MAMMOTH TRUMPET

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THE CLOVIS COMET

The Cratering Evidence

JUST AS THE WORLD was finally warming up at the end of the last Ice Age, something sent most of the Northern Hemisphere back to the deep freeze for another thousand years. We still don't know what triggered the Younger Dryas (YD) interval 12,900 years ago, but one intriguing idea is that a comet exploded in the upper atmosphere, causing climatic changes that not only devastated some human populations—including the Clovis culture—but also killed off most of the surviving megamammals. This has become known as the Younger Dryas Impact Hypothesis (YDIH), or more popularly the "Clovis Comet" theory.

Some scientists have taken enthusiastic positions for or against the YDIH, while others consider arguing the pros and cons a waste of valuable research time. Many in the First Americans research community remain on the sidelines, interested but waiting for more data. To the undecided, the question of whether there really *was* a Clovis Comet remains valid, since we haven't yet been able to establish a solid consensus on it in the First Americans archaeology community—despite almost seven years of vigorous debate, experimentation, challenge, and counter-challenge.

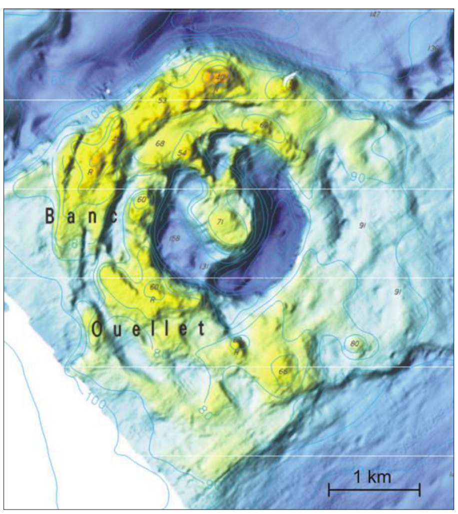
Where's the smoking gun?

Most of the original evidence for the YDIH hinges on microproxies, microscopic clues that suggest but can't prove an impact. A number of follow-up efforts have either failed to reproduce microproxy evidence presented by the YDIH camp, or have suggested it's the result of misinterpreted data or experimental error. In the near-decade since the debut of the YDIH, several categories of microproxies have become less convincing, especially as new evidence and theories about their formation have come to light.

We'll take a closer look at the micro-proxy evidence in the subsequent articles of this series. In this one, we'll view the evidence from a much larger perspective.

INSIDE

One argument against the YDIH is that there's no "smoking gun"—no large impact crater to point to, like the dinosaur killer at Chicxulub, Mexico. But recently, some YDIH advocates have suggested three candidates: Corossol in the Gulf of Saint Lawrence, Charity Shoal in Lake Ontario, and the Bloody Creek Structure in Nova Scotia. One strike against all three is that none appears especially "fresh." That may seem a specious argument, given that the Younger Dryas began nearly 13,000 years ago, but consider: Barringer Crater, the famous 49,000-year-old crater in Arizona, still looks quite sharp-edged and recent . . . and that mile-wide, 570-ft-deep crater was formed by an impactor with *one-millionth* the energy theorized for the YD impactor. Bloody Creek, Corossol, and Charity Shoal all seem to have been worn down by glacial advances and retreats; so if they don't occupy areas



CANADIAN HYDROGRAPHIC SERVICE

Bathymetric imagery of Corossol Crater in the Gulf of Saint Lawrence, Canada.

that were still glaciated by 12,900 BP, then they were almost certainly there well before the Last Glacial Maximum.

Each also seems too small for an impact that is claimed to have had hemisphere-wide effects. Admittedly, the hot jet of gases and debris from the airburst may have hit glacial ice that dissipated some of its force. The YDIH camp also claim that it's possible the impactor broke into many smaller bodies in the atmosphere, leaving a less-obvious impact footprint than expected. That's the argument favored by geologist James Kennett, which he presented at the 2013 Paleoamerican Odyssey Conference in Santa Fe, New Mexico. However, new calculations published in a recent paper by physicist Mark Boslough of Sandia National Laboratories and other YDIH skeptics make this less likely (see sidebar).

The cratering evidence is one aspect of the Clovis Comet controversy we haven't previously explored in the pages of *Mammoth Trumpet*. Let's give it the consideration it deserves, starting with the pros and cons of each candidate.

Corossol Crater

Corossol was first identified beneath the waters of the Gulf of Saint Lawrence in Canada in 2002. It was detailed in an intriguing seafloor map produced in 2004, which caught the eye of geologist Michael Higgins at the Université du Québec à

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Mammoth Trumpet, Statement of Our Policy

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

–Michael R. Waters, Director

Chicoutimi. Along with colleagues from Laval University (Quebec City) and the Université du Québec à Rimouski, Dr. Higgins made a 9-day investigative cruise in 2010 aboard the research vessel *Coriolis II*. Based on their preliminary results, the 4-km crater seemed almost too good to be true. Not only was Corossol big, its infill sediments appeared to date to precisely the right time period. "Based on the available radiocarbon dates obtained on a sediment core sampled in the crater, and by extrapolating this age to the base of the sedimentary sequence at the coring site, we estimated a minimum age of about 12,900 BP—which coincides with the start of the Younger Dryas," notes Higgins.

But 12,900 BP is only the *minimum* age for Corossol. Furthermore, the date was on marine shell, not the best organic material to assay. Finally, there was that nagging argument that, despite the presence of an ice sheet that shielded the Gulf of Saint Lawrence 12,900 years ago, a 4-km crater defined an impactor far too small to have created all the profound effects the YDIH proponents propose. Higgins estimates the Corossol impactor was probably about 100–300 m across—large, but not extinction-event large. Moreover, the evidence suggests it was most likely a physical impact rather than an airburst, which seems to put it out of the running.

What's worse, as Higgins and his colleagues discovered while this article was in preparation, Corossol substantially predates the YD interval. "New seismic data reveal that older layers of sediments are present below the dated layer," says Higgins. "In addition, parts of the crater have been glaciated, so there must have been an advance of the ice after the impact. The crater therefore is older than the YD."

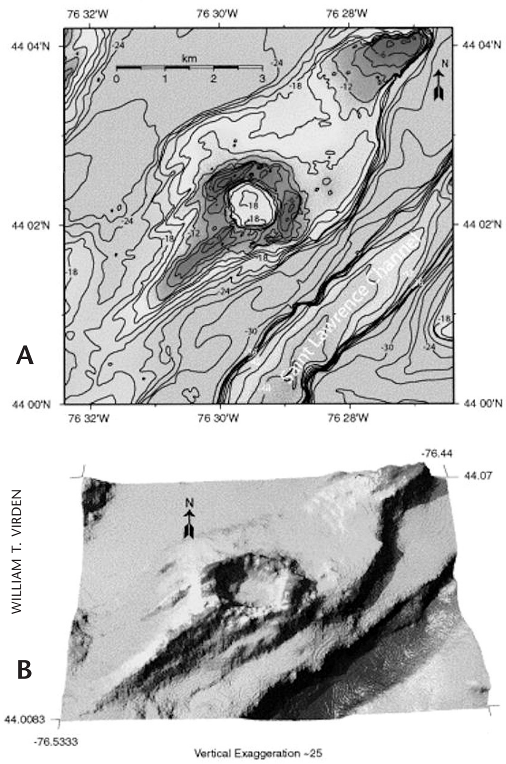
Although Corossol isn't our smoking-gun crater, it's still a big win for geology. "It's probably the best-preserved crater of its size in the world," says Higgins. "It will tell us a lot about the development of young craters." His most recent research paper about Corossol, coauthored with his Quebec City and Rimouski colleagues, was published in the journal *Meteoritics and Planetary Science* in December 2013.

Charity Shoal

The Charity Shoal feature beneath Lake Ontario has also been cited as a possible Clovis Comet crater—but even at first glance, it's a poor candidate. First, it's just 1.6 km across. Second, it's shallow. The rim lies just below the lake surface, at a minimum depth of 0.3 m, and appears to be have been repeatedly scoured by glacial ice.

Closer examination reveals a total depth (including an infill of pulverized rock) greater than 150 m. The crater extends into pre-Ordovician bedrock and may date from the Ordovician Period (443–485 MYA). This bowl-shaped depression, with a rim 5–10 m high and a low, tapering trough extending toward the southwest, resembles an enormous letter Q. This may be an instance of the "crag and tail" feature common in drumlin fields, which would suggest the crater has been glaciated in the past.

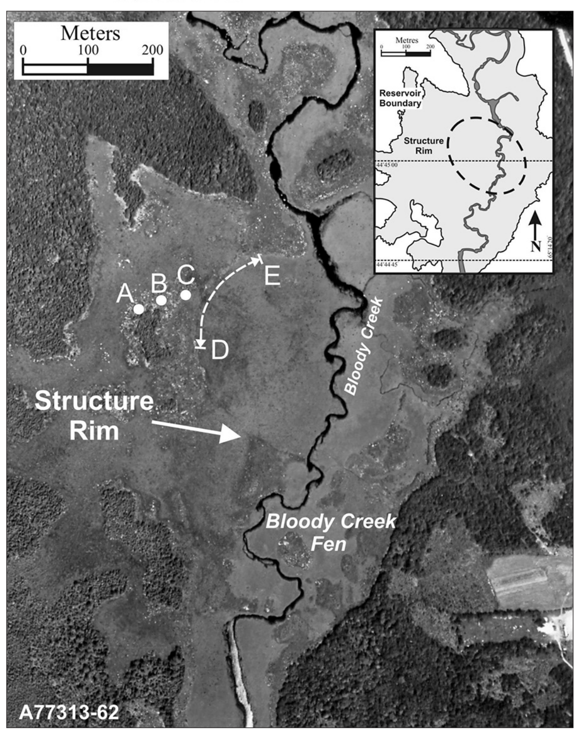
Troy Holcombe of Texas A&M University is the go-to expert on Charity Shoal, having led teams that studied the feature in both 2001 and 2010–11.



WILLIAM T. VIRDEN

◀ **Bathymetric (A) and three-dimensional (B) imagery of Charity Shoal in Lake Ontario, Canada.**

▼ **Aerial photo (1977) of the Bloody Creek structure.**



IAN SPOONER

Although he's convinced it's an impact crater, his most recent work (published in *Geomarine Letters* in August 2013) doesn't entirely prove that. It may possibly be the remains of a sinkhole, volcanic cone, or kettle. Even back in 2001, Dr. Holcombe and his coauthors concluded that it predates the Pleistocene. Now they're sure of it. "We think it's quite old, so we can discount it as a candidate for the Clovis comet," Holcombe says bluntly.

The Bloody Creek enigma

Our last candidate consists of an oblong depression and related features in southwest Nova Scotia, which were originally detected in 1987 in an aerial photo survey. Its age hasn't yet been determined, but Ian Spooner of Acadia University in Nova Scotia, who's been working at Bloody Creek for years, has this to say: "If I was a betting man, I'd put my money down on it being old and eroded. But . . ."

