emphasis on applications.

Yet another challenge is the short time available to flesh out the program's details and win the research community's full backing. The accelerated timetable has left many researchers feeling left out of the process. "Many people are miffed," says one. The current Goddard plan has not been well received by many outside scientists, who worry that the myriad spacecraft and instruments don't add up to a coherent package. "The community is delighted with the idea of Living With a Star, but there is room for reexamination," says NASA adviser Christensen. "There is a feeling we need to take a more systematic look."

NASA's Withbroe acknowledges that tension. "People are not terribly happy out there," he says. To address that concern and to avoid the kinds of mistakes that have hampered NASA's Mars program, the agency is creating an independent advisory panel to help develop a clearer and more acceptable plan. "We have the building blocks, and now we want to have a set of architects make sure they fit together," says Withbroe.

With the program ensnarled in controversy, outside researchers face the task of mobilizing a field that has never before been asked to go to bat for a program of this magnitude. "I don't think this community is very effective," says Louis Lanzerotti, a space physicist with Lucent Technologies in Cherry Hill, New Jersey. "And it's a damn pity." Colorado's Baker expects the controversy to be a learning experience for most researchers. "Only a few people in the community have been [politically] active," he says. "For the most part, people have been a little too content to let things play out."

Observers predict that Mikulski will triumph this fall in winning funding for the program and for APL. If that happens, the next step will be to maximize the project's scientific value without alienating the politicians who foot the bill. "We really don't like this [APL] deal—we think it stinks—but we don't want it to sink Living With a Star," says one solar physicist. Adds Christensen: "We want to get the program approved, so we don't want to torpedo it by being too negative."

Proponents are rooting for the solar community to demonstrate that it can play in the scientific big leagues. "It's a great program, and it's a real shame it started off on the wrong foot," says NSF's Behnke. "Let's hope it recovers." **–ANDREW LAWLER**

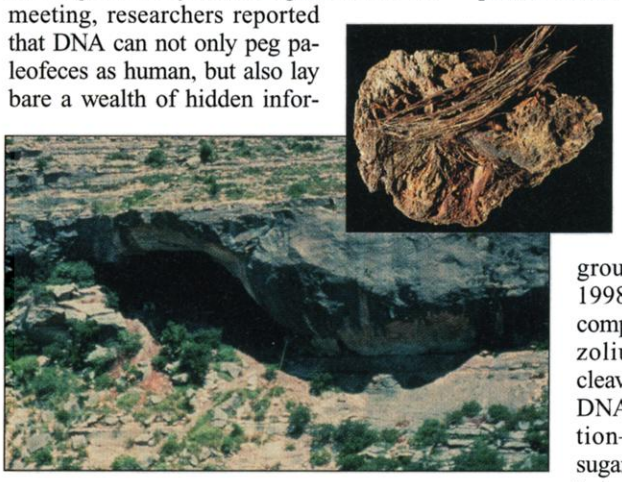
MEETING 5TH INTERNATIONAL ANCIENT DNA CONFERENCE

Divining Diet and Disease From DNA

MANCHESTER, U.K.—Some 110 scientists from a range of disciplines gathered in the overcast British midlands for the 5th International Ancient DNA Conference, held here from 12 to 14 July. Among the attractions were successful DNA extractions from human dung and from mammoth bones.

Tales of Paleofeces

What you eat can reveal a lot about your lifestyle and health. That's why archaeologists try to piece together ancient diets by picking through campsites for bones, seeds, and other leftovers. What you excrete can reveal even more. It's no piece of cake, however, to identify paleofeces or coprolites—the polite words for ancient poop—as human. Even then, the contents may have been chewed and digested beyond recognition. At the meeting, researchers reported that DNA can not only peg paleofeces as human, but also lay bare a wealth of hidden information on diet. "This is really neat," says longtime paleofeces examiner Karl Reinhard, an archaeologist at the University of Nebraska, Lincoln. "It will expand our ability to identify the total diet and use of natural resources."



Pit stop. The Hinds Cave rock shelter, where prehistoric hunter-gatherers left the digested remains of their meals, including this 6-cm specimen *(inset)*.

