MAMMOTH TRUMPET

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BLOOD WILL TELL

One of the most promising innovations in recent archaeology is the analysis of blood residue on stone tools. Within the last ten years, researchers have discovered that traces of animal blood may sometimes cling with surprising tenacity to the nooks and crannies of artifacts, even those that have been thoroughly cleaned and prepared for exhibition. Although frequently invisible and existing only in minute quantities in fissures in the stone, enough blood residue may nevertheless survive to be analyzed biochemically.

Recently, the Cultural Resource Management Program (CRMP) of the University of Pittsburgh, a program designed to assist graduate students by providing them with research work performed on a contractual basis, has been working to perfect a technique for recovering and analyzing blood residue through an enzyme immunoassay procedure. This procedure allows blood to be distinguished from other residues removed from an artifact. It is, furthermore, increasingly allowing the blood of different animal species to be distinguished via the application of particular blood antibodies.

Under the supervision of Dr. Jim Adovasio, Professor of Anthropology at the University of Pittsburgh, the technique was developed by graduate student Jean Tersak working through CRMP. When Tersak moved on, David Hyland, another graduate student, took over the project as part of his research assistantship, gradually refining the technique. Hyland and Adovasio together describe the process, along with its history and its considerable prospects for the future.

"There have been extensive studies of edgewear on lithic tools for the better part of the last 20-25 years that have been designed to identify the function of one or another kind of implement from the sort of diagnostic wear that was produced in that implement," Adovasio observes. "Usually, the attempts have been via replicative experiments combined with high-power optical and scanning microscopy. Unfortunately, even though there are frequently very close similarities in the wear patterns generated on the implements in experimental situations and the wear patterns observed on stone tools from archaeological sites, you can never be altogether certain that the experimentally-generated and the empirically-observed sets of wear patterns are in fact representative of the same activity, although there is good congruence in many instances.

"Conceivably you could have everything from mastodon-sized animals all the way down to field mice."

"Some time ago, a number of scholars began to approach this issue from a different avenue. In the case of items suspected of having been used in the processing of animal materials, they tried to detect the presence of blood, and then attempted by various means to identify that blood. Dave Hyland and Jean Tersak have been working on a system which seems to have a high degree of promise and which, if it can be replicated over and over again with artifacts from various contexts, gives us the chance of gaining insight into the sorts of animals that were being exploited at particular sites."

This technique also promises to provide important information on the types of artifacts used for animal processing, along with the actual manner of employment. In addition, the procedure may help identify certain artifacts of unknown function. Some objects recovered from sites, although exhibiting clear-

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THE WACO MAMMOTH SITE

The herd matriarch, alerted by the screams of the juvenile, rushed anxiously to the side of the young animal. Placing her six-foot long tusks beneath the inert form, the female began frantically attempting to lift the troubled calf. The single male, who had joined the herd a few days ago, moved quickly into position to help. Already, however, it was too late. As the rest of the herd watched in terror, the matriarch collapsed, followed by the male. The second-ranked female, attempting to restore order, also went down. One by one, the rest of the herd died. After a while only the wind and rapidly rising flood waters remained as witnesses to the chaos that had taken place.

Within a short period of time, the partially submerged carcasses were silted over, covered by sediment carried in the flood waters of the Pleistocene river. In a few months, all evidence of the catastrophe had vanished, obscured in time for some 28,000 years.

This is one scenario reconstructed by archaeologists excavating the Waco Mammoth site in central Texas. Located within the city limits of Waco, the site was situated during the Pleistocene near the confluence of two major rivers, the Brazos and the Bosque.

The event, however, was not discovered until early 1978, when two neighborhood boys noticed large bones eroding out of a nearby gully. The find was reported to David Lintz of the Strecker Museum at Baylor University in Waco, who conducted initial excavations at the site from 1978 to 1982. During this period, evidence of six mammoth skeletons was unearthed. Investigations resumed in 1984, when Calvin B. Smith, newly appointed Director of the Strecker Museum, Lintz, and John W. Fox, Associate Professor of Anthropology at Baylor University, began uncovering the remaining members of the mammoth herd, using an archaeological approach. Together, the two excavations have resulted in the discovery of 15 animals; possibly the largest concentration of mammoths that died in the same episode ever recovered.

Ernest Lundelius, a paleontologist at the University of Texas, has identified the specimens as *Mammuthus columbi,* or Columbian mammoths. Although Lundelius' designation is accepted, researchers are somewhat puzzled at the relatively small size of the Waco individuals. Fox and Smith suggest the small size may be a manifestation of sexual dimorphism. Similar to modern elephants, who exhibit this trait, it is possible that female Columbian mammoths were considerably smaller than their male counterparts. In contrast to the Hot Springs Mammoth site in South Dakota, which is comprised primarily of adolescent males, the Waco mammoth herd is a female and juvenile dominated group. Measurements taken on the sole possible male reveal an individual about 20% larger than the next largest animal in the herd.

Down in the trenches with Calvin Smith (left), Director of the Strecker Museum, and John Fox (right) of Baylor University, principal investigators at the Waco Mammoth site. (*Photo courtesy of John Fox*).

The Waco Mammoth site is particularly significant in that it appears to contain an entire herd of Columbian mammoths which seem to have died simultaneously in a single catastrophic episode. Startling, certainly. But significant?

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INSIDE . . . .

CENTER NEWS

WORLD SUMMIT CONFERENCE on THE PEOPLING OF THE AMERICAS

China, Japan, the Soviet Union and seven Latin American countries, as well as Canada and the United States, will be represented by archaeological experts at a World Summit Conference on the Peopling of the Americas, scheduled for May 24-28, 1989 at the University of Maine.

The purpose of this conference, sponsored by the Center for the Study of Early Man, is to examine the current status of research on the earliest peopling of the Americas and to plan for the future of this research into the 21st century.

The 40 presenters for the five-day event have been asked to also bring key artifacts from some of the earliest known sites for public exhibit in the University of Maine's Hudson Museum. A special workshop will be held for invited scientists to examine the collected artifacts with some of the latest analytical tools available.

The Center for the Study of Early Man will demonstrate its video digital imaging system, a state-of-the-art technique that allows exact measurements of artifacts to be recorded and analyzed by computer.

More detailed registration information will be mailed in September 1988 and will be announced in future issues of the **Trumpet.** For more information and registration materials, contact Conferences and Institutes Division, Chadbourne Hall, University of Maine, Orono, ME 04469 USA. Phone 207/581-4092.

EARLY HUMAN SITES IN SOUTH AMERICA

Some of the earliest evidence for human occupation in the Americas is being discovered in South America. This past March, as director of the Center for the Study of Early Man, I led a trip to four Latin American countries to examine potentially early sites and recovered material. The Center's visiting delegation included Mort Turner, Quaternary geologist, Everett Long, Center Advisory Board member, and Anne Stanaway, film producer and Center Advisory Board member.

Niede Guidon met our group at the small village of Sao Raimundo Nonato in northeastern Brazil near Toca do Boqueirao da Pedra Furada, a deeply stratified rockshelter. Ongoing excavations there extend 5.5 meters below the surface, exposing a stratified sequence of pebble and flake tools and associated hearths with charcoal. Twenty-one consecutive radiocarbon dates now exist; the oldest date, 40,000 yrs B.P., was derived from a charcoal sample 4 meters

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CURRENT RESEARCH IN THE PLEISTOCENE VOLUME 5, 1988

The new issue of **Current Research in the Pleistocene (CRP)** is now in press and will be sent to prepaid subscribers in July. Fifty-two articles report ongoing research in a suite of disciplines, all contributing to a more complete understanding of the earliest peopling of the Americas and of the world in which those events occured. Topics include: archaeology, lithic studies, methods, and paleoenvironments (plants, invertebrates, vertebrates, and geosciences). This issue's special focus is bone modification. Many papers have accompanying figures, and the entire volume is indexed by subject, author, and the geographical region where research took place.

