Bend Outdoor Center near Nashville, which hosted the project. "BBAP" painted by students on the pirate flag stands for "Bells Bend Archaeological Project," which located and examined a number of sites in the area dating from Paleoindian through the historic periods, including several large shell middens.

8 Anderson at the Topper site in 2016 troweling the base of the plowzone to expose faint features in the Late Woodland block. Working in the field every day has been a guiding principle for Anderson throughout his career.

Debra L. Friedkin site in Texas, and the Page-Ladson site in Florida. Once people arrived at the southern end of the ice-free corridor, or the mouth of the Columbia or Colorado River, they would have encountered one of the prominent east- and south-trending drainages (the Missouri, Platte, Arkansas, Canadian, and Red Rivers), which would have funneled them through the Great Plains and into the Mississippi and Ohio River systems toward the Gulf Coast.

For Anderson, the presence of early populations in South America before evidence for widespread populations in North America may reflect rapid movement along coastlines expedited by rich marine food sources associated with offshore kelp forests, a view University of Oregon anthropologist Jon Erlandson and colleagues have proposed. Accelerated coastal travel helps account for why the record of human settlement in the interior lagged behind coastal settlements.

Sea-level fluctuations muddy the water

Severe variations in sea level and the resultant effect on the contours and dimensions of coastlines in the late-Pleistocene and early Holocene would have profoundly affected coastal populations. Anderson notes that the period of widespread human settlement during Clovis times, ca. 13,276–12,933 CALYBP, is one of only moderate coastline instability when compared with several centuries immediately beforehand, when repeated fairly pronounced swings would have made the coastal environment unpredictable and less inviting.

High-resolution bathymetric mapping data, which Anderson examines with younger colleagues Thad Bissett, Stephen Yerka, and Martin Walker, make it possible to evaluate movement patterns of humans along former coastlines now submerged. When coupled with data showing locations of ice sheets and periglacial lakes that may have interfered with movement, these landscape reconstructions may offer insights into possible migration pathways.

Another useful means of determining how prehistoric people moved across the landscape is least-cost pathway analysis, which identifies the path between locations that imposes the least hardship to a traveler. Anderson has used this analytic tool extensively in his research with Chris Gillam. It unveils otherwise hidden insights because pathways can be explored from different starting points and from different hypothesized locations where people first entered the continent. A least-cost pathway analysis of South America, for instance, suggests considerable early movement east of the Andes, a region known for its great linguistic diversity.

"Once we get better at knowing where sites and artifacts are," Anderson says, "both on the landscape and in our collections, and have a better sense of where else we need to look for them, our understanding of the early colonization of the Americas should clarify quickly."

Climate change and culture dynamics

Anderson has written a great deal on climate change and its impact on early human societies. His definitive work on the subject published in 2007, *Climate Change and Culture Dynamics,* gives a global perspective on the subject through the authoritative views of archaeologists and paleoclimatologists, with particular emphasis on the impact of climate change on the early peoples of the Southeast.

"I think today's archaeologists should be addressing the ongoing global climate crisis," Anderson says, "and its impact not only on archaeological resources, but also on our continued existence as a technological civilization. Archaeological research sheds light on how humans have responded to dramatic environmental changes in the past, particularly during the late Pleistocene, when New World peoples were facing dramatic changes in physiography and biota. Archaeology can help us decide how to act and offer some hope for the future."

An impressive written legacy

David Anderson's name is synonymous with Eastern and Southeastern archaeology. He has written some 50 books and monographs, some of which synthesize Southeastern archaeology by major period (Paleoindian, Early Archaic, Middle Archaic, Woodland), by specific site (Mattassee Lake, Shiloh), and by locality, project area, or installation (for example, the Russell Reservoir, Fort Polk, and the Francis Marion National Forest). He interleaves field schools with his teaching duties and is the recipient of too many honors and awards to list on these pages. He enjoys barbecuing with his colleagues and students, home brewing mead, and reading in a wide array of areas.