It's that uncertainty that makes Bloody Creek so interesting to some YDIH advocates. The feature is about 10 m deep and elliptical in shape, suggesting the impactor came in at a very shallow angle, and measures about 0.4 km across its widest dimension—again probably too small to be a killer, though it could have been formed by one of many smaller pieces of a larger body that broke up in the Earth's atmosphere (per the modified YDIH proposed by Kennett).

Something definitely rang the Earth's bell at Bloody Creek. Dr. Spooner and his team have conducted thin-sectioning and microstructure studies of the sediments within the crater and on the rim. They display mineral-alteration features common to impact craters, suggesting shock pressures on the order of 25 gigapascals (GPa), or about 250,000 times normal air pressure.

Holcombe in Sitka, Alaska, 2009.

TROY HOLCOMBE

The low depth-to-diameter ratio of the crater suggests extensive erosion. The crater hasn't yet been directly dated, so its age remains in question. Based on peat sedimentation rates within the crater, Spooner is reasonably certain it didn't form within the last 12,000 years. But that remains impossible to determine conclusively at the moment. "We've narrowed it down to two possible ages," says Spooner, "a period of 5–20 MYA, *or* 13,000 years ago or younger. We may be seeing eroded remnants of something quite old, or it may have formed during or after deglaciation. We've found nothing to discount the possibility that it may be a relatively young feature. If it's younger than 5 MYA, then the timing to produce the geometry we see would have to be about 10,000–12,500 CALYBP. It would have impacted on a relatively thin or even stagnating ice sheet."

Spooner suspects that Bloody Creek and associated features may in fact be a few of the results of an ET body that fragmented

What about that Airburst?

WHEN RECENTLY IT BECAME CLEAR to leading YDIH proponents that no single cometary airburst could account for the phenomena they were describing, they amended their theory somewhat. They now suggest an event where an object broke into many fragments before or when hitting Earth's atmosphere. The energy from the multiple impacts, they argue, ultimately affected well over 10% of the Earth's surface. This isn't unheard of; the 800,000-year-old Australasian tektite strewnfield may cover as much as 30% of the Earth's surface. However, physicist Mark Boslough of Sandia National Laboratories cautions against making too much of this comparison: "I think it is an apples-to-oranges issue," he says. "There is no evidence for multiple impacts associated with the Australasian tektites. . . . Moreover, the mechanism of tektite formation has not been suggested to cause environmental devastation where the tektites fall. The existence of a large tektite field is well known, and this is just one example. It is by no means an argument for a cluster of impacts."

Boslough explaining the details of a hypothetical fireball exploding in the atmosphere, Sandia National Laboratories, 2007.

SANDIA NATIONAL LABORATORIES/RANDY MONTOYA

YDIH opponents led by archaeologists David Meltzer and Vance Holliday, now joined by Dr. Boslough, have published a scathing rejection of the revised YDIH theory in a 16-author paper in the 2012 edition of *Climates, Landscapes, and Civilizations,* a publication of the American Geophysical Union. Other coauthors include prominent YDIH skeptics whose views have previously appeared in these pages: Todd Surovell, Nicholas Pinter, Andrew Scott, and Tyrone Daulton. In their article, Boslough et al. quickly discount most of the YDIH evidence, rejecting it as unlikely, irreproducible, or mistaken.

Ironically, the danger of impacts from outer space was underscored 15 February 2013, when a fireball tore across the early morning sky south of Chelyabinsk, Russia, 900 miles east of Moscow. Hundreds of people caught it on camera. It exploded about 30 km above the surface after passing by, and soon fragments were being recovered from nearby snowfields. Dr. Boslough was on the spot within days of the airburst, working with Russian colleagues to learn more about what had happened. Their discoveries were chronicled in an episode of the NOVA television program on PBS shortly thereafter, and the topic was revisited in a second episode in November 2013.

Boslough estimates that the Chelyabinsk meteor was the size of an apartment building, weighing some 12,000 tons. The event proves not only that are there still sizable chunks of primordial matter floating around the solar system, but that some have Earth's name on them. Note, however, that the Chelyabinsk meteor was just *one ten-millionth* the size of the proposed YDB impactor in terms of mass and energy. "To put it in perspective, the size ratio is about the same as flea-to-elephant," Boslough observes.

in an airburst and then struck in a series of low-angle impacts, with the axes of the craters pointing in slightly different directions. As Spooner points out, if Bloody Creek does in fact represent an impact onto ice, then it might have been a much larger impact than is shown by the present crater. Similarly, erosion to its current shallow depth may have resulted in a much smaller impact scar than was initially present.

Admittedly Spooner, too, has come at this at something of an angle. "I'm frankly a Quaternary geologist—a generalist, no expert on impacts," he says. "But I think I have something to offer in bringing to light the possibility that [Bloody Creek] might have a connection to the controversial work on the early occupation of the New World." For him the most significant thing about Bloody Creek is the crater itself, "a pristine, elliptical crater that formed in a homogeneous substrate. That's very, very rare. It can provide a lot of insight into long-angle impact, if indeed it is that, and how it's resolved on the Earth's surface."

IAN SPOONER

MICHAEL HIGGINS

(*Left*) Higgins on the Gulf of Saint Lawrence, 2011; (*right*) Spooner in British Columbia, 2012.

Bloody Creek is a scientific treasure, but what we know now doesn't resolve the question of whether it contributed to the YD trigger event. If Bloody Creek isn't too old, it may be too young. So we'll have to call it a maybe.

continued on page 9

February 15 was also the day that asteroid 2012 DA14 flashed by, just 17,100 miles from Earth's surface—close enough to thread the needle between us and our geosynchronous satellites. The simultaneity was apparently a sheer coincidence, since the two bodies came from different directions. At 46 m across, the asteroid was the nearest space rock fly-by since record-keeping began 15 years ago . . . and it was actually a bit bigger than the Tunguska bolide of 1908, as recently calculated by Boslough.

TONY NETONE, VIA FLICKR

The contrail behind the fireball that exploded over Chelyabinsk, Russia, February 2013.

Like the Tunguska impactor, 2012 DA14 was capable of destroying a city—and the Chelyabinsk meteor could have done the same. If you find that unlikely, tell it to the estimated 1,200 people injured by flying glass as windows exploded throughout Chelyabinsk from the shockwave. Boslough has already calculated that if the meteor had come in at a less-acute angle, a much more powerful shockwave would have struck Chelyabinsk and done far more damage. A head-on hit could have been obliterated the city.

As for the YDIH, Boslough and his colleagues don't accept any form of the scenario. In Boslough's case, "My own skepticism was based on what appeared to be a complete lack of understanding of impact and airburst physics by the proponents, the lack of unambiguous evidence for an impact, and the extraordinary nature of a claim that invoked an exceedingly low-probability combination of circumstances and events."

Boslough is an expert on the fragmentation and explosion mechanics involved in airbursts like those argued for by the YDIH proponents. In his opinion, the nature of the event and the properties of the impactor would preclude its breaking into the thousands of fragments necessary to account for the results claimed by YDIH proponents: microproxy observations and apparent population declines over most of the Northern Hemisphere at the beginning of the Younger Dryas.

Oh, it could happen, Boslough concedes, but "that would just pile another layer of improbability on an already improbable event." As a physicist, he resists invoking extraordinary measures to rescue a theory. "There is no reason," he declares, "that multiple asteroids would impact the same geographic areas repeatedly over such a short period of time. There is no known orbital dynamical mechanism to support this, so it is tantamount to suggesting a miraculous coincidence."

Like many scientists who are very skeptical of the YDIH, Boslough feels that the theory's proponents are barking up the wrong tree. "I think it's worth pointing out that the scientific controversy was essentially over before it began," he says. "There were so many fundamental flaws with the original paper that were immediately obvious to experts in the various fields that it was essentially dismissed out of hand."

The YDIH proponents beg to differ, arguing that their thesis remains valid and they have the evidence to prove it.

In the next few articles in this series, we'll review more such evidence, weighing in on both sides of the controversy. Ultimately, you can draw your own conclusions.

– Floyd Largent

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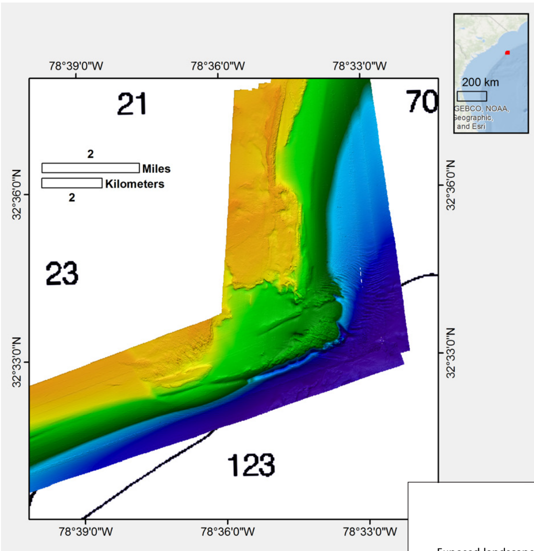
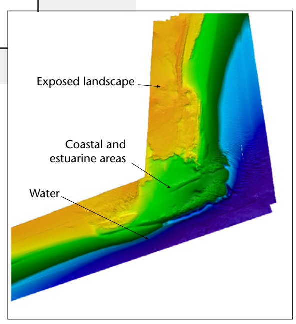




Multibeam sonar image of Bulls Scarp, approximately 120 km east of Charleston, South Carolina; the depths range from approximately 42 to 220 m. The inset identifies the topography of the imaged area at the time of the LGM.

Paleolandscapes *of the* South Atlantic Bight

THE OCEAN'S DEPTHS around America's coasts hide more than lost ships and sunken treasure. There also are submerged landscapes littered with traces of the First Americans. Geologist Scott Harris of the College of Charleston and his colleagues, using the latest technologies to reveal these paleolandscapes in unprecedented detail, are making it possible to predict the locations of important archaeological sites and someday fill in these formerly blank pages in Paleoamerican history.