CRP is increasingly being recognized as an important resource; subscriptions by libraries have increased steadily. **CRP** is now indexed in Abstracts in Anthropology, Anthropological Index to Current Periodicals, and Anthropological Literature, making the information readily available to researchers, scholars, and others interested in keeping abreast of the most recent information from the field.

Prepaid subscribers will automatically receive **CRP** 5. If you have a prepaid subscription and have since changed your address, please notify us of the new address by July 1. **CRP** will not be forwarded by the post office.

Prepaid subscriptions at last year's price of $17 will be accepted through July 1, 1988. After July 1, the price for Volume 5 and prepaid subscriptions for Volume 6 will increase to $20. See ad on page 7 for complete subscription information.

ANOTHER CONTEST?

It's been almost two years since our limerick contest, and it seemed that it would be a good idea to once again do something in a similar vein. This is an "Identify that Quote" contest. The rules appear below. You could enter just for fun, but the first prize is also worth going for. The winner of this contest will receive a free ticket to attend the gala banquet that will be part of the World Summit Conference on the Peopling of the Americas to be held in Orono, Maine in May, 1989—or a free Pleisto-Scenes sweatshirt if they do not plan to attend the Conference. See the article on page 2 for more information about the Conference.

A quote contest? When we put the **Trumpet** together, we get the typesetter to set several "pull-quotes" (the italicized quotes set off in the text) for each feature article. Then we use the quotes that fit best, both physically and philosophically, in the final layout. The extras get stuck up on a bulletin board "just in case." In case we want to have a pull-quote identification contest, of course.

Looking at the accumulated quotes out of context has become an amusing distraction for those who stray into this office. Most people reading the assemblage have sniggered, made colorful comments and eventually said, "Which article is *this* one from?" Hmmm....

We have tried to keep this contest fairly reasonable by using quotes that have some (possibly obscure) reference to the main subject of the article in which they originally appeared. But some are tricky. And some are from way back in Volume 1. If you can't find or never had the older issues, you can buy back issues from us for $3 each or $10 per volume. Simply write and tell us which issue(s) you want and where to send them, enclosing proper payment.

The rules are simple. Correctly identify the source of the quote by article title (or a recognizable approximation), or by volume, issue, and page number of the **Mammoth Trumpet** on which the quote appeared. The winner is the person who correctly identifies the most quotes. If more than one person correctly identifies all 14 quotes, the winner will be determined by a random drawing among all correct entries. All entries must be received at the Center for the Study of Early Man, 495 College Ave., Orono, ME 04473, no later than August 15, 1988 to be considered for the prize. But we welcome responses any time.

Have fun. It's hard to keep a good quote down.

1. "There is clear evidence that they were going a fair distance to bring in these plant parts, none of them natural to the site, about half of them occurring at the coast."
2. "There is no necessary correlation between the size of an artifact and what it was used on."
3. "How does one go about killing an elephant with a Clovis weapon? Answer: Carefully, very carefully."
4. "Even today, the reluctance to discuss 'soft' issues, the big-picture, humanistic issues, derives I think from a kind of *machismo*: to do so would not be scientific."
5. "This kind of patterning does not happen accidentally; it had to be built according to the master plan, or it might break some sort of ritual taboo."
6. "In addition to 'when,' these researchers are also using dung analysis to explore 'why' so many of the Pleistocene megafauna became extinct."
7. "Is it a floor, or is it merely a surface?"
8. "It takes a while to convince yourself that you have actually dug up elephant tusks out of your front yard in the middle of Washington state."
9. "It inspired me to think that ancient materials might still have some of the most stable enzymes."
10. "I think it's going to be one of the Paleoindian treasure chests of North America. It's been setting here for 12,000 years and is just waiting to be unlocked...."
11. "There are some things an anthropologist simply knows by feeling it in his bones."
12. "Rock varnish accretes on rocks in virtually every terrestrial climate and environment."
13. "Even were there to be conclusive proof that the corridor was open almost all the time throughout the last Wisconsin glaciation, I question how passable it would have been—particularly given that any individuals who tried to cross through it would not necessarily know that there was something at the other end."
14. "When I tell you something, you shouldn't necessarily believe me, but you should think about what I say."

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NEEDLE IN A HAYSTACK?

Presented with suggestive faunal remains and a highly equivocal lithic assemblage, what constitutes an early artifact? That is the question David Nash has been asking since excavating Haystack Cave, a small cavern located in Western Colorado. Similar to the 500-watt halogen lights used by Nash in the cave, Nash's investigations promise to shed light on this question, while raising many more.

Situated at an elevation of 2,450 meters, Haystack Cave is located on Haystack Mesa in the Gunnison River Basin. The cave, which measures approximately 2.5 meters in diameter by over 25 meters in length, was first recorded by Harold and Betty Husher during a survey for the Colorado Museum of Natural History in 1939. Upon finding apparent artifacts, charcoal, ash, and bone remains, in conjunction with the presence of Jasper veins, the couple concluded Haystack may have been used as a jasper mine.

The cave was reidentified during a 1976 survey of the Curecanti Recreation Area by the Midwest Archaeological Center of Lincoln, Nebraska. A one meter by two meter test pit, excavated to determine the cave's cultural significance, resulted in the recovery of 612 possible cultural artifacts and approximately 1,500 bone remains—some of the fauna clearly Pleistocene in age. Two dates in excess of 12,000 yrs B.P. were obtained.

David Nash heard of and later visited Haystack Cave. Intrigued by the materials contained in the cramped, tube-shaped chamber, the University of New Mexico doctoral candidate decided to investigate the specific possibility of a pre-Clovis occupation. More

Excavating 10 millenia of sediments in the narrow confines of Haystack Cave.

generally, he also saw Haystack Cave as a promising opportunity to focus on formation processes that modify rock within a cave environment, particularly those which create "natural" artifacts or geofacts—lithic materials resulting from natural geologic events that mimic those manufactured by humans.

Haystack Cave is relatively small, but Nash's project is quite complex. Travelling back 28 million years in time to when the cave was formed, he speculates that "as the ash-flow travelled across the landscape, it came in contact with a source of water vapor, such as a lake or a stream. The hot ash evaporated the water and the steam rose as a bubble. . . . The cave itself resulted from the steam bubble trapped inside the cooling ash-flow sheet known in this hardened state as welded tuff. As time went on, erosion dissected the ash deposits eventually exposing the mouth of the cave. Possible artifactual materials collected prior to Nash's involvement were either flakes of this welded tuff or of jasper.

Assisted financially by the National Science Foundation, the Louis Leakey Foundation, and Colorado State University, Nash reopened and expanded the test pit excavated by the Midwest Archaeological Center. In addition to tuff and jasper flakes, Nash collected approximately 200 pebbles and cobbles, ranging in size from 2 mm to 20 cm in diameter, comprised of basalt, andesite, and quartzite. Though many of these cobbles show no evidence of modification, some appear to be edge-battered, polished, or to have had flakes removed. Others seem to be fire-cracked. One cobble exhibits definite red ochre staining; unfortunately it was retrieved from the backfill of a previous excavation, and therefore cannot be assigned to any particular stratum.

Haystack Cave was formed when a large bubble of steam was trapped in the volcanic ash flow that solidified to form the surrounding cliffs. The erosion that exposed the bubble/cave has also gradually filled much of the interior with sediments and other lithic debris. (*Photo courtesy of David Nash*).