CREDITS: V. BRYANT/TEXAS A&M; (INSET) K. SOBOLIK/UNIVERSITY OF MAINE

Dry, cool caves were not only a good place to live in prehistoric days, they would seem to offer decent enough environmental conditions to preserve DNA. Still, the hunt for DNA from cave samples of paleofeces proved frustrating until 2 years ago, when Hendrik Poinar and Svante Pääbo, then of the Max Planck Institute for Evolutionary Anthropology and Zoological Institute in Munich, Germany, pioneered an approach to release DNA trapped inside the 20,000-year-old dung of extinct ground sloths (*Science*, 17 July 1998, p. 402). The secret was a compound called *N*-phenacylthiazolium bromide (PTB), which cleaves sugar bonds that entangle DNA and prevent its amplification—a particular problem for sugar-rich paleofeces. Since then, Poinar—now at the Max Planck Institute for Evolutionary Anthropology in Leipzig—and his colleagues have shown that the technique works for paleofeces of an extinct mountain goat and a different ground sloth from Patagonia, Chile. But their failed attempts to extract DNA from Egyptian mummies had discouraged them from tackling human paleofeces.

Then Kristin Sobolik, an archaeologist at the University of Maine, Orono, suggested they try paleofeces from Hinds Cave, a well-studied prehistoric rock shelter in the Lower Pecos River area of Texas. Thousands of specimens, ranging in age from 8500 to 500 years old, have been collected, but only a few analyzed. Poinar was game, so Sobolik sent the lab five of the fist-sized nuggets ranging in age from about 2100 to 2400 years old.

The PTB method worked like a charm. Poinar pulled out human mitochondrial DNA and found sequences, called haplogroups, that are known to be Native American. (An independent lab has replicated the findings.) The group next extracted chloroplast DNA, from which they matched sequences to buckthorn, acorns, sunflower, a shrub called ocotillo, and a kind of nightshade, probably wild tobacco. Sobolik examined the samples under a microscope but could see no remnants of these plants. (On the other hand, cacti and rodents found by Sobolik did not show up in the molecular analysis.) Both the DNA and visual methods identified traces of legumes, yuccas, and elm, which may have been used to brew tea.

The paleofeces also contain visible bones of pack rats and mice, as well as fish scales. Poinar didn't find DNA from these, perhaps because the samples that he tested lacked the tiny bone fragments. However, he did find sequences for sheep and pronghorn antelope, bones of which have not been found in Hinds Cave. That suggests that the large game was killed and eaten elsewhere,

Poinar says.

The paleofeces findings show that prehistoric American diets were "incredibly diverse," Sobolik says. One paleofeces alone contained remains of four kinds of animals and three plants, while another had two animals and four plants. If archaeologists and molecular biologists work together, Poinar says, "we get a more complete picture of what the hunter-gatherers ate."

Next the team hopes to track diet over time. "There was a continual flow of dung over 8000 years," Poinar notes. Previous studies indicate that diet changed little over those centuries, a hypothesis that DNA may be able to test. For instance, the researchers might be able to detect changes in big game abundance. And two other caves nearby also contain ancient dung. The hunter-gatherers are thought to have switched caves during different times of the year to exploit different resources, such as fall acorns in the upland forests. If so, the paleofeces might reveal seasonal changes in diet.

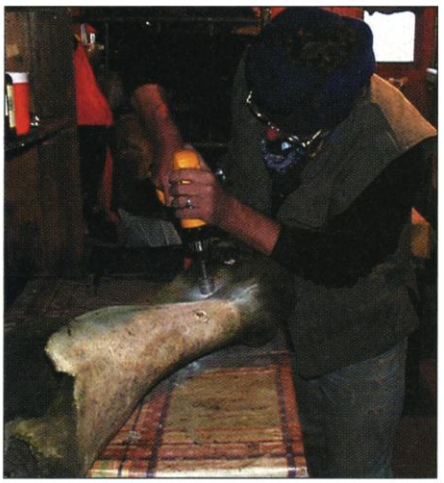
What many archaeologists would especially love to know, however, is the sex of a defecator. This could provide insights into dietary differences between males and females, Sobolik notes. She and others have attempted to determine the sex in some paleofeces by the ratio of testosterone and estradiol. Analysis of nuclear DNA, of course, would give a much less ambiguous answer. Nuclear DNA is harder than mitochondrial DNA to amplify, because it is so much scarcer, but Poinar says he is working on it.