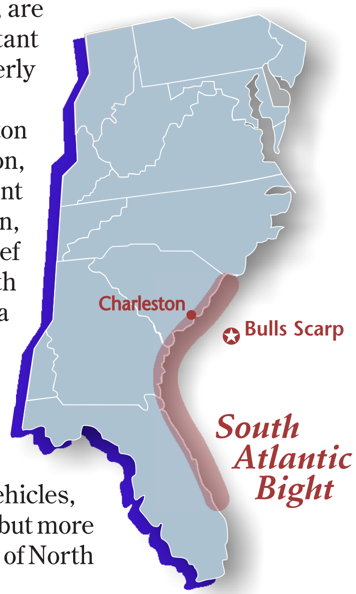
Harris's team includes fellow College of Charleston geologists Leslie Reynolds Sautter and Kacey L. Johnson, along with Katherine E. Luciano, a graduate student in Environmental Studies at the College of Charleston, George R. Sedberry, a marine ecologist from Gray's Reef National Marine Sanctuary, Eric Wright, a geologist with the Department of Marine Science at Coastal Carolina University, and Amy N. S. Siuda, an oceanographer with the Sea Education Association at Woods Hole. Using such new technologies as multibeam bathymetry surveys, sidescan sonar mosaics, high-resolution sub-bottom profiles obtained from seismic surveys, along with ground-truth surveys and remotely operated vehicles, they are revealing not just formerly hidden landscapes, but more than 80,000 years of landscape evolution along the coast of North and South Carolina, Georgia, and Florida.

Just in case global warming hasn't made it obvious to some that the world's coastlines are not fixed and unalterable boundaries separating the land from the sea, confirmation comes from a deep time perspective, which reveals a complex history of marine transgressions, periods when rising sea level submerged formerly dry land beneath the sea; and regressions, periods when falling sea level made dry land of what used to be seabed.

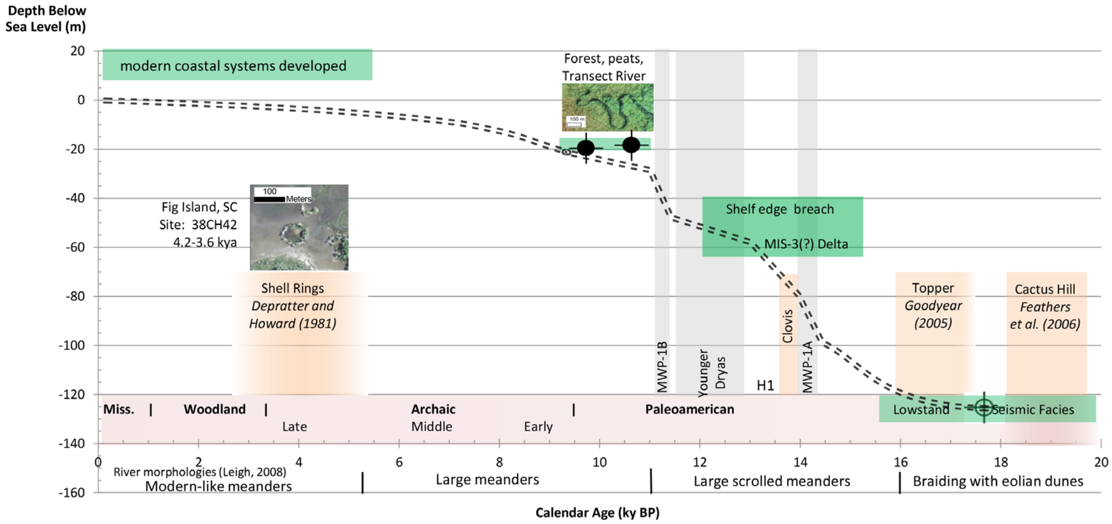
South Atlantic Bight

Harris and colleagues have focused their work on the South Atlantic Bight, the section of coastline between North Carolina and Florida. A bight is a long, gradual indentation in the coastline, like a bite taken out of the continent by some enormous creature.

Harris and his coauthors, writing in a forthcoming issue of the journal *Geomorphology*, observe that the South Atlantic Bight "preserves a scattered but distinct record of landforms and strata from which one can construct the migration of Quaternary coastal landscapes." That record can be read, in general terms, across zones of increasing depth below the modern level of the oceans. As climates have alternated between warmer and cooler periods, sea level has tended to rise and fall in more or less lockstep rhythm. This is because the glacial ice sheets that advanced during the cold periods and retreated during warm periods ultimately were formed from water drawn from the oceans. As a result, descending along a transect from the modern coastline into ever deeper waters also can be a voyage back in time. Harris and his colleagues' map of the South Atlantic Bight is divided into four zones of increasing depth: the Modern Coastal Zone, the Inner Shelf, the Middle and Outer Shelf, and the Shelf Edge.



Modern Coastal Zone The Modern Coastal Zone extends from approximately 1 m above the current mean sea level down to sea level. This encompasses the area between the ap-



M. SCOTT HARRIS

Variations in sea level in the South Atlantic Bight from modern times to 20,000 CALYBP.

proximate high water mark of the last interglacial, about 80,000 years ago, and the modern shoreline. Our current coastline became established between 5,000 and 6,000 years ago.

Inner Shelf The Inner Shelf begins at mean sea level and ends at about 25 m below that. Much of the inner shelf has been scoured down to the sedimentary bedrock by wave action, but there are areas where peat deposits and exposed tree stumps mark the locations of ancient forests and swamps. Radiocarbon dates for cypress tree stumps at 19 m below current mean sea level indicate that these forests were above water and thriving around 11,500 years ago.

Middle and Outer Shelf The Middle and Outer Shelf zone picks up where the Inner Shelf ends and extends another 55 m in depth to about 80 m below current mean sea level. This area is relatively flat to gently sloping with exposures of bedrock interspersed with deposits of sand and mud. In one location a large, D-shaped lobe of sand extends seaward across the Middle and Outer Shelf for 3–5 km. Called the Geneva Delta, it's interpreted as sediments deposited at the outlet of an ancient river.


COLLEGE OF CHARLESTON

Harris *(background)* training students to pilot the ROV.

Shelf Edge The Shelf Edge extends from the deepest limits of the Outer Shelf to a depth of about 250 m below current mean sea level. The most prominent feature on the Shelf Edge of the South Atlantic Bight is Bulls Scarp, an underwater mesa about 5 km wide by 12 km long encompassing an area of 40 km^2. It juts 8 km out into the Gulf Stream, and the rocky outcrops along its flanks likely include deposits of flint.

When the top of Bulls Scarp was above the sea, the more or less flat plain would have included a rich diversity of habitats including marshes and lagoons. Harris and his coauthors think the rocky outcrops around the periphery of Bulls Scarp "would have provided seasonal habitat for seals and other marine mammals" as well as "year-round sources of oysters and clams."

Evolution of paleolandscapes on the Bight

The complex landscape history revealed in the underwater investigations of Harris and his colleagues begins around 80,000 years ago, when sea level lay about 1 m above the current level. The coastline during this period would have had extensive estuaries and tidal inlets similar to the modern coastline.

By 70,000 years ago, sea level had dropped precipitously to about 80 m below current sea level, exposing the entire continental shelf. According to Harris and his coauthors, "the emerged shelf was covered by a relatively cold and dry landscape, with dune fields, Carolina Bays, shallow and intermittent rivers, and a narrow coastal zone constricted against a steep headland."

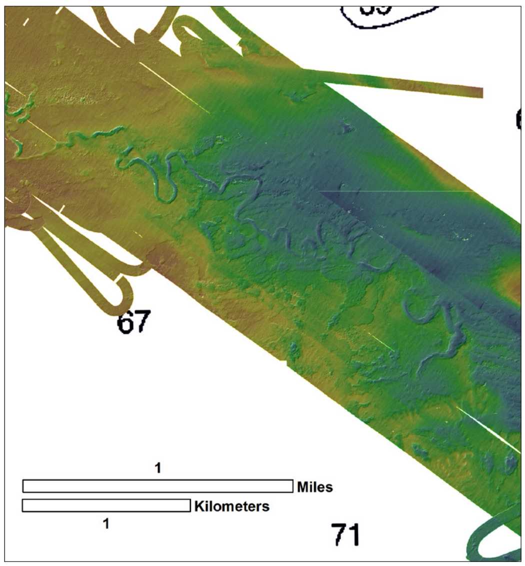
By 60,000 years ago, sea level had risen to between 40 and 50 m below current sea level, resulting in the formation of new estuaries, swamps, and tidal inlets farther up the submerging valleys. The Geneva Delta formed during this period.

Between 50,000 and 18,000 years ago, sea levels fluctuated. Periods of lowered sea level exposed delta plains and, according to Harris and his colleagues, created "open dune fields, savannah, bogs, or swamps each depending on soil drainage and water table elevations."

At the Late Glacial Maximum, around 18,000 years ago, sea level fell again to about 130 m below modern levels. According to Harris and his co-researchers, the generally colder sea temperature and lower wave energy would have made this coastline a "refugium for larger marine mammals, providing ample food sources for human populations at the coast"—presuming, of course, human populations were here at the time to take advantage of such bounty.

The warming that marked the end of the Pleistocene melted the massive continental glaciers, and sea levels climbed up the Shelf Edge within 6,000–7,000 years. Once the sea level rose above the break in the slope at the Shelf Edge, waters rose rapidly across the more gently sloping landscapes of the Middle and Outer Shelf and inundated the expanse between Bulls Scarp and the break between the Inner Shelf and Middle Shelf within about 1,000 years. This rising sea flooded the 11,500-year-old cypress forests and swamps that today are found preserved in places on the sea floor.

By 4,000 years ago sea level had risen to about 2 m below current sea level; 3,000 years ago sea level dropped to about 3.5 m below current sea level; and about 2,400 years ago sea level rose again to the modern level.



Transect meanders, an area on the seafloor where a preserved meandering channel is incised into the seafloor, indicating a time of slow sea-level rise when the shoreline was at approximately -20 m, ca. 10,000 CALYBP. Depths are in feet. Relief in the channel in the center of the image is approximately 2 m (4–7 ft).

Predicting the locations of undersea sites

These data and the landscape history they reveal make it possible to identify underwater topographic features that are likely candidates for prehistoric occupation sites associated with the time period that roughly corresponds to a particular depth below sea level.

Harris and his team assert that large areas along the shelf edge were above water between approximately 70,000 to 10,000 years ago "creating a high probability of locating Clovis and earlier sites adjacent to shelf-edge estuaries." One of the most potentially important such areas identified is Bulls Scarp, located about 100 km off the coast of Charleston. In a July 2013 article in the Charleston *Post and Courier* newspaper, Harris and co-researcher George Sedberry described Bulls Scarp as perhaps "the most fascinating and important archaeological site waiting to be surveyed in the region." Harris and his coauthors write in their technical report that Bulls Scarp would have provided "vantage points of almost 80 m . . . spanning a view of tens of kilometers to the north and south." Around the sides and base of Bulls Scarp, there would have been estuaries and rich habitat for shellfish, fish, and marine mammals, such as seals. Rockshelters, freshwater springs, and workable stone, including chert, quartz, and rhyolite, also would have been available along the flanks of the scarp. It would have been a paradise for ancient hunters and gatherers. George Seberry told the *Post and Courier*, "I think it's fantastic. I can just picture it in my mind. We know these hard grounds were occupied by herd animals and people at the time."