An impressive array of faunal remains were recovered from the excavation. With between five to ten percent of the bones examined, comparative analysis reveals at least 40 different species. Although most of the bones are from small mammals, other identified animals include reptile, fish, bird, weasel, fox, coyote, puma, bobcat, American cheetah, bear, antelope, deer, bighorn sheep, bison, Pleistocene horse, and an extinct ovibovine.

"Peculiar bone breakage patterns" have been noted, primarily among the remains of the larger species. In contrast to the small species bones, which are typically unbroken, the bones of these larger animals are frequently fragmented. Bone element percentages also vary according to animal size. Although bones of the smaller animals generally include all elements, lower leg portions tend to dominate the large mammal remains. "This patterning," comments Nash, "is usually suggestive of scavenging, either by humans or animals." Nash observes that possible cutmarks, spiral breaks, and polish characterize some specimens, but emphasizes further research is necessary to determine the causes responsible for this damage.

Jasper flakes and cobbles recovered from varying depths of Haystack Cave. Note the ochre spot on the far left cobble. (*All shown actual size*).

Some breakage, for example, has already been determined as being caused by animal trampling or rocks breaking off (or spalling) from the cave ceiling and walls.

Two radiocarbon dates of 14,935 ± 610 yrs B.P. and 12,154 ± 1,700 yrs B.P. were obtained by the Midwest Archaeological Center from bone apatite. Although bone apatite often produces erroneous dates, Nash suggests the former date is "about right" in relation to the stratigraphic position of the extinct Pleistocene fauna. Bone samples collected by Nash unfortunately lacked enough collagen to produce reliable dates.

Though willing to call only a few of the items found in the cave definitely cultural, Nash believes there has been some early human activity in Haystack. He postulates that the cave may have been an early mine, a hypothesis prompted by the rich source of jasper contained in the cave. The larger cobbles and presence of jasper flakes that appear to have been heat treated (potentially from fires used to help extract it) are particularly suggestive.

Nash is the first to admit Haystack Cave is a poor candidate for a verifiable pre-Clovis site, at least according to criteria set forth by researchers involved in the search for an unequivocal pre-Clovis site. Yielding no consistent or reliable radiocarbon dates, no definite artifacts in direct association with dates, and lacking a distinct stratigraphy, Haystack is the type of archaeological quagmire many researchers would prefer to avoid. Nash, however, observes that "instead of trying to dismiss the sites that don't meet these criteria, we need to develop methods and research goals which will eliminate the ambiguities implicit in such sites."

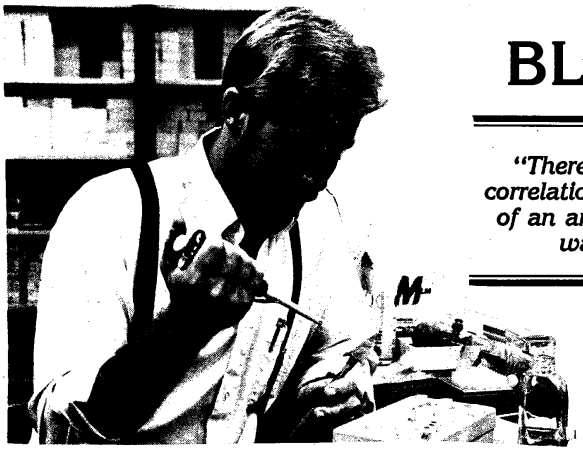
Natural events, such as spalling, frequently result in material that appears to be produced by humans. The likelihood of this happening at Haystack is high. "The floor is pretty cluttered," comments Nash, "resulting in an overlap of spatial patterns caused by different agents acting in the same area of the cave." Spalling, trampling by animals, and the use of the cave by a variety of carnivores and rodents are three possible agents affecting the bone and stone assemblages.

As a means of separating geological processes from cultural ones, Nash has begun conducting experimental work regarding the production of geofacts. How far, for instance, does a rock have to fall to simulate the fracture patterns typical of the Haystack Cave lithics? What type of material? What weight? Should flakes be expected, or a lot of shatter?

As Nash continues his investigation into cave formation processes, the question remains: Does Haystack Cave contain a pre-Clovis site? The excellent shelter and solar exposure, good tool-making materials, and strategic position for monitoring game movement make it an ideal location for a site, although the small size of the cave would limit the activities that could be carried out there. Nash stresses anything postulated thus far is strictly tentative. "My gut feeling is that the ochre-stained cobble and some of the other lithics are cultural, some came in via animals, and some we just don't know about. If a pre-Clovis occupation did occur at Haystack Cave, this may be an important clue as to the type of site and technology we should be searching for elsewhere."

—*Mark Petersen*

BLOOD WILL TELL



Dave Hylan (left) demonstrates the technique used to dissolve and reclaim ancient residues from artifacts. The dart he is holding (shown below), from Fat Burro Cave in northern Mexico, was cleaned and on display at the Smithsonian Museum of Natural History for 40 years before being examined by the CRMP group and found to still have identifiable residue on the wooden shaft.

(Photo courtesy of Dave Hyland).

"There is no necessary correlation between the size of an artifact and what it was used on."

(Continued from page 1)

ly defined formal characteristics, are nonetheless enigmatic. The presence of blood on them not only confirms that they are indeed artifacts but suggests at least one probable use. Finally, says Adovasio, "We may be able to make certain kinds of environmental and local climatic inferences about which areas were being exploited, and about the local climatic regime."

For details of the technique itself, Adovasio turns the conversation over to David Hyland. "The history of determining blood antigen residues on stone tools is fairly recent," Hyland comments. Indeed, it does not go back much further than a decade.

"Our method involves an immunoassay procedure, something that has been used extensively in molecular biological research to distinguish different types of proteins. It's a simple system and we merely have modified it, since we're trying to identify species instead of isolate a particular protein or enzyme.

"First, we suspend any residue that might be on a stone tool in a saline buffered solution. To do that, a small amount of the solution, on the order of 100 microliters, is drawn into a pipette. We then pipette the solution into the stone tool where we think the residue might be. Because you can't see the residue, you just have to go around the edge of the tool, working the solution into any likely-looking nooks and crannies. That washing solution is then tested for the presence of blood through the utilization of a common indicator used in urinalysis, a paper strip which changes color somewhat like a pH strip. If we get a color change, it may indicate the presence of blood. Although a color change may also occur in the presence of chlorophyll and other environmental contaminants, this doesn't concern us too much because those can be ruled out during the next step. So for the time being, we treat all color changes as being positive due to blood. The solution is then retracted into the pipette and transferred to a small sample tube, which we can refrigerate and process later. Unfortunately, the amount of residue-suspending solution acquired is usually so small that we can only do one, possibly two tests with it.

"After we have the residues suspended and tested for blood, we go on to the next step, the actual species identification. This utilizes a nitrocellulose membrane, something that looks like a little piece of plasticized paper, that has an affinity for proteins; proteins will bind directly to it. The membrane is inserted into a microfiltrate apparatus which is only about 4 by 5 inches across and one inch tall. The top contains 96 very small cells; between it and the base is a plastic membrane to prevent leakage. We place one of the nitrocellulose membranes between the top and base sections to act as a filter in this flow-through device. Liquids drain through it from each of the 96 cells, which are segregated and will not leak into one another. At the base is a manifold that collects all the residual solution that leached through the membrane.

"We put 100 microliters, if we have that much, into each of the cells; one sample from one tool is put into each cell. Then we let gravity take its course, leaving it for about 45 minutes to an hour to allow the proteins in the blood to bind to the membrane.

"The next step is to block any protein-binding sites on the membrane that have not been occupied by a blood protein residue from the original washing solution, because the antibodies, which are applied next, could possibly bind to them. Besides the blood, there might also be some nonspecific proteins capable of binding to the membrane and obscuring the results. So we apply a blocking solution, a protein made of nonfat dry milk. That takes another 45 minutes or so.

