

change, focusing on why and how, in addition to what and when.

Four Smithsonian-associated scientists reflect the new trends in their work. Bruce Smith used a scanning electron microscope to show that early North Americans domesticated local grasses long before maize was introduced. Alison Brooks studied present-day hunters and gatherers to understand the lives of their ancient African counterparts and is working with physicists and chemists to develop new dating techniques for the earlier sites. Using computers to manipulate huge quantities of data, Melinda Zeder investigated the rise of specialized urban economies in the Near East through a study of the way animals were butchered and the meat distributed. And George Frison experimented with the replication and use of stone tools on modern elephants to understand the uses of such tools and weaponry by ancient mammoth hunters of the North American plains.

STORED SEEDS SURPRISE

Curator Bruce Smith has long puzzled over the sudden emergence of complex, ranked societies and intensive maize agriculture, both appearing in eastern North America about A.D. 800-1000. Smith and others became interested in the possibility of horticultural practices prior to that period based on local rather than imported plants. Since the 1960's, using seed flotation devices, archeologists have documented the existence of a few domesticated native plants prior to A.D. 750, bolstering the argument that seed agriculture provided an important food before corn.

But, how does one irrefutably demonstrate that people were deliberately storing seeds for future planting, that they were, in fact, domesticating native plants? Since no farming implements or evidence of garden plots exist, Smith needed a

storage device containing domesticated seeds from an archeological site dated well before A.D. 750.

In 1982 Smith read an article listing examples of stored seeds recovered from archeological sites. Included was a site Smith knew, for its collections were under his curatorial care: the Russell Cave site in Alabama excavated from 1956-58. Intrigued, Smith sorted through forty-five drawers of uncatalogued material looking for a small basket of carbonized seeds. Smith found the basket and a small handful of tiny seeds, looking much like poppyseeds, lying amidst dirt and charcoal. An earlier archeologist might have tossed away the contents; for Smith his treasure-trove meant 50,000 seeds to be analyzed for identification and charcoal to be sent to the Radiocarbon Dating Laboratory. Smith identified the seeds as Chenopodium berlandieri, a starchy native plant. When the date came back, 1875 plus or minus 55 years, Smith knew he had the proof: native seeds in the New World deliberately stored by human beings right around A.D. 1.

SEM PROVES DOMESTICATION

But, did these seeds represent wild or domesticated plants? Was there any way to document the morphological changes domestication inevitably brings to seeds? In the 1950's, the archeologist who thought to save the basket of seeds could neither date them nor ascertain their wild or domesticated status. In the intervening years, science and technology had developed methods to determine both. Like all scientific discoveries, Smith's depended on other scientists' work, on slowly accumulating bits of evidence fitting together like an intricate jigsaw puzzle. In 1981 botanist Hugh Wilson, using the scanning electron microscope (SEM), demonstrated the extreme reduction or lack of an outer seed coat in "chia," a variety of a domesticated Chenopodium.

The SEM allows scientists to enter the world of the infinitesimal, seeing nature's intricacies of design on a scale of magnification difficult to imagine. Under the SEM, a tiny pollen grain appears like the moon's surface photographed by astronauts. With the Smithsonian's SEM, Smith looked at three different kinds of Chenopodium seeds: Russell Cave, modern domesticated "chia," and modern wild species. The experiment clearly demonstrated that the Russell Cave seeds came from domesticated plants: the seed's thin outer coat (averaging 11 microns) was clearly comparable to that of domesticated "chia," not to the thick outer coat of the wild species (averaging 47.6 microns) (Science, October 12, 1984). By the beginning of the Christian era, New World peoples were cultivating garden plots by storing and planting a domesticated variety of Chenopodium.

NEW DATING TECHNIQUES

The radiocarbon dating which pinned down Smith's Chenopodium cannot help Research Associate Alison Brooks whose research focuses on the Middle Stone Age ca. 80,000 years ago. With present technologies, radiocarbon dating simply will not work on material older than 60,000 years. Working with chemist Alan Franklin and physicist Bill Hornyak at the University of Maryland's Thermoluminescence Laboratory, Brooks has turned to a substance archeologists previously threw away: sand. Since Brooks works in Botswana's Kalahari Desert, she has plenty of sand samples containing the quartz grains which may yield a new archeological "time clock." Quartz crystals absorb and trap radiation energy from the soil at a constant rate for each location.