As the Northern ice sheets melted, the river systems of the Southeast were filled with sediment blowing off the barren landscapes newly freed from the ice. Braided streams then dominated the drainage patterns in the region. After about 16,000 years ago, the climate became warmer and wetter and the drainage patterns gradually became meandering streams. This change, which enriched resources on the Coastal Plain, also increased the likelihood that sites would be preserved, particularly earlier occupations on the shelf edge if they exist. One important implication of this altered topography is that geological processes may have obliterated pre-Clovis sites lying on the Middle and Inner Shelf, if they were present. Harris believes that "of all places, the Outer Shelf and Shelf Edge areas will be the best places to search for evidence. Context will in some places be destroyed by erosion, but the lag deposits won't be washed away, particularly on the top of Bulls scarp."

Sites of the Clovis culture appear shortly after the change in drainage patterns, and Harris and his coauthors observe that Clovis people would have had access not only to the newly enriched riverine habitats, but also to "a small maritime belt" while the sea level was still below the modern shelf edge. They point out that this zone would have provided "more consistent habitat for oysters and other estuarine species" and estimate that Clovis-era sites "may be spread across a much wider area" of the now submerged landscape. Areas with especially high potential for sites would be these estuaries, but also 'high ground between expanding tidal river systems.' " Bulls Scarp is the most dramatic such feature identified in this new survey. Harris told the *Post and Courier* that he and his team

Suggested Readings

Harris, M. S., L. R. Sautter, K. L. Johnson, K. E. Luciano, G. R. Sedberry, E. E. Wright, and A. N. S. Siuda 2013 Continental shelf landscapes of the southeastern United States since the last interglacial. *Geomorphology*, in press. http://dx.doi.org/10.1016/j.geomorph.2013.02.014

Petersen, B. 2013 Scientists want to study Bulls Scarp, ocean-bottom archaeological site that was Ice Age coast. *The Post and Courier*, 7 July 2013. http://www.postandcourier.com/article/20130707/PC16/130709582/1177/scientists-want-to-study-bulls-scarp-ocean-bottom-archaeological-site-that-was-ice-age-coast.

"feel very strongly this area would have held populations of people" in both Clovis and pre-Clovis times. Regarding the potential for pre-Clovis sites, Harris says, "It literally would undermine archaeological regimen. Pre-Clovis sites still freak people out."

The rapidly melting glacial ice sheets caused sea levels to rise correspondingly rapidly, moving inland across about 80 km of coastal plain in something less than 2,000 years. That's an average rate of about 40 m per year. Consequently, Harris and his coauthors note, long-term settlements by tidewater communities simply weren't possible during this period and any temporary encampments that may have existed on what is now the Middle Shelf were likely short-term occupations, which would leave little material to be preserved.

The consequences of the rapid sea-level rise experienced by Southeastern Paleoindians offer a parenthetical warning here about what will happen to modern tidewater communities if global warming continues apace and the Earth's remaining continental glaciers melt.

Once the rapid rise in sea level began to abate, long-term settlements in coastal areas became more feasible. Accumulated shell middens and constructed shell rings make these sites much easier for archaeologists to locate.

What's next?

The work of Harris and his team provides almost a literal road map for locating ancient archaeological sites long submerged beneath the wine-dark sea. According to the recent article in the Charleston *Post and Courier*, Harris and his team are now looking for partners to help search for sites in their research area. They also point out that the model for paleolandscape evolution they have worked out for the South Atlantic Bight may provide a template for archaeological investigations "for other regions of the world that have wide shelves and similar sea level histories."

It will be fascinating to see what the archaeological exploration of this new frontier reveals about the First Americans. Whatever it reveals may introduce a new chapter in Paleoamerican prehistory.

– Brad Lepper

For contributing to this story, we thank NOAA, NOAA Ship Nancy Foster, College of Charleston BEAMS program, CARIS, and QPS–Fledermaus.

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The Clovis Comet

continued from page 5

Who's right?

We may never know what caused the Younger Dryas reversal. About the only thing everyone can agree on is that it happened. YDIH proponents argue for a visitor from outer space; their critics see no need to invoke one, given so many other possible triggers, particularly ice-dam collapses that changed oceanic circulation patterns. What's more, when skeptics test the evidence proposed by YDIH proponents, they often fail to produce the same results. The alliance of physicist Mark Boslough with the camp skeptical of the YDIH now adds a formidable argument against the evidence: That the proposed impact, as described, runs counter to known physics (see sidebar).

At this point, both sides are digging in harder, and a resolution seems less likely than ever. As far as craters go, there may still be one or more smoking guns—or rather, bleeding wounds—somewhere in the northern reaches of the Northern Hemisphere that we've failed to recognize . . . but we certainly don't have a convincing candidate yet.

In the next installment of this series, we'll start taking a look at recent microproxy evidence for and against the Clovis Comet, reaching down to the near-atomic level to attempt to prove or deny this extraordinary hypothesis.

– Floyd Largent

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Hogeye Secrets

Jennings in 2010 pointing to a biface in the sand pile that was excavated and dumped at the Hogeye Cache site by a front-end loader in 2003.

UNLESS NOTED, ALL PHOTOS: MIKE WATERS, CSFA, TAMU

A CACHE OF PRISTINE CLOVIS BIFACES unearthed by a commercial sand-mining operation in central Texas in 2003 drew Texas A&M University archaeologists Mike Waters and Tom Jennings into investigating the discovery. It proved to be a godsend, for the 52 unused bifaces, in varying stages of completion, show lithics analysts the sequence of specialized operations Clovis knappers performed as they crafted tools needed for survival at the end of the last Ice Age.

"A cache is a tightly clustered group of artifacts," Dr. Waters explains, "that are left at a location on the landscape at the same time in the past. Caching of tools and raw materials has occurred through time and for various reasons." Whatever their reason for caching artifacts, toolmakers surely intended to retrieve them sometime in the future. Scientists congratulate themselves on their good fortune in discovering a cache that was overlooked 13,000 years ago.

The discovery

It wasn't unusual for workers excavating a sand pit located 5 km east of Elgin, Texas, to find artifacts in the sand that was hauled to a plant that made tiles and bricks. In the 10 years that workers had been mining sand from this pit, they had found thousands of late-Prehistoric and Archaic projectile points as they stripped the upper levels; as they mined deeper they occasionally found Paleoindian projectile points. Over the years several workers had amassed large collections of artifacts.

On 22 April 2003, John Wayne Farris was operating a front-end loader, excavating sand from the 3-m-high wall of the pit and dumping the loads into piles to be trucked to the plant, when he noticed in the bucketload unusually large bifaces, some 17 cm long. He showed them to his supervisor, Lee Jones, who recognized them as Clovis and suspected they may have come from a cache. Together they searched the last pile that had been dumped and found two more bifaces. Jones immediately closed the area of the pit where the bifaces had been unearthed.

The stockpiled sand at the plant was processed in batches over the next three to four months. In this operation sand was dumped into a hopper and from there onto a conveyor belt, which transported the material to a large rotating metal drum, where it was heated to 500˚ F. to dry it. Sand discharged from the drum was spread onto a vibrating screen, which separated objects larger than one-ninth of an inch and sent them down a chute onto another conveyer belt, which carried them to a reject pile. Jones and his wife, Cindy, and Farris kept a watchful eye for bifaces at all stages of the process. Farris found another biface on the belt that fed the rotating drum. Most of the artifacts, however, were picked off the belt that carried rejected material. A few were also found in earlier piles of rejected material, and Jones was given one biface by another employee.

The Joneses eventually collected 21 complete bifaces and several fragments, and Farris had 13 complete bifaces. Jones named the cache Hogeye to honor his uncle who lived near Elgin on Hogeye Lane. Interestingly, Lee's uncle, father, and grandparents had lived in the immediate vicinity of the sand pit in the 1940s—in fact, only about 100 yards from where the cache would be found over 60 years later.

Field investigations

The bifaces in Farris's collection were bought and sold by various collectors until Mark Mullins, believing that the cache should be kept intact, purchased the entire collection in 2005 and loaned the assemblage to Mike Waters to study. In 2010 Waters and graduate students Tom Jennings and Ashley Smallwood met with the Joneses, who confirmed that the Mullins artifacts were indeed the bifaces that Farris had originally found. The Joneses graciously loaned Waters all their artifacts for study. Better yet, they offered to show him the location in the sand pit where they had originally been found.

Waters and Jennings began excavating at the site in 2010. At Jones's suggestion, they first excavated a sand pile that had been left behind in the pit on the day the cache was found in 2003. To everyone's surprise, the sand pile yielded another 15 complete bifaces and one fragment of a biface. Most of the bifaces were found in the middle of the sand pile in a lens of white sand with pieces of the underlying red Tertiary clay bedrock within it. This showed that the bifaces had been buried in loose white sand close to the bedrock. Next, archaeological excavations were undertaken along the wall of the pit from where the bifaces were originally excavated. This excavation yielded a number of Archaic artifacts and features and revealed the stratigraphy of the site. At the base of the geological section was a layer about 20–25 cm thick of white sand with pieces of the bedrock in it. This sediment matched the sediments found surrounding the bifaces in the excavation pile and was the likely stratigraphic position of the Hogeye cache. This was supported by OSL dating of the sediment overlying this deposit. Although excavating along the wall of the pit didn't yield additional Clovis bifaces in place, it did define the geological context for the cache and the other artifacts that had been previously found at the site.

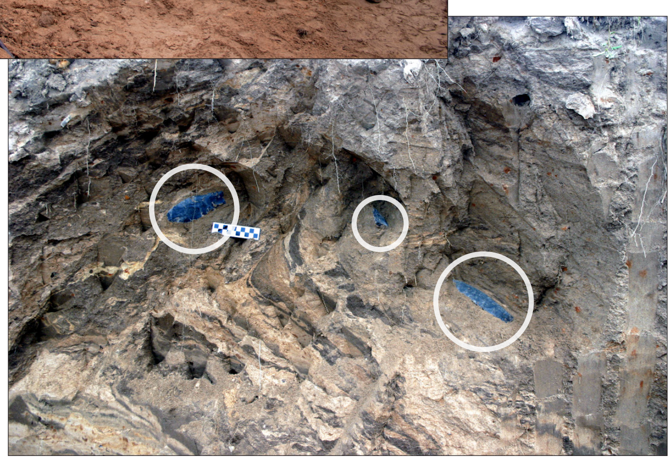
The sand quarry where the Hogeye Cache was found.

They found that the site of the Hogeye Cache originally lay at the toe of a sandy colluvial slope near the confluence of two small streams that flowed into a larger tributary, thence into the Colorado River. In Clovis times the bedrock would have been nearly exposed, covered only by a meager layer of sand that had slumped from the slope. "Clovis people probably dug a pit into the soft colluvial sands and buried the bifaces to conceal them for later use," Waters says. For some reason the people who left the cache didn't return to the site, and over the next 13 millennia the cache became deeply buried by sand shedding downhill.