"The 'primary antibody' is then added, 'primary' meaning of the species that we think might be represented by the blood residue now bound to the membrane. Working up faunal studies from other findings at an archaeological site is really the first step in this procedure because we need to know exactly what animals we're testing for. This is critically important because the small quantity of sample solution is enough for only one test. So we need to have an educated guess as to what animal we should test for. And this guess is based on a knowledge of the predominant animals in the locality we're working from."

Making an educated guess is anything but easy; common sense assumptions could turn out to be only misleading oversimplifications. As Adovasio points out, "We have this preconception that big Clovis projectile points were used to take big animals. So you find one at, say, the Shoop Paleoindian locality [in central Pennsylvania] and you sit down and say, 'What are the big animals that would have been around?'

"Yet," he continues, "there is no necessary correlation between the size of an artifact and what it was used on. Some of the Clovis projectile points from Blackwater Draw are tiny, yet they were probably associated directly with the taking of mammoth. Likewise, we have this jargon that we use for the Northeast woodlands: that this or that looks like the size of projectile point you'd use on a bird—and we find those kind of points stuck in deer." In northern Mexico, source of another artifact analyzed by Adovasio's team, "We know that the biggest prehistoric animal reported from the time the tool comes from was the occasional bison that strayed down from Texas. But because the desert Archaic Indians ate everything they could get their hands on, and probably didn't have artifacts that were species-specific, they could have used that point to take a vole, for all we know. Thus, depending on what the dating of the Shoop site turns out to be, conceivably you could have everything from mastodon-sized animals all the way down to field mice.

"Nevertheless," Adovasio explains, "we just don't have enough residue from any one of these items to check the full spectrum of the Pleistocene bestiary of the area. So we end up saying, 'All right, let's use common sense here. We suspect that it isn't mastodon; the site's a little too late by conventional wisdom. What's the next biggest set of animals that should be around?' Well, it would be the elk-deer-moose-caribou family, and that's turned out to be a pretty good guess. But other times we find out that it's blood, but we can't identify the animal; and that's simply what we're stuck with."

Supposing that the decision made is to test for deer, the primary antibody is then produced by injecting some animal—generally a rabbit—with deer serum. Hyland takes up the account again: "The animal would then create antibodies against that deer blood; so now we have an anti-deer antibody." Although the research group does not manufacture its own antibodies, obtaining them instead from various biochemical manufacturers, this is how the antibodies are originally derived.

"If we suspect deer blood in the sample solution," Hyland goes on, "we would then pipette 100 microliters of anti-deer antibody into each of the cells of the microfiltration apparatus containing the sample solution. The antibodies will match up with the deer protein; so now we have deer antibodies conjugated to the blood residue.

"Next, we apply a secondary antibody. The secondary antibody is important because it has an enzyme conjugated to it which allows us, through a chemical reaction, to "develop" the membrane over a period of 15-30 minutes, so that a purplish color will appear when we have a positive residue-antibody reaction. The secondary antibody amplifies the reaction as well. Since we have a rabbit anti-deer primary antibody, we need to have an anti-rabbit secondary antibody to link to it. There are various washing steps, with detergents mixed in, which provide for better sensitivity throughout the procedure."

Deer blood has been the primary substance tested for so far. In order to discriminate between blood of deer and that of closely-related species such as caribou, elk, or moose, an antibody against just the red blood cell itself must be used, rather than antibodies produced against the whole blood sera. "Mammals have many antigenic sites in common," Hyland explains: "if you applied an antibody from deer to human blood you would get some reaction, as there are many sites held in common." The research group is currently attempting to refine the subtlety of the technique, magnifying its sensitivity to differences between the blood of various genera and species by utilizing artifacts from the Shoop site. It is an appropriate choice, as the place and time frame, directly post-Pleistocene (about 11,000 years ago), suggest that there were caribou in the area, not deer. "To date, the solitary "hit" on artifact residue from the Shoop site is on an end uniface, or end scraper, a dominant tool type at the site.

"Studies of this class often have led those doing the studies to speculate that the item in question was some kind of woodworking device," Adovasio notes, "and it may well, at some stage in its career, have been so used. But because there is blood residue on it, we know that it obviously served another function as well. Also, the fact that this thing has been sitting around, cleaned and scrubbed down, for a long time underscores the implication that even with exceptionally vitreous items there still exist enough places where even attentive cleaning allows for the continued presence of residue over at least 10,000 years. What we may be getting on items used as scraping tools is some of the blood bonding to fat, and the fat resisting the effects of water and cleaning.

"As a matter of fact," Hyland adds, "one of the tools we tested not too long ago had been in the

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THE WACO MAMMOTH SITE

(Continued from page 1)

"Significant," emphasizes Fox, "because the death positions of the mammoths reflect the life positions we see today among matriarch-led African elephant herds. We are looking at the social organization of a mammoth herd, 28,000 years in the past!"

The suggested scenario, the research team explains, is similar to what is seen today in African elephant herds. When a juvenile is in distress, the herd matriarch rushes in to investigate. If a matriarch is eliminated from the herd, there is a leadership crisis, resulting in confusion and disorientation.

This modern description of the life and death behavior of African elephants is reminiscent of the Waco mammoth remains. It appears that in the case of the larger female, the forelimbs went down first, the skull second, and the hind limbs spread out in sudden collapse. This, say the investigators, parallels the sudden death body position observed among modern African elephants.

Next to the Waco "matriarch," excavators discovered the remains of what is apparently the lone male. "He died with his body paralleling hers," observes Fox. "Perpendicularly positioned to these two senior animals, the two largest animals in the herd, was the second-ranked female. So, together we have the three senior animals dying next to each other, with a very young juvenile in there, too. Additionally, we have perhaps four other females encircling the other juveniles who are towards the center of the herd."

"The death positions of these mammoths," reiterates Fox, "appear to replicate the hierarchic spatial positioning of the matriarchal African elephant herds. Apparently, there is a similarity in social organization between African elephants and Columbian mammoths!"

The discovery of the Waco Mammoth site also provides scientists with a unique opportunity to study the biometrics of a single mammoth herd. Most of the skeletons are complete, allowing researchers to obtain age and sex profiles on individual animals. This, in turn, has enabled the Baylor University research team to begin addressing such issues as seasonality and migration patterns among mammoths.

"The herd," comments Fox, "was found pretty close to the southeastern terminus of the existing prairie grasslands transition zone, an area in which the western prairies give way to the eastern woodlands. There is a very high concentration of Columbian mammoth remains along this zone of transition. The animals may have simply have preferred this area of tall-grass prairies.

"But," Fox continues, "if we're dealing with a mid-continental climate during the mid-Wisconsin interglacial, with seasonal extremes of climate, we could be seeing evidence of seasonal migration. We can therefore hypothesize that the animals may have wintered in these localities."

"We are looking at the social organization of a mammoth herd, 28,000 years in the past!"

Fox suggests that the Waco Mammoth site may be a late winter/early spring site. Extrapolating again from the social organization of African elephants, Fox elaborates, "Elephants have approximately a 22-month gestation period. In other words, the season that they breed is the same season that they give birth. African elephant herds" Fox continues, "are generally restricted to females and their young, led by a herd matriarch. Usually, however, there are also bull herds, consisting of three or so males, that are in some proximity, several miles away. Not to go way beyond our data," Fox cautions, "but the presence of a single male at the Waco site, along with the large number of young, quite possibly supports the notion of seasonality."