"I hope my future will include another 20 years or so of productive research," Anderson tells us, "at the end of which time I believe we will finally have reached a consensus on where and when the Americas were first settled by humans. I would like to be around to see that, but if not, I have come to accept that in archaeology the journey is as important as the destination."

"David Anderson might be the most awesome, best-read intellect in American archaeology," says David Hurst Thomas of the American Museum of Natural History. "I once asked him, pretty reluctantly, if he could find time to look over a too-long, 2,000-page manuscript of mine. David's response was immediate: 'Why not? I try to read everything anyway. . . . I'll see it sooner or later!' That's a pretty audacious statement, but in the immortal words of Dizzy Dean, 'It ain't bragging if you can do it.' And David does indeed do it—and better than anybody else." MT

–Martha Deeringer

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Suggested Readings

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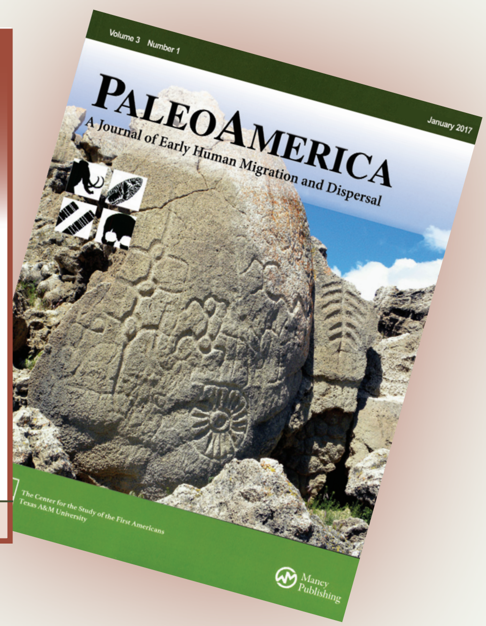

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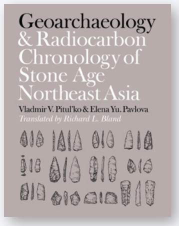

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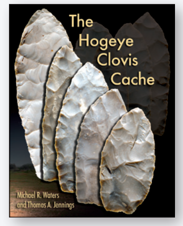

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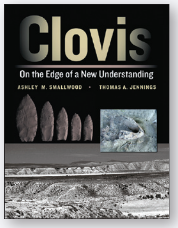

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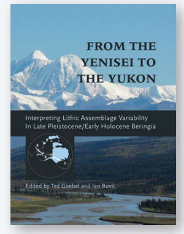

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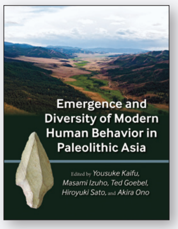

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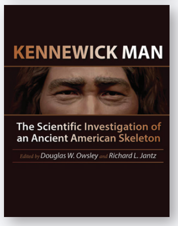

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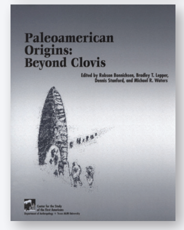

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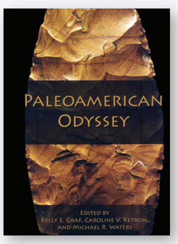

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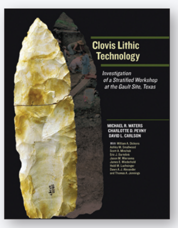

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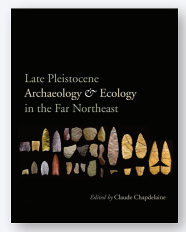

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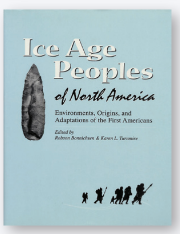

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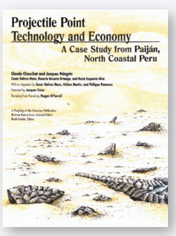

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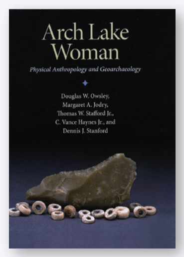

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