In strata above the Clovis cache Waters and Jennings found many other artifacts along with fire-cracked rocks, evidence that the area was used for millennia as a campsite and lithic workshop by Archaic and Late Prehistoric peoples.

It's an interesting footnote that many years before the Hogeye Cache was found, two Clovis points were found near the site. One is identical in toolstone, morphology, and workmanship to bifaces found in the cache and perhaps foreshadows the 2003 discovery.

◀ TAMU student Larkin Kennedy at the sand pile that was dumped by a front-end loader in 2003. Level with the top of the shovel handle are three Clovis bifaces shown in the close-up below.



The Clovis bifaces

Clovis toolmakers were connoisseurs of fine toolstone and often traveled long distances to replenish their supply at favored quarries. The Hogeye bifaces exemplify the tradition: They're all made on high-quality Edwards chert in varying shades of gray.

Clovis tools were made using the process of bifacial reduction in which raw material was removed from both faces of a stone flake until the piece achieved a finished form (**MT 26-1, -2, -3,** "What It Means to Be Clovis"). "The bifaces of the Hogeye Cache followed two separate trajectories or paths to the completion of a finished tool: the point-production trajectory or the ovate-biface trajectory," Jennings explains. Most of the Hogeye bifaces are projectile-point preforms. Five are ovate bifaces, which would likely be fashioned into knives, flake cores, or even projectile-point preforms.

The Hogeye Cache is valuable because the bifaces clearly illustrate the sequence of operations toolmakers used to shape a stone blank into a fine tool.

In the early phase, the thinning and shaping process was begun by removing large unpatterned flakes.

In the middle phase, both faces were shaped and flattened by removing large overface or overshot flakes. An overface flake begins at the margin and extends beyond the biface midline, stopping short of the opposite margin. Overface flaking therefore thins the preform without significantly narrowing it. An overshot flake, on the other hand, extends past the midline and removes a flake from the entire width of the face, including a portion of the opposite margin, thus simultaneously thinning and narrowing the preform. Overshot flaking, known as *outre passé,* rapidly thins the biface. It's a technique—risky in the hands of an inexpert knapper—that was developed into a fine art by Clovis knappers and is, in fact, a diagnostic feature that identifies a tool as Clovis. Endthinning, another important middle-phase operation, tapered the ends of the biface.

In the late phase, the roughly shaped biface was refined into a recognizable projectile-point preform. The base was typically fluted on both faces for secure hafting to a shaft, thus adding the Clovis hallmark to the point.

In the final phase the preform was finely shaped, smoothed, and its margins sharpened. The edges of the base were dulled to prevent damage to the binding that would secure the finished point to the shaft.

The phases of production for ovate bifaces seem to differ very little in the early reduction process from that for projectile points, although the stages of ovate biface reduction have not been studied.

All the bifaces of the Hogeye Clovis Cache, including preforms for projectile points and ovate bifaces. The entire assemblage weighs 4 kg.

JOSHUA KEENE, CSFA, TAMU

Of the 52 artifacts in the Hogeye Cache, 47 are late-stage projectile-point preforms, which range from rough pieces to almost finished points. Because of this diversity, Waters and Jennings classified them into three categories. Stage A preforms (26), the roughest of the preforms, have flat faces with lanceolate shape and sinuous edges. Stage B preforms (9) are distinguished by fine retouch and shaping, concave bases that have been trimmed, and endthinning scars on both faces. The Stage C preforms (12) have concave bases, and the midsection and tips have been finally shaped and trimmed; these lack only final edge retouch, tip sharpening, and grinding of the basal edges to become finished projectile points.

Cache analysis

Stage A and B preforms are larger than those in Stage C, as you would expect. Stage C bifaces, having had much of their mass removed in the various shaping operations of the point-production trajectory, weigh less and are significantly shorter, narrower, and thinner than stage A and B preforms. Stage C preforms are also considerably smaller and lighter in weight than ovate bifaces of the Hogeye Cache.

Thanks to the complete ensemble of bifaces in various stages of completion, Waters and Jennings have identified three strategies used to thin point preforms in the Hogeye Cache: lateral overshot flaking, lateral overface flaking, and basal endthinning. Scars from overshot flaking, which removes large amounts of toolstone and is therefore useful in roughly thinning and narrowing a biface, are very noticeable in stage A bifaces. Many of these overshot scars are no longer visible in stage B preforms, however, having been removed by lateral edge trimming. By the time a preform reached stage C, no overshot scars remained.

Scars from overface flaking were also removed in later stages by lateral retouching, but not completely. All 52 bifaces from the Hogeye Cache still bear at least two discernible overface scars, indicating that this was an important strategy in Clovis biface reduction.

All point preforms from the cache bear endthinning scars. On some preforms, endthinning was accomplished in a single step; on other specimens, endthinning was done in successive operations. The bases of stage B and C bifaces were nearly completed by the end of stage B.

Biface flaking patterns

Waters and Jennings have identified three unique Clovis knapping strategies used to thin bifaces of the Hogeye Cache.

Alternate-opposed flaking, the most commonly used flaking strategy, removed an overshot or overface flake first from one edge, then from the opposite edge of the same face, working both sides of the same face.

Serial flaking removed flakes in a single flaking direction from a single edge. Waters and Jennings have detected two different modes. **Dual-edge serial flaking** removed flakes from one face along a single edge; then the preform was turned over, like a page in a book, and the other face was flaked from the other edge. **Shared-edge serial flaking** removed flakes from one face; then the biface was flipped over, end for end, and the other face was flaked using the same edge as the platform.

In some serial-flaked bifaces, the flake scars travel from left to right, in others from right to left. This may indicate right-handed and left-handed knappers. These two previously undocumented serial-flaking techniques add to the known repertoire of Clovis toolmakers. Score another first for the Hogeye Cache.

Cindy and Lee Jones, whose vigilance saved the Hogeye Cache from destruction.

Chert from the Gault site?

Results of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), a method used by Charles Speer (University of Texas, San Antonio) to determine the chemical composition of chert used in three of the Hogeye bifaces, surprised those involved in the study of the Hogeye Clovis cache. The chemical signature of the bifaces matches, to a 95% confidence level, chert samples taken from the Gault site, a Clovis workshop and camp with nearby outcrops of Edwards chert (**MT 20-1, -2,** "Assault on Gault"). These findings suggest that the Edwards chert used to make the bifaces came from quarries at Gault, which lies 75 km northwest of Hogeye. Moreover, the bifaces may have been manufactured at the Gault site in the workshop area known as Excavation Area 8. Debitage and many abandoned and broken tools have been found on this occupation floor, but preforms and finished pieces are conspicuously missing. The Hogeye Cache of unused late-stage preforms may fill this gap.

Waters believes that "the Hogeye Cache bifaces are products that were likely made at and taken away from the Gault workshop." Some projectile points were completed at the Gault site, but others were left unfinished at the late stage of reduction. Evidence suggests that Clovis hunters carried away these partially finished pieces as insurance. The majority (47) of the Hogeye Cache bifaces are late-stage projectile-point preforms. Five are ovate bifaces, which may have been intended as toolstock for knives or as cores for making large flakes. They could just as easily have been made into projectile points.

The Hogeye Cache story

Clovis caching is a Clovis subsistence strategy of great interest to archaeologists. Clovis hunters, aware that the best hunting grounds might be distant from sources of toolstone, carried extra preforms on hunting forays to replace tools lost or broken. The Hogeye site contains one of the largest known concentrations of cached bifaces. The hunters that buried the Hogeye Cache were likely residents of the Gault site, 75 km away, who carried with them spare nearly finished projectile points and biface blanks. Because the artifacts were heavy and bulky and wouldn't be needed again until their return trip, it made sense to bury them for safekeeping, hidden from other hunting groups.

Like the squirrel that forgot where it buried the acorn, the hunters lost track of the cache, which became more deeply buried under colluvial sediments over years that became centuries, then millennia. Archaic and prehistoric hunters left their own evidence of occupations above the 52 bifaces, which lay undisturbed for 13,000 years until Texas workmen dug them out.

For lithics analysts, the Hogeye Cache is a marvelous opportunity to expand our knowledge of how Clovis toolmakers practiced their craft. The Clovis hunters' loss is our gain.

–Martha Deeringer

Suggested Readings

Jennings, T. A. 2013 The Hogeye Clovis cache, Texas: Quantifying lithic reduction signatures. *Journal of Archaeological Science* 40 (2013): 649–58.

Waters, M. R., and T. A. Jennings. 2013 *The Hogeye Clovis Cache, Texas*. Unpublished book manuscript.

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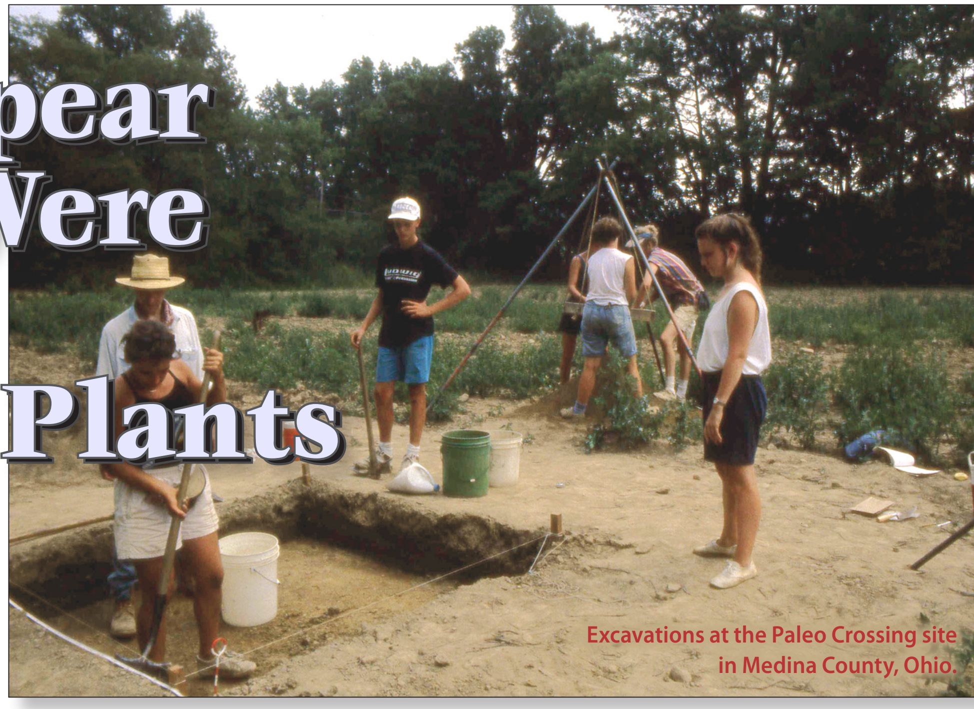
Clovis Spear Points Were Used to Process Plants

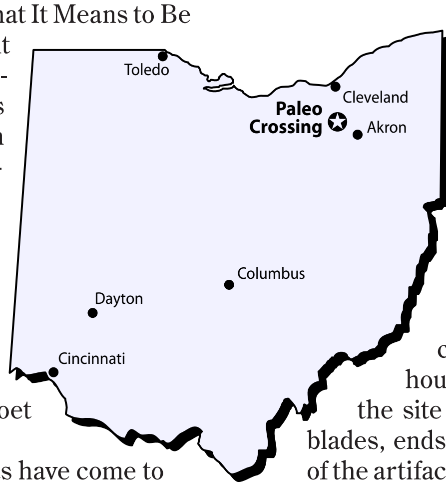


Excavations at the Paleo Crossing site in Medina County, Ohio.

