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NATURAL HISTORY

Vol. 96, No. 9, September 1987

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Toronto: American Publishers Reps. (416) 363-1388

NATURAL HISTORY (ISSN 0028-0712) is
published monthly by the American
Museum of Natural History, Central Park
West at 79th Street, New York, N.Y. 10024.
Subscriptions: \$20.00 a year. In Canada and all
other countries: \$26.00 a year. Second-class
postage paid at New York, N.Y., and at
additional mailing offices. In Canada second-class
postage paid at Windsor, Ontario (permit no. 9579).
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Natural History is indexed in Reader's Guide to
Periodical Literature.

Museum information: (212) 769-5100
Membership and subscription information: Write to
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POSTMASTER: Send address changes to:
Natural History
Post Office Box 5000
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Cover: *A juvenile great gray owl stretches its wings. Photograph by Michael Quinton. Story on page 32.*

The Ginsberg Experiment

Archeology can be bone-breaking work

by Dennis Stanford

The fall of 1975 in northeastern Colorado was especially cold and stormy. Along with other archeologists from the Smithsonian Institution, I was laboring in farm country near Idalia, trying to complete the excavation of a bison killed 10,000 years ago by early hunters. On Halloween night, a telephone call came from Gary North, a heavy-equipment operator working in our vicinity, who told of finding countless mammoth bones while digging an irrigation pit. The brisk early morning found us at the Selby farm, not sure if we should regard this diversion as a trick or a treat. There were indeed mammoth bones aplenty, frozen solid into clay deposits beneath a soil layer we knew to be at least 12,000 years old. Conventional wisdom decreed the site was too old to contain any signs of human presence, but the impending construction work induced us to set aside the bison kill in an effort to salvage the mammoth remains.

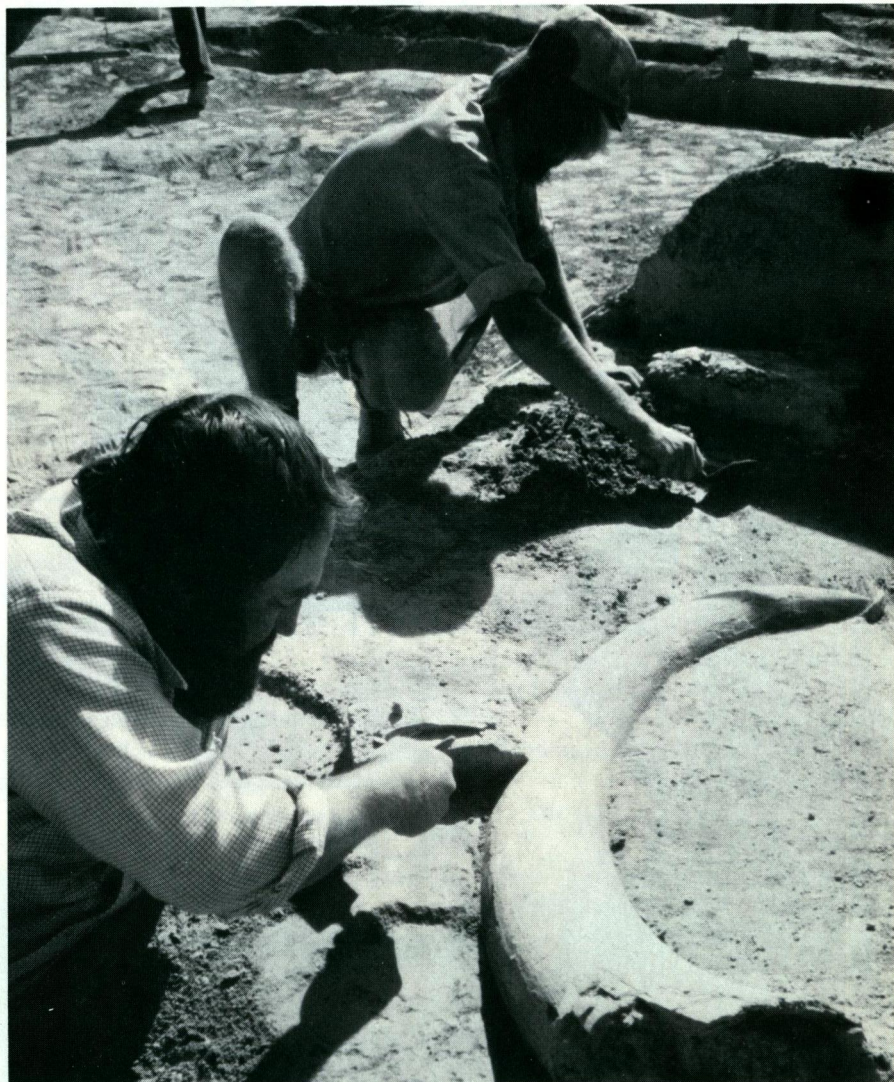
North's work was temporarily discontinued, and he took a similar contract on

rib right next to it. It had been split lengthwise by several blows to its front edge and was beveled at one end to a highly polished point. We could not overlook the possibility that it might be a prehistoric tool.