If sand will not do it perhaps ostrich egg shell will. It appears for at least 100,000 years in the African archeological record not only because the eggs were eaten, but also because such shells were used as water storage

containers and later made into beads. Until recently, ostrich eggshell was collected, but treated only as another food remain. With today's technology, Dr. P.E. Hare of Washington's Carnegie Institution hopes that chemical analysis of eggshell can reveal the approximate date when the shell was laid, by measuring the slow deterioration of its amino acids. In addition, study of the shell may reveal the average annual temperature when the ostrich lived, by measuring the ratio of lighter to heavier oxygen bound into the shell's chemical structure. Even the environment can be partially reconstructed, since the varying quantities of a stable isotope of carbon (C-13) reveal whether the ostrich was eating tropical savannah grasses or shrubs.

ON THE ROAD TO URBANISM

What ancient people ate is a question many archeologists are asking, for traces of ancient diets also provide evidence of environment, changing economies, and even the organization of society. For Melinda Zeder, completing her doctoral dissertation as a Smithsonian Research Associate, diet provides a powerful analytical tool for defining and tracing urbanism in the Middle East.

Like Smith, Zeder is fascinated by the process of change in populations undergoing major transitions. Whereas Smith studies plant remains, Zeder analyzes animal bones--100,000 of them excavated from several levels of Tal-e Malyan, a Bronze Age site in Iran occupied between ca. 3500 and 1000 B.C. Few archeologists have saved whole collections of animal bones from sites where written texts existed, much less analyzed them for 42 different bits of information and 11 measurements! Only the new computer technology can deal with such large quantities of data. Like Brooks' sand, here was material previously ignored from which new

techniques can glean answers provided the right questions are asked.

Zeder began with a working definition of urbanism as a regional economic system characterized by increasing specialization. Zeder predicted that the increased specialization in the management of economically important animal resources would cause changes detectable in the recovered bones. From an early direct distribution system, with people eating their own animals (sheep, goats, pigs, cattle) or procuring them directly from herders, urbanism would bring about an indirect distribution system with middlemen removing consumers far from herders or meat producers.

CRUNCHING NUMBERS

How could 100,000 broken bones reflect a changing distribution system in turn reflecting the transition to urban life? A laborious identification of each bone's species, age at death, sex, and butchering scars, along with sophisticated computer analysis, tested Zeder's prediction that economic changes would affect the types of animals consumed, their ages, sex, and the butchering techniques used. For example, if people raise their own animals or procure them directly from herders, they consume mostly young males, six months to two years of age, both to control male reproduction and to avoid culling the breeding stock. If meat is procured from a middleman, however, the bones remaining from domestic meals would reflect the middleman's preferences, particularly for male sheep and goats two to three years of age when they provide the most meat.

Zeder also predicted that butchering techniques would become more specialized and uniform during periods of urban expansion when an indirect, centralized system of butchering replaced individual households procuring and butchering meat according

to individual styles and preferences. On the whole, the computerized analysis of the bones did bear out Zeder's predictions, demonstrating that faunal analysis can help monitor and explain the ebb and flow of urbanism in the ancient Middle East.

THE REVEALING PRESENT

In addition to borrowing laboratory techniques from chemists, physicists, botanists, and zoologists, archeologists also use the present as a laboratory for testing theories about the past as demonstrated in the research carried out by Alison Brooks and John Yellen with modern hunting and gathering peoples in Botswana, Africa.

"By studying why and where the San camp as they do, leave their refuse, and set up their hunting blinds, we gain greater understanding of human responsiveness to the environment. Hunters and gatherers do not leave a strong archeological record because they do not often come back to the same location to camp. They are more apt to leave evidence at ambush sites than at places they stop to sleep."