CLEVELAND MUSEUM OF NATURAL HISTORY

A PILOT STUDY OF MICROWEAR on stone tools from the Paleo Crossing site in Ohio provides new evidence that Clovis people used their stone tools as general-purpose Boy Scout knives, and sometimes even used spear points to cut soft plants. Does this also mean that Clovis hunters enjoyed a salad on the side with their mammoth steaks? Logan Miller, a graduate student in Anthropology at Ohio State University, is looking for the answer to this question through the lenses of a microscope.

The Clovis culture (**MT 26-1**, "What It Means to Be Clovis"), best known for its elegant flint spear points occasionally found associated with the bones of mammoths and mastodons, traditionally has been pictured as far-ranging bands of big-game hunters. Archaeologists who subscribe to this view generally believe that Clovis hunters spread rapidly from Alaska into South America, eating their way through the Hemisphere's megamammal herds "like tent caterpillars going through an elm," to quote the anthropologist-poet Loren Eisely's memorable simile.



More recently, some archaeologists have come to see Clovis as more closely akin to hunter-gatherers described by cultural anthropologists—generalized foragers with a more limited range who dined only occasionally upon the biggest game (**MT 28-1**, "The Big-game Hunting Conundrum"). Owing to the great age of Clovis sites, animal bones are often poorly preserved. To recover the remains of more-perishable foods, the hawthorn plum seeds, for example, found in a hearth in Pennsylvania, is a phenomenal stroke of luck (**MT 22-2,** "The Shawnee-Minisink Site"). Usually all that remains is stone tools, and that has left archaeologists in a bit of a quandary as to how to resolve the debate over the Clovis diet.

Using techniques pioneered by Russian archaeologist Sergei Semenov back in the 1950s, archaeologists now use high-powered microscopes to detect faint traces of wear, clues to how a stone tool was used and even the kind of material that was stabbed, cut, or scraped with the tool. These methods, when applied to sets of Clovis tools, may provide important clues to the ways of life of the first Americans.

The Paleo Crossing site

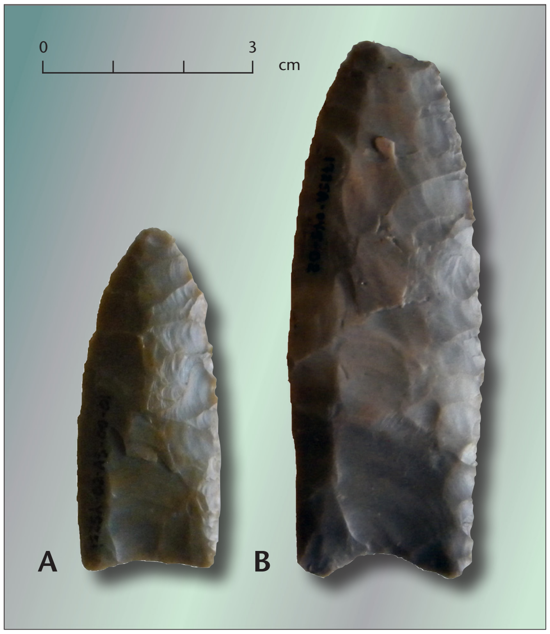
Avocational archaeologist Jim Remington discovered the Paleo Crossing site back in 1990 and brought it to the attention of archaeologists at the Cleveland Museum of Natural History (**MT 7-4**, "Investigations at Ohio Site Push back Dates for Clovis"). Subsequent surveys and excavations by the Cleveland Museum revealed a remarkable record of Paleoindian inhabitation, including postmolds that may be part of a Clovis-era house as well as pit features. Artifacts recovered from the site include Clovis fluted projectile points, prismatic blades, endscrapers, and unifacially worked flake tools. Most of the artifacts, more than three-fourths of the formal tools, are made from Wyandotte flint, also known as Indiana hornstone, which outcrops in southern Indiana more than 600 km to the southwest. The site has been radiocarbon dated to around 10,980 RCYBP, making it, according to Miller, "one of the oldest archaeological sites in the Great Lakes region."

Paleo Crossing is located on a south-facing terrace below the crest of a glacial kame with a series of kettle bogs to the east. Based on the large and diverse artifact assemblage

MAMMOTH TRUMPET

and the predominance of scraping tools, the site has been interpreted as a base camp where hunters could watch for migrating caribou from the nearby heights while their families engaged in a variety of domestic activities, including processing caribou hides, while enjoying freedom from mosquitoes afforded by the camp's elevated position.

The purpose of Miller's pilot study was to test that interpretation of the site, and to determine specifically what sorts of activities the people of Paleo Crossing performed, by examining the tools for microscopic evidence of how they were used. The method he would use to tackle the problem was microwear analysis.



LOGAN MILLER

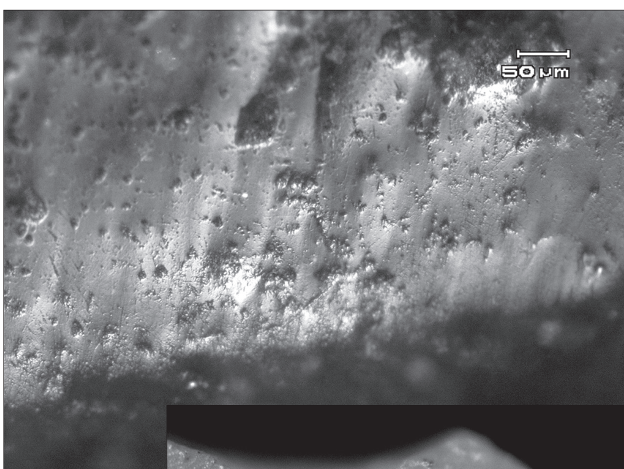
Clovis points from the Paleo Crossing site. A, resharpened point (CMNH catalog # 1725A-02-A3-00-01), which exhibits use-wear traces of butchering meat and cutting soft plants. B, point (CMNH catalog # 1725A-045-02) with probable impact fracture at the tip and other evidence of projectile wear.

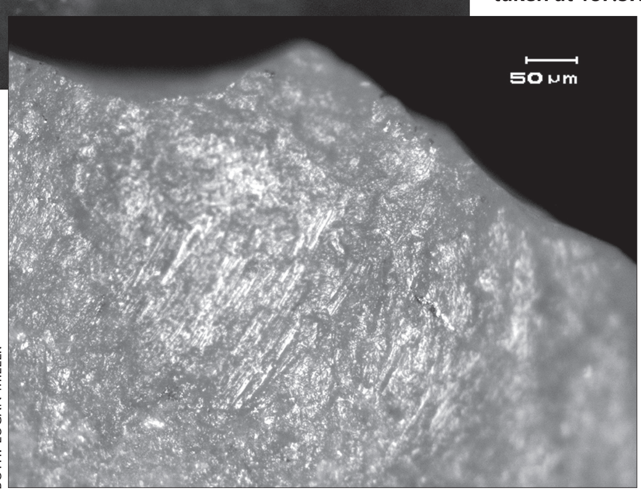
Looking for telltale evidence

Microwear analysis is based on the premise that the manner in which a stone tool is used produces consistent, identifiable patterns of wear on the edges and surfaces of the tool. The traces of use may be damage to the sharp edges of the tool, often visible using low-power magnification, or polishes and striations only visible under high-power magnification. Microwear analysts have compiled a library of wear patterns by experimentally exercising replica stone tools and documenting the kinds of wear produced by specific actions, such as cutting versus scraping, on various materials, such as meat, hide, and soft plants.

Miller examined a sample of 10 Clovis artifacts from Paleo Crossing selected by Brian Redmond, Curator and Head of Archaeology at the Cleveland Museum of Natural History (CMNH). Six of the tools had been recovered during fieldwork by the CMNH; the other four were donated to the museum from private collections. Redmond's goal was to provide Miller with a representative sample of the kinds of tools present at the site. The sample included two Clovis points, three scrapers, and an endscraper, knife, preform, blade, and retouched flake.

The tools were carefully washed to remove any residues that might interfere with determining evidence of use. Miller then examined the edges and surfaces at magnifications of up to 500X and interpreted microwear traces with the aid of a reference collection of more than 200 tools with experimentally produced wear patterns. These experiments, according to Miller, have produced edge damage, striations, and polishes that are characteristic of a wide range of motions, including "cutting, scraping, whittling, sawing, engraving, and projectile use on materials such as meat, wet, dry, and greased hide, bone, antler, wood, plant, soil, stone, shell, and even pottery."





BOTH: LOGAN MILLER

◀ The edge of the Clovis point shown in A above. The bright, smooth polish indicates the point was used to cut soft plant material.

▼ The tip of the Clovis point shown in B above, showing parallel linear striations characteristic of projectile use wear. Both photomicrographs taken at 187.5X.

What were Clovis people doing with those tools?

You would naturally expect the Clovis points to exhibit evidence for use as projectile hunting weapons—and you'd be mostly right. One of the fluted points had a broken tip, which Miller says was "possibly due to an impact fracture." That same point also exhibited linear striations near the tip that confirm it served as a projectile point.

The other Clovis point is smaller, having been resharpened, probably multiple times. All that reworking makes it impossible to know how this point was used in previous incarnations. On the existing surface, however, Miller observed "highly invasive dull greasy polish," which indicates that one of its

PaleoAmerica is the new journal soon to be published jointly by The Center for the Study of the First Americans and Maney Publishing. The principal focus of this peer-reviewed quarterly journal will be on the Pleistocene human colonization of the New World, which makes it the only scientific journal of its kind. The interdisciplinary subject matter embraces archaeology, genetics, paleoanthropology, linguistics, and paleoenvironmental sciences. International in scope, ***PaleoAmerica*** will report on discoveries in North and South America, the Caribbean, northeast Asia (Siberia, Japan, China, Korea, and Mongolia), and southwest Europe.

Scholars investigating the dispersal of modern humans in such lands as Australia, island southeast Asia, and even Tibet will welcome ***PaleoAmerica*** for its incisive reports on research programs similar to theirs. We expect ***PaleoAmerica*** will quickly become the international scientific marketplace for exchanging up-to-date information on worldwide dispersals of early modern humans.