Further investigation revealed that the stratigraphic horizon that contained the

mammoth jaw and the rib lay beneath an archeological level containing Clovis artifacts, named for a site near Clovis, New Mexico, and thought by most scholars to have been made by the earliest people in North America. These big game hunters manufactured stone spear or dart points that were bifacial (shaped by flaking on

Dale Anderson



This is the eleventh in a series of articles exploring archeological sites and other lines of evidence that bear on the peopling of the New World.

the Dutton farm, just a few miles to the south. Shortly after beginning this second job he stopped by the Selby farm to report that he had encountered more mammoth bones. A brief examination of the new finds indicated that once again the bones were too old to be considered related to human activity. Nevertheless, in an effort to collect some of the better fossil specimens, my crew spent a day following North's massive Terra-Rex scraper, removing bones as they were revealed. An exceptionally fine mammoth jawbone was discovered. While excavating this specimen, we found a portion of a mammoth

The author (foreground) uncovers a mammoth tusk at Colorado's Dutton site

both faces) and had thinned, "fluted" bases, apparently for insertion into the split end of the shaft. Whereas Clovis sites have been radiocarbon dated to about 11,500 years ago, the rib and the animal remains we had found seemed to represent an earlier human presence. The implications were exhilarating!

That evening, as a High Plains norther blew about, we huddled around the heater in our camp, examining the rib. Rumors out of the Canadian Yukon suggested there had been pre-Clovis people who had relied primarily on bone tools (see William N. Irving's article "New Dates from Old Bones," February 1987). We knew, however, that most scholars were skeptical of

the evidence. Thus began the odyssey of the mammoth rib. Carefully packed, it traveled with me to scientific meetings all that winter. A show-and-tell was in store for anyone willing to listen. Although many people questioned whether the rib really originated in a pre-Clovis layer as claimed, all who examined it agreed that it was a tool fashioned by a human being.

To make our case, we needed to find other early tools, preferably some made of stone. In subsequent excavations, mammoth and other animal bones were unearthed whose curving, "spiral" fractures indicated they had been broken shortly after death (drying changes the properties of bone so that it either crumbles or breaks

into roughly rectangular fragments when struck). The mammoth leg bones had definite areas of impact, where hard objects had crashed down upon them with sufficient force to break the massive bone walls. Fragments of these leg bones resembled flint artifacts in the way they had been flaked. Bone flakes were polished as if they had been used. Yet after several field seasons, nothing beyond this possible bone evidence was discovered in the 17,000- to 12,000-year-old pre-Clovis level that established a human presence.

Apart from the absence of stone tools, three questions nagged us: Were Ice Age people capable of breaking and flaking the massive bones of mammoths? Would the resultant flakes have been useful as tools? Could natural phenomena have created similar or identical specimens? To assess human ability to alter mammoth bone, pieces equivalent to those we had discovered had to be replicated by hand. The usefulness of the freshly made tools needed to be tested. And possible natural explanations had to be examined in the field.

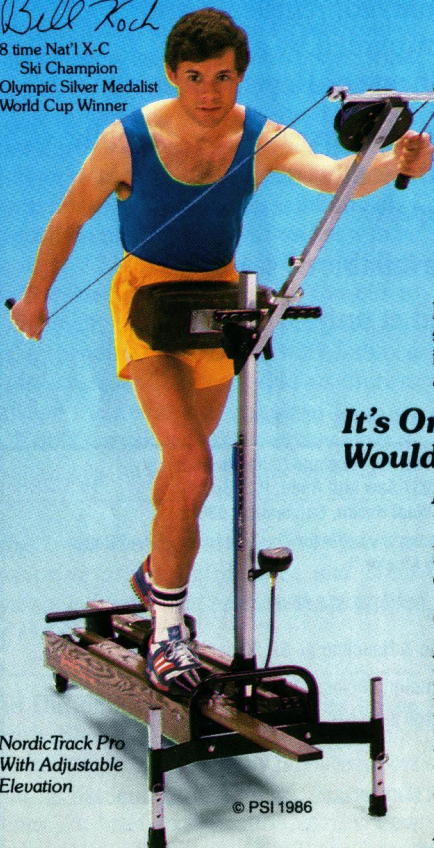
Enter Ginsberg, an African elephant resident in Boston's Franklin Park Zoo. One tragic afternoon in the winter of 1977-78, she died from a cerebral hematoma, brought on by a broken leg. Her body was transported to the National Zoological Park's research station in Front Royal, Virginia, to serve as a substitute mammoth in experimental butchery and bone tool manufacture studies. Because of unusually frigid weather, her remains kept until a research team was assembled and a plan of action devised.