In the 1970's Brooks excavated an archeological site located at the edge of a large seasonal water hole. Although radiocarbon dating suggested that the uppermost layers were at most a few hundred years old, chipped stone tools showed it was older than the memories of living people who do not remember the use of chipped stone arrowheads or scrapers. Hunters and gatherers today do not camp at the edges of large water holes, to avoid both insect pests and large predators, which may lie in wait there for game. Furthermore, a fire pit dug into the ground at the site was unlike most fires at a living site, where visible fires are built on the surface for warmth and protection. And larger pits closer to the water contained bone and

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stone points and the jaws and horns of large animals. What might explain this new type of site?

Experience with modern hunting and gathering San suggested a probable answer. Like large African carnivores, hunters use the edges of large seasonal waterholes as ambush sites, lying in wait at night for game behind circular brush or stone blinds. Pit fires are reduced to coals and covered over to provide warmth without visible light or smoke to scare away prey. In the past, larger pits were dug as traps in the soft earth at the water's edge and then concealed. One day, one of Brooks' own excavation trenches was used as a pit trap into which hunters chased a kudu and speared it. After butchering, the head (including jaw) and horns were the only parts left at the site. One of Brooks' students collected data on the efficiency of nighttime ambush hunting. Brooks then compared this with previous data on the meat yield of daytime stalking. Ambush hunting was six to seven times more efficient.

The lowest levels at the waterhole site are much older, around 80,000 to 100,000 years, and contain little direct evidence of blinds or traps. The environment and possibly the people were also different from those of the present. Can the present still illuminate the past? The great number of large spear points and teeth of difficult to stalk animals, like zebra, suggest that at this time, too, the water hole was mainly used for ambush hunting. This strategy would have been even more important since the poison arrows crucial to the present stalking tactics were apparently unknown. "Archeologists should be looking at the evidence of early human sites more in terms of ambush and kill sites than in terms of camps or home bases."

OLD TOOLS FOR MODERN PREY

Hoping to understand 12,000 year old behavior in North America, University of Wyoming professor and former Smithsonian Regents Fellow George Frison travelled to Zimbabwe's Hwange National Park last August in conjunction with a government supervised elephant culling operation. Frison hoped to observe wild elephant behavior to test his ideas about early hunting strategies and to test replicas of early North American stone tools against the hides and tendons of these huge animals. "The modern-day elephant is the closest available parallel to the extinct and ancestral mammoth that we know was hunted by early man," Frison explains.

In the 1970's Frison excavated the Colby site near Worland, Wyoming where at least seven mostly young mammoths were butchered about 11,200 years ago. Three Clovis points were found along with bone and stone tools among the densely piled bones, including a large front quarter of mammoth placed in the center of other bones. Frison thinks the entire ensemble, which would have been covered with snow and ice, was placed there as an "insurance" meat cache similar to those left by Eskimos.

In Zimbabwe, Frison found that most of the meat on an elephant is concentrated on the forequarters. His observations of wild elephant behavior gave him clues to a possible prehistoric hunting strategy which he feels has been misrepresented by modern artistic renditions showing early man spearing huge mammoths head-on.

"A frontal assault on a family group would be hazardous in the extreme, but individual animals, often the younger ones, tend to wander and become isolated on the fringes of grazing areas. At that point they are vulnerable to a careful hunter." All this sheds light on the Colby site where a high percentage of the remains

were those of younger animals, and the 'stockpile' was largely composed of forequarters."

In his African research, Frison experimented with both tools and weaponry. He found that his stone tool butchering kit could pierce and skin the thick hides and dismember the huge carcasses more easily than expected. For skinning, Frison found quartzite flake tools superior to chert and much superior to large bifacial knives. With regard to weaponry, Frison commented, "One chert point I used, fixed to the haft with sinew and pine gum, reached the lung cavities of seven different elephants without the slightest damage. One that struck a rib lost part of its point, but could easily have been retouched for further use."

The new approaches which bolster George Frison's arguments, analyze Alison Brooks' ostrich eggshell, sort through Melinda Zeder's 100,000 bones, and identify Bruce Smith's domesticated seeds obviously come from very different sciences. While archeologists look to the past, they constantly utilize today's technologies and experimental methods in their search to uncover and explain human prehistory.

Ruth O. Selig