Hunting a Mammoth Killer

Last year, molecular biologist Alex Greenwood and his colleagues at the American Museum of Natural History (AMNH) in New York City prised the first sequences of nuclear DNA from an extinct species, the woolly mammoth. Now they are hoping to use the mammoth as a vehicle for pioneering a new field: paleovirology.

As a first foray into the relatively uncharted area of ancient viral genetics, Greenwood announced at the meeting that his group had managed to pull out of a mammoth cell's nucleus partial sequences of a class of endogenous retroviruses (ERV). An ERV is born when a retrovirus sneaks into an egg or sperm and sets up camp in its DNA. This has happened many times in all creatures, from yeast to people. Because ERV sequences—some of which are thought to have maintained their activity or acquired functions—appear to be strongly conserved in living mammals, experts caution that ancient sequences probably don't represent a potential gold mine of new information on viral evolution.

That's fine, because Greenwood and his AMNH colleagues have bigger game in mind. They want to probe a novel idea about what might have driven mammoths, giant ground sloths, and other large mammals to extinction in North America at the end of the last ice age. The two leading ideas are that rapid climate change sharply curtailed food supplies and shrank populations below sustainable levels, or that overhunting by early Americans did the job. The new idea comes from AMNH mammalogist Ross MacPhee and virologist Preston Marx of the Aaron Diamond AIDS Research Center in New York City, who in 1997 proposed that pathogens brought across the Bering land bridge by humans or commensals such as dogs jumped into mammoths with the infectivity of the flu and the lethality of Ebola. Although the idea is provocative, the researchers know of no modern pathogen that would fit this description—thus complicating any hunt for such a shadowy rogue.



Big game. Discovery of ancient DNA in mammoth bones like this humerus has launched a quest for deadly ice age pathogens.

CREDIT: CLARE FLEMMING/AMERICAN MUSEUM OF NATURAL HISTORY

That doesn't mean it's not worth searching for evidence of a so-called "hyperdisease." Woolly mammoth flesh—sometimes even whole carcasses—is found deep-frozen in permafrost in Alaska and Siberia. MacPhee's team has collected samples from Alaska, mainland Siberia, and Wrangel Island in the East Siberian Sea. Tissue from individuals ranging in age from 26,000 years to 4500 years was well enough preserved to yield nuclear DNA sequences, which were published last November in *Molecular Biology and Evolution*. This was the first proof that it's possible to extract single-copy nuclear DNA from extinct animals. This kind of DNA is much rarer than the plentiful DNA of mitochondria, the miniature powerhouses inside animal cells that have their own genome.

Finding a pathogen lurking in frozen mammoth tissue will be much trickier. Their DNA may be even scarcer than native mammoth DNA, and the pathogen may not have infected bone, the most common fossilized tissue. "It is mostly a matter of luck," says Greenwood. "You have to find an infected individual who had a high enough viral load that is detectable."

Greenwood and MacPhee plan to search mammoth remains before and after humans arrived in North America. If they find viruses or bacteria only in the younger samples, it would support the notion that humans or their domesticated beasts brought diseases that doomed the mammoths. "If they find an exogenous virus," says retrovirus expert Robin Weiss of University College London, "then I'll sit straight upright." **–ERIK STOKSTAD**

DIABETES RESEARCH

Islet Transplants Not Yet Ready for Prime Time

Although recent highly publicized transplantation results are promising, lack of islet tissue will limit the procedure's availability for years

When researchers in Edmonton, Canada, announced last month that a new procedure for transplanting pancreatic islet cells had freed seven adults with type I diabetes from taking insulin, the news got front-page treatment around the world. Because of the potential therapeutic implications of the work, *The New England Journal of Medicine* lifted the embargo on a paper detailing the results of the procedure, known as the "Edmonton Protocol," releasing it on 6 June—more than 7 weeks before its scheduled publication date of 27 July.

News stories touted the findings as the beginning of the end of life with syringes for the more than 1 million Americans with type I (or "juvenile") diabetes. And on 13 July, President Bill Clinton took a break from peace talks between Palestinian and Israeli leaders to announce a mostly federally funded $5 million study aimed at replicating the Edmonton team's results that will be carried out at 10 centers in North America and Europe. But impressive as the Edmonton group's achievement was, some important caveats tended to get lost in the public enthusiasm.

A big drawback is that transplant recipients would need to take immunosuppressive