In addition to modern analogues, the team is exploring the idea of seasonality using more empirical data. One such method, developed by Daniel Fisher, of the University of Michigan, Ann Arbor, is to look at tusk growth rings. Similar to tree rings, mammoth tusks are laid on layer by layer. Although the study of these rings is still in its infancy, there are suggestions that tusk growth patterns may reflect certain seasons throughout the year, and can be used to determine the season an animal died.

Another way of addressing the seasonality issue is by tabulating the large number of mammoth finds discovered along the eastern prairie-woodland transition zone. Age profiles made on the remains thus far reveal a high frequency of very young animals, again supporting the hypothsis that sites in this zone reflect a late winter/early spring occupation, the time the females would have given birth.

The apparently similar social organizations of African elephants and Columbian mammoths may also provide a base for reconstruction of daily herd habits. "In other words," Fox comments, "we can begin to think about mammoth trails and daily movements between juxtaposed environmental zones. In this particular case, during the Holocene, and presumably during the mid-Wisconsin interglacial, we have medium height grasslands with a wooded river valley below, and prairies with 6-8 foot tall grasses about two miles away. This transitional habitat, explains Fox, is similar to habitat favored by African elephants.

But what *caused* the sudden demise of the Waco herd? "That is one of the most important questions we're trying to answer," Fox replies. "Nothing has been very obvious in that regard, but what we have been able to do is to dismiss a myriad of hypothetical situations that may have caused the deaths. We have explored everything from lightening and volcanic ash to disease and natural poisoning."

Baylor University students at the Waco Mammoth Site unearth the skeleton of a female Columbian one member of a herd of mammoths possibly buried here by a flash flood 28,000 years ago.

Although the herd went down in a single event, the placement of the carcasses demonstrated that this event was not instantaneous. "There was," says Fox, "enough time for the animal we have tentatively identified as the matriarch to kneel and try to lift up the infant. There was also time for the apparent bull to position himself parallel to the female, and time for the second-ranked female to move perpendicularly between the first two adults." This suggestive spatial positioning of the animals has enabled the investigators to rule out such possibilities as drowning, hypothermia, or attack by mammalian predators.

"There are two possibilities we haven't been able to dismiss. One is that the herd died in a flash flood when a 10 meter high bank collapsed along what is now the Bosque River drainage parallel to the Balcones Escarpment. This escarpment," Fox observes, "is an abrupt 100 meter rise in an area presently characterized by sudden, torrential downpours. The animals could have been trying to climb out of the rapidly rising river and been caught when the bank gave way."

Lending credence to this theory is the stratigraphic positioning of the remains. "The two-year-old juvenile is the only animal not completely within the burial stratum," which is comprised of 30-40 cm of river-edge silty clay. Unlike the other members of the herd, that infant is in a sandy clay bank deposit. "The herd," says Fox, "died positioned between two geologic units."

The other possibility, to mention the unmentionable, is, "Paleoindian hunters . . . 28,000 years ago."

Fox readily admits there is no discernible evidence of butchering at the site. "However," he points out, "given a case of early hunters dealing with that many tons of meat-weight on partially submerged animals, the lack of cut-marks is not necessarily indicative." Additionally, much of the argument for pre-Clovis kill sites is in the bone positioning, that is, the differential distribution of bone. The definitive, life/death positioning of the mammoths resembles the positions taken by African elephants when shot by hunters. According to Gary Haynes of the University of Nevada at Reno, a noted taphonomist and consultant on the Waco project, this sudden death position rarely occurs when elephants die of natural causes."

No lithics were recovered from the site. "However," questions Fox, "in waist-deep water, and at that time period, what kind of lithics can we expect?"

The wealth of data contained in the Waco Mammoth site promises to elucidate much about an animal long vanished from the face of the earth. Whatever the catastrophic set of circumstances that caused the demise of the herd, the discovery is unquestionably, as Fox terms it, "an enigmatic and suggestive site."

—Karen Turnmire

EARLY HUMAN SITES IN SOUTH AMERICA (Continued from page 2)

below the surface. These new dates establish Pedra Furada as the oldest archaeological rockshelter in the Americas. Other charcoal samples are now being processed, and will likely push the antiquity of this locality even further back in time.

Guidon is testing two other sandstone rockshelters in the area that have produced radiocarbon dates in excess of 15,000 yrs B.P. At yet another rockshelter under marble cliffs, excavations into calcareous sediments have produced the remains of extinct horse and sloth, a bone tool industry, and quartz and quartzite flake and pebble tools. Charcoal samples from this site have yet to be dated.

From Pedra Furada, we travelled south to Sao Leopoldo, Brazil, where we met Pedro Schmitz and his students. Collections of Itaparcia Complex artifacts from the Serranoplis project, Bahia Province, are undergoing intensive study. This early complex, which has been dated to 8,000 - 11,000 yrs B.P., is composed of unifacially flaked blade and flake tools and modern faunal remains, including llamas, small deer, and anteaters.

From Brazil, our travels took us to La Plata, Argentina, where Gustavo Politis led a three day field trip across the Pampas. There we visited some of the most important Paleoindian sites investigated in the Pampas during the last 15 years. Stratigraphic sections were examined at the La Moderna site where quartz flakes were found in association with giant armadillo, and at Arroyo Seco, an important burial locality where 12 Paleoindian skeletons were found in association with extinct sloth and horse remains. We next visited Nora Flegenheimer who is excavating the Cerro El Sombrero site. This new excavation with its remarkable assemblage of fishtail fluted points has yet to be radiocarbon dated.

Moving west to the Pacific side of the continent, our next stop was at Tom Dillehay's project at Monte Verde near Puerto Montt, southern Chile. Mario Pino, the project geologist, guided a tour of the site: Pino exposed stratigraphic sections of the lower terrace where the 13,000-year-old village site was discovered and of the upper terrace where pebble tools have been dated to 33,000 years before present.

At the base of the Andes in San Pedro de Atacama, northern Chile, Lautaro Nunez gave a tour of early llama domestication sites of Holocene age, and quarry and workshop sites which possibly date back to the last Ice Age. Lautaro also presented a slide lecture and reviewed artifact collections from his recent work at Tagua-Tagua, near Santiago. Through this project he is demonstrating that this 11,000-year-old site with mastodon remains is extensive and merits additional excavation.

Gonzalo Correal and Gerardo Ardila provided opportunities to meet with students in Bogata, Colombia, to review museum collections, and to visit several late Pleistocene sites in the vicinity of Bogata. The most important of these are the Tequendama and Tibito sites that have yielded mastodon remains, stone tools, and late Pleistocene radiocarbon dates.

In summary, excellent archaeological work is occurring in the Southern Hemisphere and is of great importance to our overall understanding of the peopling of the Americas. Yet, my initial impressions of this pre-12,000-year-old archaeological record is that we are very much at the preliminary data gathering stage of research. We know very little yet about these early populations, and what we do know is very difficult to relate to the North American archaeological record. Moreover, the rate of discovery of new pre-12,000-year-old sites in South America seems to be accelerating. These new data could radically change our understanding of the peopling of the Americas. Clearly, more scientific work needs to be conducted in the Southern Hemisphere to enhance our understanding of the peopling of the Americas.

On behalf of the Center, we would like to thank our South American colleagues for their outstanding hospitality. We hope we will be able to do as well for them when they visit us next May 24th at the World Summit Conference to be held at the University of Maine. This occasion will provide an opportunity for North Americans to meet colleagues from the Southern Hemisphere and to review collections from several of the most important South American sites that will be on temporary exhibit at the University of Maine's Hudson Museum.

—Robson Bonnichsen

NEW REFERENCES AND RESOURCES

JOURNAL ARTICLES

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Barlow, H.B. 1988 Review of **Neural Darwinism: The Theory of Neuronal Group Selection**, by G.M. Edelman. **Nature** 331:571.