To make the most of this opportunity, experiments were designed to address questions we archeologists had about both Clovis artifacts and our possible pre-Clovis technology. The Clovis problems included testing the effectiveness of replicated Clovis points for penetrating the tough hide. We also wanted to try butchering the elephant using the same points, as well as with a larger type of Clovis artifact. On the pre-Clovis side of the ledger, we sought to break fresh leg bones and test the sharp edges of the resultant fragments as butchering tools. Some leg bones were to be flaked and the sharp flakes used as knives. We were also curious to see if bone projectile points would have sufficed to bring down a mammoth.

Both scholars who favored the idea that pre-Clovis hunters had manufactured and used bone tools and those who discounted our evidence were invited to disassemble the carcass. The more skeptical folks failed to show, but about ten people, including myself, Robson Bonnicksen, and

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several other archeologists adept at flint knapping worked diligently to carry out all the experiments. As we gathered, a light snow dusted the elephant carcass, helping us imagine we were Ice Age hunters. After five days of cold, strenuous work, in which we bloodied our tools and hands, we began to look the part.

Our mock hunting convinced us that both bone and flint projectile points could have caused mortal wounds in a mammoth, especially if propelled by hunters equipped with spear throwers. Admittedly, Ginsberg's remains were semi-frozen and thus we did not re-create a completely natural situation. In fact, for us to have learned the depth of wounds with certainty, only an experiment on a living beast would have sufficed, for skin and flesh immediately change tension and resiliency after death. But we concluded that spears with long, slender bone points or even wooden tips would have made lethal weapons.

Microscopic examination of edge wear on Clovis points had previously suggested they sometimes doubled as butchery tools. Our experiments demonstrated that a Clovis point hafted to a spear's detachable foreshaft makes an excellent knife. The

foreshaft serves as a handle and the edges are extremely durable.

We also tested some large, bifacially flaked ovoid artifacts made of various cherts, replicas patterned after finds from a Clovis cache in Montana known as the Anzick site. These bifaces, which are about eight inches long and two inches thick, were generally regarded as "blanks" for manufacturing the characteristic points, which are two to four inches long and much thinner. Scholars reasoned that the blanks were made at or near the chert quarries, the makers removing most of the superfluous weight so that a larger quantity of useful raw material might be transported long distances, to be completed into finished tools when needed.

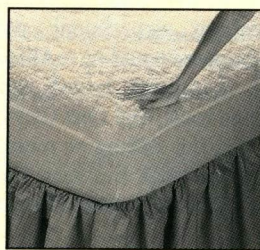
When our experimental bifaces were hafted to handles, however, we found that they were excellent butchery tools in themselves, better in fact than the Clovis points. Their long, sinuous edges cut more rapidly and with comparatively little effort. The edges were remarkably durable and required little maintenance. Usually the butcher wore out before the tool; often all that was required to revitalize an edge was a change of personnel.

Epoxy casts were made of these bifaces before and after they were resharpened so that the edge wear and attrition could be tracked. We also photographed them under a ballistics microscope. These records, coupled with recordings made by computer plotters wired to the tools during use, have provided controlled data for wear-pattern studies.

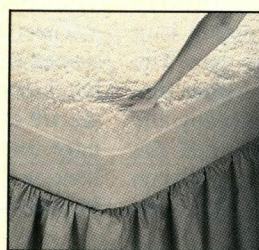
The only complete examples of the larger bifaces are from Anzick and from a site in Idaho. Both collections are caches consisting of numerous bifaces, Clovis points, and other artifacts. A few incomplete examples have been found at other Clovis sites. Why are these tools so rare if they function so well? Probably because they were used as cutting tools and as raw material stock until they became small and thin enough to be converted into projectile points. Thin flakes were removed when needed for making other tools, such as scrapers and graters. Once the remainder was fluted and rehafted, its usefulness continued in a dual capacity as both projectile point and knife. This economy and versatility were especially important to hunters who traveled on foot, carrying their tool kits with them.