PaleoAmerica continues the tradition of ***Current Research in the Pleistocene,*** the trusted annual journal published by CSFA for almost 30 years. Like its predecessor, the new journal will include a number of succinct reports on new research results in every issue. As a bonus, moreover, every issue of ***PaleoAmerica*** will also feature at least one major article that enlarges our knowledge of a particular subject or region, several extensive reports on new scientific discoveries, and one or two short commentaries written from the perspective of leaders in their fields. You can be confident that every issue of ***PaleoAmerica*** will be brimful of news, views, and reviews.

PaleoAmerica will be available in two media, the paperback printed edition and the electronic online edition. For CSFA members, subscription will be $35 for the printed edition, $22 for the online edition. Subscription information will appear in the next issue of ***Mammoth Trumpet.***

The first call for manuscripts has just been sent out. If you wish to submit a manuscript, contact editor Ted Goebel (goebel@tamu.edu). This summer CSFA and Maney Publishing are organizing the ***PaleoAmerica*** website, online submission protocol, and subscription system. Watch for future announcements as we unveil ***PaleoAmerica,*** the newest publishing venture of CSFA.

uses was to butcher meat or cut fresh hide. That's interesting, but not all that surprising. Many archaeologists have argued that a Clovis projectile point, perhaps hafted to a foreshaft, could have been mounted onto a mainshaft and used first as a spear to kill game, then, removed from the mainshaft, used as a butchering knife. As a side note, Miller also observed on both points "bright spots of polish near the margins of the fluting scar[s]," which he interprets as evidence of hafting.

One observation of Miller's, however, came as a big surprise: "In several places, both on the lateral edges and further in on the face, very bright, smooth polish with fine and filled-in striations overlies the meat polish." This kind of polish is characteristic of a tool used to cut soft plant material. Since plant polish partially overlies the meat polish, cutting plants is the last purpose the point served.

Many archaeologists over the years have argued that Clovis points were specialized big-game hunting weapons and that Paleoindians were blood-thirsty carnivores on a Paleolithic blitzkrieg through the Americas (**MT 28-1**, "The Big-game Hunting Conundrum"). To suggest to adherents of this classic model that a Clovis spear point was used to cut soft plants smacks of heresy, as outrageous as accusing a Texas cattleman of using his steak knife to cut up a vegetarian quiche.

Endscraper from the Paleo Crossing site (CMNH cat # 1725A-02-00-00-01). It was used to cut soft plant material.

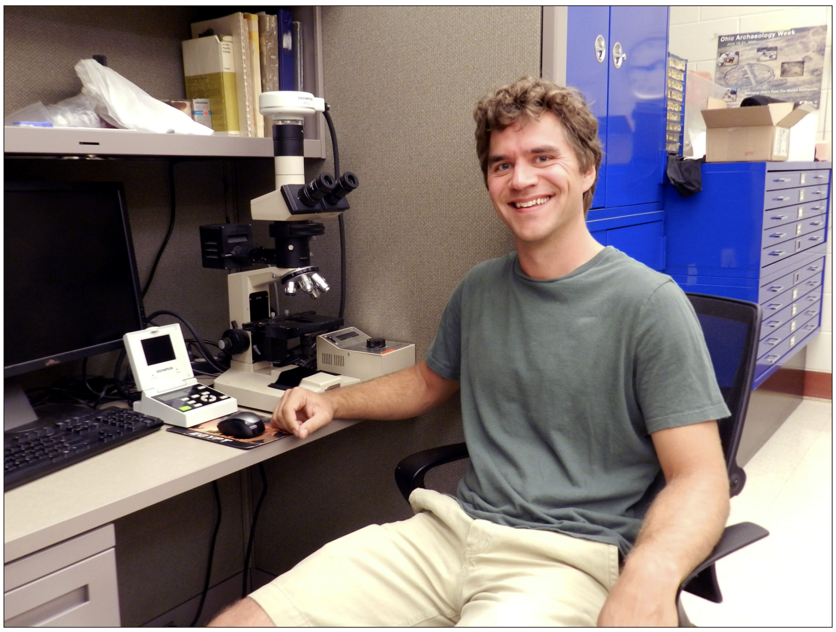
LOGAN MILLER

If this were the only instance Miller found of a tool made for slaughtering used for mundane kitchen work, then it could be dismissed as an inexplicable mistake or an aberrant example of human carelessness. Other stone tools Miller examined, however, displayed a history of diverse activities, including processing plant material.

The bifacial preform was used to butcher meat. The Clovis blade, on the other hand, showed evidence "highly suggestive" of having been used to cut plant material. Of the four scrapers Miller examined, he found that one was used to scrape hide—surely no surprise there. Another was used to cut meat, a third to scrape bone or possibly antler, but the fourth exhibited "intense plant polish." The retouched flake, actually a graver, had been used to engrave bone or antler. A large unifacial tool showed evidence of having been used in a variety of tasks, including scraping and sawing bone or antler, and cutting hide *and* soft plants. The "hide polish" Miller found on several raised ridges he attributes to the tool's rubbing against the inside of a leather bag in which it was carried.

Stalking the wild asparagus in late-Pleistocene Ohio?

Miller identified a wide range of activities on the very small sample of 10 stone tools from the Paleo Crossing site. Surprisingly, cutting plants was the most common activity he detected. Not so surprisingly, he also found evidence for butchering, working hide, bone or antler, and use as projectile points.



LOGAN MILLER

Miller at his microscope.

Miller's study isn't the first time Paleoindian tools have been put under the microscope, but in almost every case the tools were found to have been used to butcher meat, cut and scrape hides, or work bone or wood. Only at Paleo Crossing is there such a high frequency of plant-cutting tools.

Although Miller candidly admits that he doesn't have an explanation for the intensive plant processing going on here, he notes that "many scenarios could be imagined, all of which would require further testing." He suggests it might indicate "extreme toolstone exhaustion." Since most of the flint used at Paleo Crossing came from more than 600 km away, perhaps the Paleoindians encamped here hadn't yet found a local source and were forced to repeatedly reuse their tools, sometimes for tasks different from that for which they were originally intended.

An alternative explanation he offers is that perhaps the folks at Paleo Crossing were simply taking advantage of an unusually prolific plant resource. The abundance of diverse plants in the kettle bogs near the site would have yielded a rich supply of food and raw materials for craft production greatly exceeding that of other Paleoindian sites so far investigated.

It's also possible, of course, that the seemingly high incidence of plant-cutting tools discovered at Paleo Crossing is a statistical glitch. The small number of artifacts in the sample Miller examined means that the operations he detected may not accurately represent the entire range of activities performed at the site. However, at the Midwestern Archaeological Conference in October, Miller presented the results of microwear analysis of 45 additional artifacts from Paleo Crossing, which showed that 35 had been used as work tools and that 7 of those had been used to process plant material. This high frequency of artifacts used on plants corroborates the results of Miller's pilot study and adds a measure of confidence that his results aren't a statistical accident.

Miller freely concedes that only after further microwear studies of Clovis artifacts at Paleo Crossing and other sites of comparable age across North America will archaeologists be able to assess the significance of the results of his pilot study. Nevertheless, the relative abundance of tools used to process soft plants at Paleo Crossing is intriguing and supports Miller's contention that although "big-game hunting may have drawn inhabitants to Paleo Crossing, the site's proximity to plant resources may have been equally, if not more, important."

At a minimum, Miller's study shows that, at least at Paleo Crossing, Clovis people used projectile points and other stone tools to cut soft plants. Far from being specialized big-game hunting gear, the Clovis toolkit was highly adaptable and could be applied to a diversity of tasks, including apparently dicing a salad.

–Brad Lepper

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Suggested Readings

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Part 1

The Cody Complex

All about bison hunting . . . and much more

MENTION THE CODY COMPLEX to archaeologists gathered around a campfire, and the discussion might sound something like this:

"They're Great Plains bison hunters that date to the late-Paleoindian period, early-Holocene, right?"

"Didn't they have unique toolkits—the Cody knife, Scottsbluff and Eden projectile points?"

"Didn't key sites include Horner, Hell Gap, and Scottsbluff?"

"And weren't there some large bison kills associated with them?"

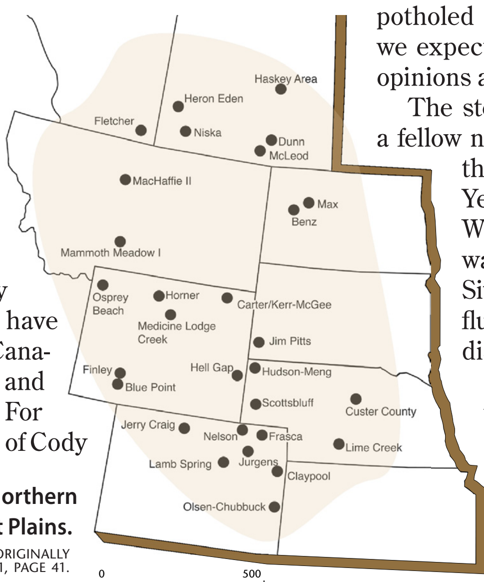
Fragmented perceptions pretty much characterize the results of more than seven decades of site research of a people that roamed the North American continent from about 10,000 to 8600 RCYBP (ca. 11,800–9600 CALYBP). Much of the early archaeological literature labels these people as "Classic" early American bison hunters of the Great Plains, somehow different from their contemporaneous early-Holocene neighbors who inhabited the nearby foothills and mountains. If Cody people are painted as stiff, unimaginative hunters who practiced a simple, unaltering subsistence strategy, the fault with the picture probably lies with earlier archaeologists who focused almost exclusively on excavating bison kill sites and associated butchering areas and campsites.

It fell to a new generation of archaeologists, with new analytical methods and a broader perspective, to plumb the depths of the lifestyle of these hunter-gatherers. A much fuller picture appeared in *Prehistoric Hunter-Gatherers of the High Plains and Rockies,* published by Marcel Kornfeld, George C. Frison, and Mary Lou Larson. Then in 2013 anthropologists Edward Knell and Mark Muñiz edited and published a landmark synthesis of site research titled *Paleoindian Lifeways of the Cody Complex.* To all these recent authors, the importance of the Cody Complex can't be overstated.

For starters, Cody sites aren't isolated to the Great Plains, or to the type site near Cody, Wyoming. Sites firmly linked to the Cody Complex have been found from the central Canadian plains to the Gulf of Mexico and from Nevada to the Great Lakes. For Knell and Muñiz, the vast sweep of Cody sites makes this complex second only to Clovis in geographical expanse and rife with possibilities for future research. Anthropologists Edward Knell of California State University at Fullerton and Mark Muñiz of St. Cloud State University in Minnesota argue that it should be considered one of the most important Paleoindian cultural traditions in North America—despite being generally well known but little understood.