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Bray, W. 1988 The Palaeoindian Debate. **Nature** 332:107.

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de Lumley, H., M.-A. de Lumley, M. Beltrao, Y. Yokoyama, J. Labeyrie, J. Danon, G. Delibrias, C. Falgueres, and J.L. Bischoff 1988 Discovery of Flaked Tools Associated with Middle Pleistocene Fauna in the Toca da Esperanca, Bahia State, Brazil. **C.R. Acad. Sci. Paris** 306:241–247.

Dillehay, T.D., and M.B. Collins 1988 Early Cultural Evidence from Monte Verde in Chile. **Nature** 332:150–151.

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Gryba, E.M. 1988 A Stone Age Pressure Method of Folsom Fluting. **Plain Anthropologist** 33:53–66.

Haynes, C.V., Jr. 1988 Geofacts and Fancy. **Natural History** 97(2):4–12.

Haynes, G. 1988 Longitudinal Studies of African Elephant Death and Bone Deposits. **Journal of Archaeological Science** 15:131–158.

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Mellars, P. 1988 The Origins and Dispersal of Humans. **Current Anthropology** 29:186–187.

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Odell, G. 1988 Review of **Technical Aspects of Microwear Studies on Stone Tools**, edited by Owen and Unrath. **American Antiquity** 53:203.

Pettipas, L. 1986 Comments on David Meyer's "A Component in the Scottsbluff Tradition: Excavations at the Niska Site." **Canadian Journal of Archaeology** 10:167–170.

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Rogers, R.A., and L.A. Rogers 1988 Notching and Anterior Beveling on Fossil Horse Incisors: Indicators of Domestication? **Quaternary Research** 29:72–74.

Stanford, D. 1988 Reviews of **The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming**, by G.C. Frison and L.C. Todd; **How to Deep-Freeze a Mammoth**, by B. Kurtén; **On the Track of Ice Age Mammals**, by A.J. Sutcliffe. **American Anthropologist** 90:174.

Stringer, C.B., and P. Andrews 1988 Genetic and Fossil Evidence for the Origin of Modern Humans. **Science** 239:1263–1268.

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CONFERENCES

UPCOMING CONFERENCES

July 10-15, 1988 INTERNATIONAL WORKING MEETING ON SOIL MICROMORPHOLOGY, Sponsored by Sub-Commission B of the INTERNATIONAL SOCIETY OF SOIL SCIENCE, San Antonio.
Contact: Dr. Richard Dress, Dept of Soil and Crop Sciences, Texas A&M University, College Station, TX 77843-2474.

July 22-24, ATHABASKAN LANGUAGES CONFERENCE, University of Alaska.
Contact: James Kari, Alaska Native Language Ctr, Box 900111, U of Alaska, Fairbanks, AK 99775-0120.

July 24-31, 1988 12th INTERNATIONAL CONGRESS OF ANTHROPOLOGICAL AND ENTHNOLOGICAL SCIENCES, Zagreb, Yugoslavia.
Contact: Linda Bennett, Amer Prog Coord, Dept of Anth, Memphis State U, Memphis, TN 38152.

July 26-30, 1988 SYMPOSIUM ON ASIAN PACIFIC MAMMALOGY, sponsored by AMERICAN SOCIETY OF MAMMOLOGY, and the MAMMALOGICAL SOCIETY OF CHINA, Kunming, Yunnan Province, People's Republic of China.
Contact: Dr Andrew T. Smith, Dept of Zo, Arizona State U, Tempe, AZ 85287.

August 2-5, 1988 5TH INTERNATIONAL CONFERENCE ON PERMAFROST, Tronheim, Norway.
Contact: VICOP, Norwegian Road Research Laboratory, PO Box 6390 Etterstad, N-0604 Oslo 6, Norway.

August 11-13, 1988 23rd INTERNATIONAL CONFERENCE ON SALISH AND NEIGHBORING LANGUAGES, University of Oregon.
Contact: Jay Miller, Newberry-CHAI, 60 W Walton, Chicago, IL 60610; 312/943-9090, ext 266.

August 18-20, 1988 AUSTRALIAN ANTHROPOLOGICAL SOCIETY, 1988 Annual Conference, Newcastle, New South Wales, Australia.
Contact: AAS Secy, Linda Connor, Dept of Soc, U of Newcastle, NSW, 2308, Australia.

August 21-23, 1988 7th YORK QUATERNARY SYMPOSIUM, Lethbridge.
Contact: Dr. R.W. Barendregt, Quaternary Symposium, Dept of Geography, U of Lethbridge, 4401 University Dr, Lethbridge, Alberta, Canada T1K 3M4.

August 23-31, 1988 JOINT OCEANOGRAPHIC ASSEMBLY, Acapulco, Mexico.
Contact: W.S. Wooster, JOA HF-05, U of Washington, Seattle, WA 98195.

August 29-September 2, 1988 FIRST CONGRESS OF THE AUSTRALIAN ROCK ART RESEARCH ASSOCIATION, Darwin Performing Arts Centre, Beaufort Hotel Convention Complex, Darwin, Australia.
Contact: Australian Rock Art Res Assn, PO Box 216, Caulfield South, 3162, Victoria, Australia.

September 1988 ARCHAEOLOGICAL WOOD SYMPOSIUM, Los Angeles, CA.
Contact: Dr. Roger M. Rowell, USDA, Forest Products Laboratory, 1 Gifford Pinchot Dr, Madison, WI 53705.

September 5-9, 1988 FISSON TRACK DATING, 6th International Workshop, Besancon, France.
Contact: J.-L. Janier-Dubry, Laboratoire de Microsnalyses Nucleaires, UFR des Sciences et Technology, 16 Route de Gray, 25030 Besancon Cedex, France.

September 19-23, 1988 INTERNATIONAL SYMPOSIUM ON ENGINEERING GEOLOGY AS RELATED TO THE STUDY, PRESERVATION, AND PROTECTION OF ANCIENT WORKS, MONUMENTS, AND HISTORIC SITE, organized by the INTERNATIONAL ASSOCIATION OF ENGINEERING GEOLOGY, Athens, Greece.
Contact: Paul G. Marinos, Greek Committee of Engineering Geology, PO Box 19140, GR-117 10 Athens, Greece; Telex: 45-4312 POLX (c/o Marinos).

September 23-October 2, 1988 UNSPECIALIZED BONE INDUSTRIES, 6th Meeting of Working Group No. 1, Sardinia, Italy.
Contact: Dr. Marylene Patou, Institut de Paleontologie Humaine, 1 rue Rene Panhard, 75013 Paris, France.

October 14-16, 1988 MIDWEST ARCHAEOLOGICAL CONFERENCE, Annual Meeting, University of Illinois and Chancellor Inn, Champaign.
Contact: Prog Chair, Kevin McGowan, 109 Davenport Hall, Dept of Anth, U of Illinois, Urbana, IL 61801.

October 25-30, 1988 AMERICAN FOLKLORE SOCIETY, Annual Meeting, Hyatt Regency Hotel, Cambridge.
Contact: Hugh Flick, Linda Morley or Eleanor Wachs, Committee on Degrees in Folklore and Mythology, Harvard U, 69 Dunster St, Cambridge, MA 02138.

October 31-November 3, 1988 GEOLOGICAL SOCIETY OF AMERICA, Annual Meeting, Denver, CO.
Contact: Jean Kinney, GSA Headquarters, Box 9140, 3300 Penrose Place, Boulder, CO 80301: 303/447-2020.

October 31-November 5, 1988 9th CONGRESO NACIONAL DE ARQUEOLOGIA ARGENTINA, Buenos Aires, Argentina.
Contact: Comision Organizadora, 9th Congreso Nacional de Arqueologia Argentina, Instituto de Ciencias Anthropologicas, 25 de Mayo 217 4to. piso, 1002—Buenos Aires, Republica Argentina.