During testing of the Clovis artifact

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replicas, one of Ginsberg's leg bones was finally exposed. The periosteum, a membrane tissue, was scraped off so the leg would break more easily, but the bone remained attached to the carcass. As we watched with anticipation, Robson Bonnichsen lifted a twenty-one-pound stone high overhead and threw it down onto the leg. The tough bone did not break. Bonnichsen tried again and again, and at last, on the fifth blow, the bone broke into three pieces. As our cheers echoed down the Shenandoah Valley, we quickly examined the spiral fractures and the impact depression: they were identical to those present on the Dutton and Selby specimens.

A sharp bone fragment was used to chip out the inner tissue from the leg bone. This tissue resembles a honeycomb and contains highly nutritious marrow. When it is heated, it yields large amounts of buttery fat. Present-day elephant hunters in Africa extract elephant bone marrow in a similar way, but with metal tools. The bone we used as a tool developed a highly worn and polished point, similar to the pointed rib from the Dutton site.

The next stage of the experiment required flaking the bone to produce sharp knives. First a piece of bone was shaped, as a flint knapper would a stone core, so that it had a flat striking platform on top. Then the bone was struck on this platform with an elk antler baton to remove long thin flakes from the side of the core. The flakes came off easily and in shapes that resembled flint flakes. Occasionally the blow was not forceful enough, and the resultant flake broke off, leaving a step on the core. Subsequent flakes could not be

driven beyond that step; the same problem arises with stone work. Thus, the bone core had to be "cleared" by taking off an extra large flake that removed the step fracture. Then, once again, useful bone flakes could be produced.

The bone flakes were extremely sharp and with some effort functioned very well as cutting tools. Their edges didn't last as long as those of stone tools, however, and they could only be resharpened by grinding. Grinding is a time-consuming process, so anyone using such a tool would presumably manufacture another instead.

Why, if bone tools were less efficient than stone tools, would prehistoric people have manufactured them? There are several possible reasons. Early immigrants to the New World would not have been familiar with suitable flint sources, thus they would have placed a premium on materials in hand. Bone may also have been a standby during winter, when stone sources were covered with snow and frozen in the ground. More important, a bone tool is more durable when twisting or prying tasks are to be performed. Stone tools break immediately when subjected to these stresses. Eskimos know this and have a flexible tool kit containing both bone and stone knives. I suspect that if pre-Clovis peoples were present in the New World, they made use of both raw materials.

The Ginsberg experiment demonstrated that humans could have killed and butchered a mammoth largely without the aid of stone tools, and that they could have controlled the flaking of mammoth bone as a raw material. But were the prehistoric bone "artifacts" from Dutton and

Selby actually produced by human beings? To address this question, Gary Haynes, in Zimbabwe's Hwange National Park, investigated how carnivores and scavengers altered elephant bones and how bones in various states of preservation were affected by animal trampling and other natural events. (An article by Gary Haynes, "Where Elephants Die," appeared in the June 1987 issue of *Natural History*.) Haynes's work has demonstrated that much of the evidence formerly considered a sign of human handiwork is mimicked by a variety of natural causes. Spiral fractures, for example, may result from gnawing or trampling.

Haynes has similarly studied the condition and distribution of recently deposited mammal bones in undisturbed wilderness areas of northern North America. In addition to the effects on bones of hunting and feeding by timber wolves and brown bears and of trampling and wallowing by moose and bison, he has considered the effects of turbulent streams, soil pressure, and freezing and thawing. As a result of his work we can no longer assume that apparent impact scars, flaking, localized abrasion and polishing, or unequal dispersal of skeletal parts is a result of human activity. But to date, Haynes has not reported finding any examples of bone cores. So far, therefore, the bone cores we have found continue to confirm human workmanship.

The distribution of the bones at the Selby and Dutton sites is similar to what we expect would accumulate around watering holes, where animals might be killed by carnivores or die from other natural causes. In addition to mammoth bones, we have found the remains of horses, bison, camels, sloths, peccaries, and some smaller mammals. Some of the animals were apparently devoured by four-legged carnivores, but some may have been killed or scavenged by humans, and perhaps the remains of these meals were cleaned up by other scavengers. When the damage produced by natural events is superimposed on bone butchered and discarded by people, sorting out the causes and sequences of bone modification is difficult, perhaps impossible.

Bone flaking seems to have been a technological tradition in the Old World since early Stone Age times, and flaked mammoth bones are found at most of the major Clovis sites. The absence of stone tools, however, continues to cloud the interpretation of the Dutton and Selby sites. Today, we are not certain that even our original mammoth rib was used by a prehistoric hunter. In the process of being enlightened, we have become more cautious; but the odyssey will continue. □



Using a baton of elk antler (at top), a participant in the Ginsberg experiment flakes elephant bone.

Smithsonian Institution