Hill in front of the Very Large Array, Plains of San Augustin, west-central New Mexico, 2006.

MARGARET BECK



Cody Complex sites in the northern and northwestern Great Plains.

MAP AFTER MATTHEW E. HILL. ORIGINALLY PUBLISHED IN *AMERICAN ANTIQUITY* 77:1, PAGE 41.

A culture that resists classifying

Today most archaeologists agree about what constitutes the Cody Complex, but the long road to this happy resolution is potholed with disagreements and arguments, the obstacles we expect to encounter before scientists harboring differing opinions achieve consensus.

The story of the Cody Complex begins in July 1939 when a fellow named Jimmy Allen set out to find arrowheads along the Shoshone River near Sage Creek and to the east of Yellowstone National Park near Cody in Park County, Wyoming. What he found on land owned by Pearl Horner was a vast bison bone bed containing unique stone tools. Situated largely on a terrace about 150 ft above the confluence of Sage Creek and the Shoshone River, Allen's discovery later became the Cody Complex type site.

The site languished without detailed examination until the early 1950s, when archaeologist Glen L. Jepsen excavated the Horner site, as it was then known. In the *Princeton Alumni* weekly of 8 May 1953, Jepsen described the site as a "great butchering ground and perhaps habitation area" rich with the skeletal remains of more than 200 bison, as well as assorted deer, antelope, wolves, rabbits, turtles, and birds. Associated with the bones were found more than 200 stone tools, including projectile points, scrapers, knives, gravers, choppers, awls, rubbing stones, and axes. Radiocarbon dates from the site ranged from 9300 to 8700 RCYBP.

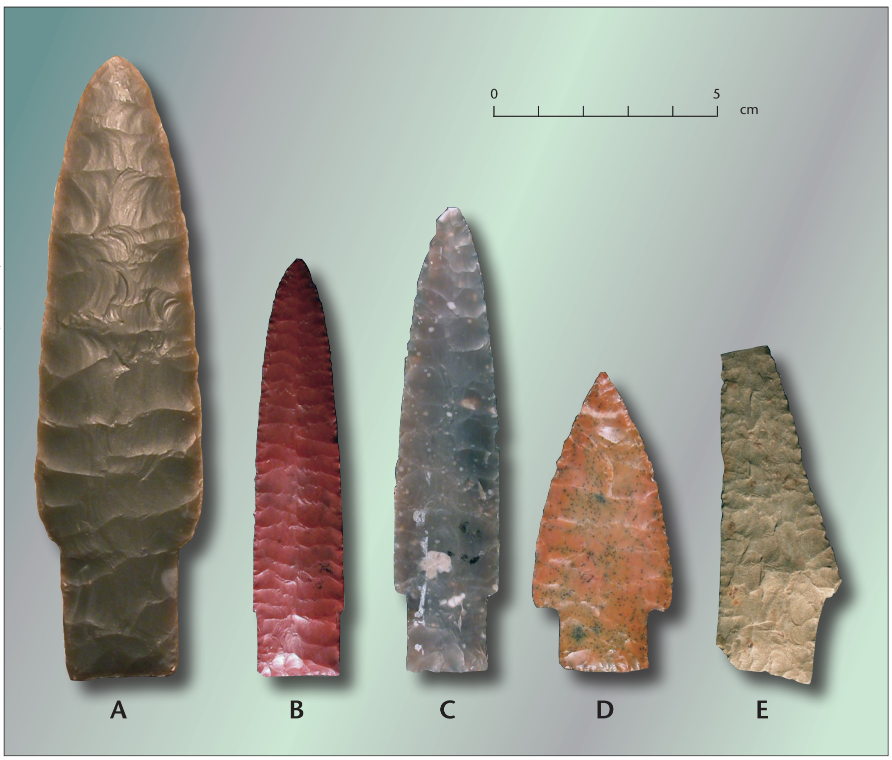
A tangle of names

Jepsen himself coined the term "Cody Complex" because both Eden and Scottsbluff projectile points were found at the site. Academic squabbling soon erupted when similar point types were found elsewhere. Arguments swirled around the definition of terms, particularly "Complex."

Earlier, points of a similar style found in Great Plains sites had been grouped under the broadly defined classification of Yuma point. Labels became awkward when more variations of this style began appearing. For example, varieties of the Yuma point surfaced in the Eden Valley of Wyoming, and a type of point found near Scottsbluff, Nebraska, was called a Scottsbluff Yuma. Unwieldy nomenclature was threatening to become even more complicated until famed archaeologist H. Marie Wormington of the Denver Museum suggested replacing the Yuma type with Eden and Scottsbluff.

Following Wormington's lead, Jepsen suggested in 1951 that the Eden and Scottsbluff points found at the Horner site be considered members of an integral group, the Cody Complex. Wormington soon elaborated on "Complex," suggesting that it be defined as "a group of related traits or activities that combine to form a complete activity, process or cultural unit." She determined that the primary stone tools unearthed at Horner—Eden and Scottsbluff points, and Cody knives—were "hallmark indicators of the Cody Complex." Her definition was widely accepted.

Since then, the waters have been slightly muddied by the type known as the Alberta point, which is generally considered a "distinct yet direct antecedent of the Cody Complex." Drs. Knell and Muñiz adhere firmly to Wormington's definition of the Cody Complex, with the difference that they include the Alberta point, which escaped Wormington's attention. Typical of arguments that inevitably arise when archaeologists congregate, variants of the defining point styles frequently insinuate their way into archaeological roundtable discussions.



AFTER MARK MUÑIZ. ORIGINALLY PUBLISHED IN *AMERICAN ANTIQUITY* 77:1, PAGE 4.

Cody Complex artifacts: A, Alberta point (Hudson-Meng); B, Eden point (Horner I); C, Scottsbluff point, type I (Horner I); D, Scottsbluff point, type II (Horner I); E, Cody knife (Claypool).

The Cody Complex toolkit

Even in academe, fortunately, a rose sometimes remains a rose. Authorities are sufficiently agreed about what constitutes the Cody Complex that we can confidently define the basic stone tools.

Cody knife Although varieties abound, the basic tool has an asymmetrical blade with a square base. It is usually, but not always, stemmed on one side. Use-wear analysis confirms it was a primary butchering tool, which is consistent with its appearance in bison-kill sites.

Scottsbluff point This is a medium to large bifacially flaked point with straight or convex margins and a rectangular stem, which may be straight and extended; shoulders are generally weak and angular.

Eden point This is a narrow-stemmed bifacially flaked lanceolate point with numerous regional variations.

Alberta point Examples of this point from the Hudson-Meng site in Nebraska are large stemmed points with abrupt rounded shoulders, triangular blades, slightly blunted tips, and bases that range from straight to slightly concave; some specimens, finished by well-controlled direct percussion, exhibit regular collateral flake scar patterns that terminate at or near the median ridge; the base, shoulders, and stems were manufactured by pressure flaking, and the margins finished with noninvasive pressure retouch. Most Alberta points from other sites, however, lack this specialized finishing technique.

Points of the Alberta-Cody style, thought to be midway in age between Alberta and Eden/Scottsbluff, have both Alberta and Eden/Scottsbluff morphological attributes.

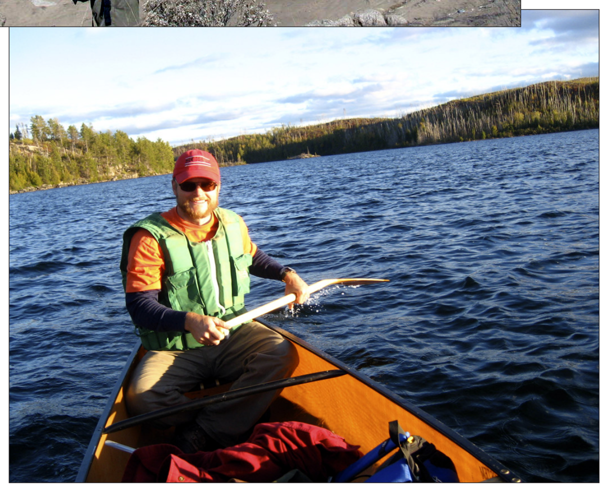
Planning made intelligent use of the land

Research tells us that Cody people didn't simply react to quirks of nature. Quite to the contrary, they displayed wisdom in anticipating the abundance of fall and the hardships of winter. To date, four distinct patterns of land use have emerged.

Some Cody people occupied local regions or "ecozones" for extended periods, sometimes as part of the hunter-gatherer's seasonal rounds. Local toolstone found at such sites as Osprey Beach in Yellowstone National Park, the Hell Gap site in Wyoming, and the Jerry Craig site in Middle Park, Colorado, suggests long-term occupation and possible overwintering.


EMILY GAME

Knell surveying in Hemet, California, 2008. ▲


JENNIFER NORMAN

Muñiz paddling back from field work on the Knife Lake sites, near the Canadian border in Minnesota. ▶

Some groups adapted to variations in resources by selecting areas in the Rocky Mountain foothills for seasonal game hunting. Cold stress may have dictated these choices. Evidence suggests that Cody hunters avoided the high mountains during colder periods and instead exploited biotically diverse areas near the plains.

In times of environmental stress, Cody hunters may have spent more time in marginal environments. The contributors to *Paleoindian Lifeways of the Cody Complex* caution that more study is needed to verify this theory on a region-wide basis.

In the case of High Plains groups, where Cody sites date as old as 10,770 CALYBP, hunters appear to have traveled long distances to converge on bison herds and engage in communal hunts during the fall. This practice is supported by toolstone that had been transported great distances from kill sites. The distance that lithic materials were transported lessens considerably after 9,000 years ago, possibly reflecting the shrinking of High Plains grasslands in response to climate changes.

Thinking hunters were deadly efficient

Conclusions about land-use patterns are, of course, subject to dueling theories and models. Even many aspects of the Cody culture when explored in new ways raise as many questions as they answer.

Take, for example, the long-running debate over how Cody hunters organized and structured their hunts, a topic explored by University of Iowa anthropologist Matt Hill. For much of the 20th century, Dr. Hill reminds us, scientists assumed bison hunting remained unchanged throughout the Paleoindian period: Large communal hunts were staged in late summer or early fall, timed to bag animals at their peak growth and amass a large stockpile of meat to last throughout the winter.

After comparing bison remains from about 30 previously excavated sites and factoring in several environmental variables, however, Hill shattered the one-style-fits-all Paleoindian hunting model. He discovered that bison hunting occurred year round, probably with seasonal and regional variations, thereby maximizing the success of Cody and other Paleoindian hunters. What's more, Hill's data also show that Cody hunters appear to have been a cut above other Paleoindians in their ruthlessness, for they placed greater emphasis on large bison kills and communal hunting than other Paleoindians. MT

–*George Wisner*

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Suggested Readings

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