November 2-5, 1988 PLAINS ANTHROPOLOGICAL CONFERENCE, Ramada Broadview Hotel, Wichita.
Contact: Donald Blakeslee, Dept of Anth, Wichita State U, Wichita, KS 67208.

November 16-20, 1988 AMERICAN ANTHROPOLOGICAL ASSOCIATION, 87th Annual Meeting, Hyatt Regency, Sheraton Phoenix, Phoenix.
Contact: Prog Chair, Harriet Klein, Dept of Anth, Montclair State C, Upper Montclair, NJ 07043.

August 2-6, 1989 CIRCUM-PACIFIC PREHISTORY CONFERENCE, The Seattle Center, Seattle.
Contact: Dr. Dale R. Cross, WSU, c/o Pacific Celebration '89, 1001 4th Avenue Plaza, Seattle, WA 98154-1101; 206/622-2536.

Life On The Edge

The 23rd Annual Meeting of the Geological Society of America Northeastern Section was held in Portland, Maine, March 9-12, 1988.

"Life on the Edge", a symposium focusing on environmental change and human adaptive patterns along the margins of melting glaciers was of particular interest to Quaternary scientists. Organized by Harold W. Borns and Robson Bonnichsen, both of the University of Maine, Orono, the seminar featured presentations by climatologists, geologists, biologists, and archaeologists.

Central to the theme of the symposium was the idea that retreating glacial ice produces unique environments. Bonnichsen, co-convener of the seminar, explained that the dynamics of the ice marginal environment are important in developing knowledge about the variables controlling biological and cultural evolution. He suggested the rapid collapse of the ice sheet around 11,000 years ago probably resulted in the restructuring of plant and animal communities, which in turn produced major shifts in human adaptive patterns.

Participants observed that the position and shape of the ice front was important, as were the local topography and drainage patterns. Mauri S. Pelto (University of Maine, Orono) suggested that cold air draining off the ice caused strong, persistent, very moist winds. Lakes may have dominated the environment along the ice rim, according to Terrence J. Hughes (University of Maine, Orono).

Edward J. Zeller (University of Kansas, Lawrence) proposed that essential plant nutrients (calcium, potassium, and phosphate) were produced by the mechanical grinding processes of glaciers which overrode rocks of the Canadian Shield. Additionally, high energy particles from the sun colliding with nitrogen atoms in the upper atmosphere produced nitrates, important to plant growth in the recently deglaciated landscape. Nitrates concentrated in the polar regions by low precipitation, evaporation, and compaction, could then be carried to glacial margins by ice streaming. Glacial runoff and katabatic winds could have further distributed these essential plant nutrients into the environment, permitting higher levels of plant productivity than are commonly attributed to the ice-marginal environment.

Harold Borns discussed favorable geological conditions for early plant growth along ice margin edges, contrasting a desirable environment for animals and humans with the presence of meltwater rivers and lakes which would have provided formidable barriers to summer migration.

This vegetation-rich biome would have attracted and supported a wide variety of fauna. Alan L. Bryan (University of Alberta, Edmonton) suggested herds of caribou and bison would have thrived in these conditions, providing early hunters with a ready food source. Valerius Geist (University of Calgary, Alberta) noted the diversity and large body size of mammals from ice-marginal environments, which suggest "great resource abundance and long periods of annual body growth."

Although researchers agreed that the land along retreating glacier margins may have been highly productive in some areas, Charles E. Schweger (University of Alberta, Edmonton) suggested that the ice-marginal environment in the vicinity of the "Ice-Free Corridor" would have resulted in an unstable landscape unsuitable for human occupation.

International Radiocarbon Data Base Workshop

The first American workshop on the International Radiocarbon Data Base (IRDB) was held March 25-26, 1988 at the Peabody Museum, Yale University, New Haven, CT. The two day conference was organized by IRDB's executive director, Renee Kra, and was funded by the Wenner-Gren Foundation for Anthropological Research, Inc.

As one of the many policy-making and promotional sessions that have been convened over the past three years, the IRDB workshop's agenda included four primary goals, specifically: to find a home for the IRDB, to form an American Advisory Board, to launch a fund raising campaign, and to select two pilot projects which effectively demonstrate the need and the benefits of a permanent, international radiocarbon data base.

In attendance at the conference were some 30 participants representing radiocarbon laboratories and end-users. Consensus was achieved on several issues during the two-day proceedings. These were: an agreement on the immediate need for the IRDB; the establishment of an American Division of the larger, global organization; the recognition of the multidisciplinary nature of the project and of C-14 users; the preference for a flexible, open-ended format for data entry instead of a fixed, index-structured format; the need to control the quality and standards of the IRDB; the creation of an IRDB independent of but associated with the journal, **Radiocarbon**; and the redefinition of the role of **Radiocarbon** as the vehicle for generalized scientific articles on C-14.

Follow-up sessions have been scheduled by Renee Kra to take advantage of the momentum she has achieved virtually single handedly over the past couple of years. Besides maintaining contact with past IRDB participants through up-dates and news releases, she has planned several workshops and promotional sessions in the near future. Included are a poster session at the Archaeometry 88 Conference in Toronto, May 16-20, 1988; a poster session at the Quaternary Association (AMQUA) Meeting in Amherst, MA, June 6-8, 1988, and an IRDB workshop at the 13th International Radiocarbon Conference at Dubrovnik, Yugoslavia, June 20-25, 1988. Future meetings of the IRDB will be publicized in advance through notices from Renee Kra in major journals and newsletters.

The Center for the Study of Early Man is committed to the goals and objectives of the IRDB. The resolution of specific problems relating to the peopling of the Americas demands access to vast quantities of chronometric information that can only be provided by an organization such as IRDB.

—John Tomenchuk

Call for Samples

LOOKING FOR A DATE

Approximately 11,000 years ago, one of the most intriguing events in prehistory occurred with the extinction of late Pleistocene megafauna. Seemingly within a few years, giant sloths, camels, mammoths, mastodons, and 29 other large mammal genera previously abundant on the North American continent vanished from the face of the earth. Were these animals hunted to extinction by early humans? Unable to adapt to changing climatic conditions? Decimated by disease?

Although numerous theories have been proposed to account for the disappearance of New World megafauna, it is unlikely the cause of this event will be established until two issues are resolved: when did specific genera disappear; and how long were these animals contemporaneous with humans in the New World. Dr. Thomas W. Stafford of the University of New Mexico, Albuquerque is attempting to answer these questions by means of tandem accelerator mass spectrometry C-14 dating. It is now possible to accurately date fossil bone collagen using accelerator radiocarbon dates on individual amino acids, a method which yields bone ages having precisions of ± 80 years on individual amino acid dates! When used on a large suite of fossils, this degree of precision promises to greatly aid researchers in evaluating both extinction causes and the contemporaneity of extinct fauna and humans.

Dr. Stafford is presently seeking osteological samples from up to ten stratified sites for radiocarbon dating by accelerator mass spectrometry. These samples will be used to more accurately determine the last occurrence of specific genera, as well as to better establish the time range during which the fauna became extinct. One fossil per archaeological or paleontological site will be used, and four to seven radiocarbon dates will be obtained from each fossil.

Because of the complexity of the chemical and dating procedures, samples must be carefully selected and meet the following criteria for acceptance: Localities should be stratified and have a conformable stratigraphic sequence over at least the time range of 10,000-12,000 yrs B.P. Sediments with modern (Holocene) fauna should overlie conformably the Pleistocene strata. The extinct fauna should be at the highest-known stratigraphic occurrence (youngest) of that animal in the area. The sites must be available for Stafford to examine the sedimentology and stratigraphy, and to geologically locate the samples. Museum samples will be avoided unless the original stratigraphic section can be seen. Wood or charcoal has least preference unless its stratigraphic association with the bone is definite. Bone should be dense, cortical tissue from long bones of extinct megafauna. Whole bone must have at least 0.2% nitrogen and a collagenous amino acid composition, which will be determined by Stafford. Preservative-free bone is desired but acetone-soluble preservations will not affect the dating.

References pertaining to the chemical separation of amino acids and dating methods are listed in the upcoming **CRP**, Volume 5, pp. 41-43 (Accelerator C-14 Dating of Late Pleistocene Megafauna), or are available from Stafford upon request. Correspondence should be addressed to: Dr. Thomas W. Stafford, Jr., Department of Anthropology, University of New Mexico, Albuquerque, NM 87131, (505)-277-4524; or 14206 Arcadia, N.E., Albuquerque, NM 87123, (505)-298-1704.

THUNDERBIRD SITE DAMAGED BY BULLDOZERS

On March 12 and 13, 1988, two adjacent lots on the Thunderbird site in Warren County, Virginia were cleared of timber and partially bulldozed, apparently in preparation for building on the property. The Thunderbird site (44Wrll) is recognized nationally and internationally as one of the most important archaeological sites in the Eastern United States.

The site exhibits a continuous stratigraphic record ranging from the Paleoindian period to the end of the Early Archaic, preserved in a series of largely undisturbed, superimposed living floors. Additionally, the Thunderbird site contains the earliest documented evidence of a human structure in the Western hemisphere.

The clearing and grading out across a 300 foot section of the site hit the core of the recent excavation. The damage to the site was discovered by the Director of the Thunderbird Research Corporation, Dr. William Gardner, and representatives of the Archaeological Society of Virginia, Ms. Sandra Spieden and Mr. Steve Kimball on Sunday, March 14. The entire area that was the focus of past excavations, including the Paleoindian house structure, was destroyed. Although severe, the damage to the site was less than it could have been. Because most of the grading was relatively shallow, most of the damage was confined to plow zone levels which are less important than the deeper sections.

The site, like other privately owned archaeological sites and historic structures, is virtually unprotected regardless of significance. Part of the site has now been destroyed in spite of privately arranged protective covenants.

Happily, the Archaeological Society of Virginia, in the name of the Thunderbird Research Corporation, now has a signed contract which will enable the organization to purchase the 5 lots that contain most of the site. The Society has received an interest-free loan from a major real estate firm for the initial purchase. Those of our readers wishing to aid the Society in repaying this loan may send their donations to: Thunderbird Research Corporation, 126 East High Street, Woodstock, VA 22664. Please specify contributions as being for "site purchase".

In addition, you may also help by encouraging the state of Virginia to aid in preserving this unique site. Although the governor has set up a study commission to research the problem of historic preservation, the state presently has no mechanism for stepping in to preserve sites on private land. Letters may be addressed to: Governor Gerald L. Baliles, Office of the Governor, Commonwealth of Virginia, Richmond, VA 23219.

SUGGESTED READINGS

On The Waco Mammoth Site

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Sikes, Sylvia 1971 **The Natural History of the African Elephant.** Weidenfeld and Nicolson, London.

On Needle In A Haystack?

Dincauze, Dena F. 1984 An Archaeo-Logical Evaluation of the Case for Pre-Clovis Occupations. **Advances in World Archaeology** 3:275-323.

Lynch, Thomas F. 1974 The Antiquity of Man in South America. **Quaternary Research** 4:365-377.

Nash, David T. 1987 Archaeological Investigations at Haystack Cave, Central Colorado. **Current Research** 4:114-116.

On Blood Will Tell

Loy, Tom 1983 Prehistoric Blood Residues Detection on Tool Surfaces and Identification of Species of Origin. **Science** 220:1269-1271.

Loy, Tom 1987 Blood from a Stone. **Mammoth Trumpet** 3(4).

Sensabaugh, G.F., A.C. Wilson, and T.L. Kirk 1971 Protein Stability and Preserved Biological Remains. **International Journal of Biochemistry** 2:545-568.

BLOOD WILL TELL

(Continued from page 4)

Smithsonian for around 40 years, cleaned and set up on display." Adovasio elaborates: "In an earlier study I had worked on basketry collections from northern Mexico. While doing that basketry study, I came upon an early Archaic hafted projectile point from Fat Burro Cave, excavated by Walter Taylor in the 1940s. We don't know yet what species of animal is on that Mexican tool because paleofaunal studies in that part of Mexico are in their infancy, and theoretically this tool could have been used on anything from an armadillo to a bison."

If the residue survives cleaning, how well does it survive various environmental abuses—acidic soil and the like? "Until this is applied on a large scale over wide areas," answers Adovasio, "we're not going to know about differential preservation, for instance, whether being thermally altered in a fire pit will destroy whatever residue in on an artifact. Yet these problems should be amenable to close scrutiny, and if it does turn out that depositional variables can be controlled with some measure of precision, it obviously means that we're going to get infinitely more information out of stone tool assemblages that we're getting now."

In developing the procedure, Jean Tersak put various stone tools and cracked rocks with fresh blood residue on them through several regimes. Some of them were boiled, some baked at various temperatures in order to simulate in a speeded-up fashion what might have occurred in the environment over time. "It turned out that there was still a significant amount of active residue on all samples except for the one that was boiled," Hyland says. "even on one baked at a temperature beyond what you would find in any natural environment. So that says a lot for the resistance of blood residues to degradation."

To date, the method has been used on approximately 100 prehistoric tools. The group is trying very hard not to have preconceptions. As Hyland states: "We do not say, 'I don't think there's any blood likely to be on this; I'll just skip it'. We treat every item the same, without prejudice." Although the researchers may be able to become more selective through experience, there is not enough data yet to afford that risk, particularly since one of the technique's biggest potentialities is that of linking hitherto-unsuspected artifacts to a meat-processing context.

As to time, "We wanted to try early materials first, because we assumed they would be most subject to having residues disappear," Adovasio says. "That just turned out not to be the case; it seems at this point the technique will work for the whole range of human occupation in the Americas. Earlier than that, I just don't know. We don't have any Neanderthal or Middle and Lower Paleolithic materials to try it on."

Various archaeologists have contributed materials from their projects to the CRMP group for analysis. Some of these include Marie Wormington, Tom Dillehay, and Niede Guidon, whose sites are located in the southwestern U.S., southern Chile, and northern Brazil, respectively.

The immunoassay procedure also works on residues retrieved from bone, wood, and other materials, in addition to stone. Textiles have recently been tested from the Windover site in Florida, a late-Early or early-Middle Archaic cemetery located in a bog. Using the technique, researchers have identified a residue on the textiles as possibly indicative of collagen. Further testing is proceeding to determine whether the source of the residue is animal or human.

As well as other types of material, the range of this new technique promises to expand to include other types of residue. Hyland observes, "We're working with blood, but conceivably we should be able to work with any type of protein. We've been talking of trying to adapt it to detect plant residues on tools—to determine if a tool had been used to cut hardwood, to prepare baskets by cutting reeds, to grind up plant remains."

Hyland surmises that perhaps 20-30% of artifacts tested show residue after the first step is completed and therefore go on to the second step, the antibody-antigen reaction. Although some of these first tests can yield false positives, Hyland is reasonably confident that they can be pretty well eliminated by the latter step: first, because those reactions are specific to different species; second, because the analysis includes a number of positive and negative controls.

So far, the method seems reliable, as well as promising. Time, and blood, will tell.

—*Michael Dolzani*