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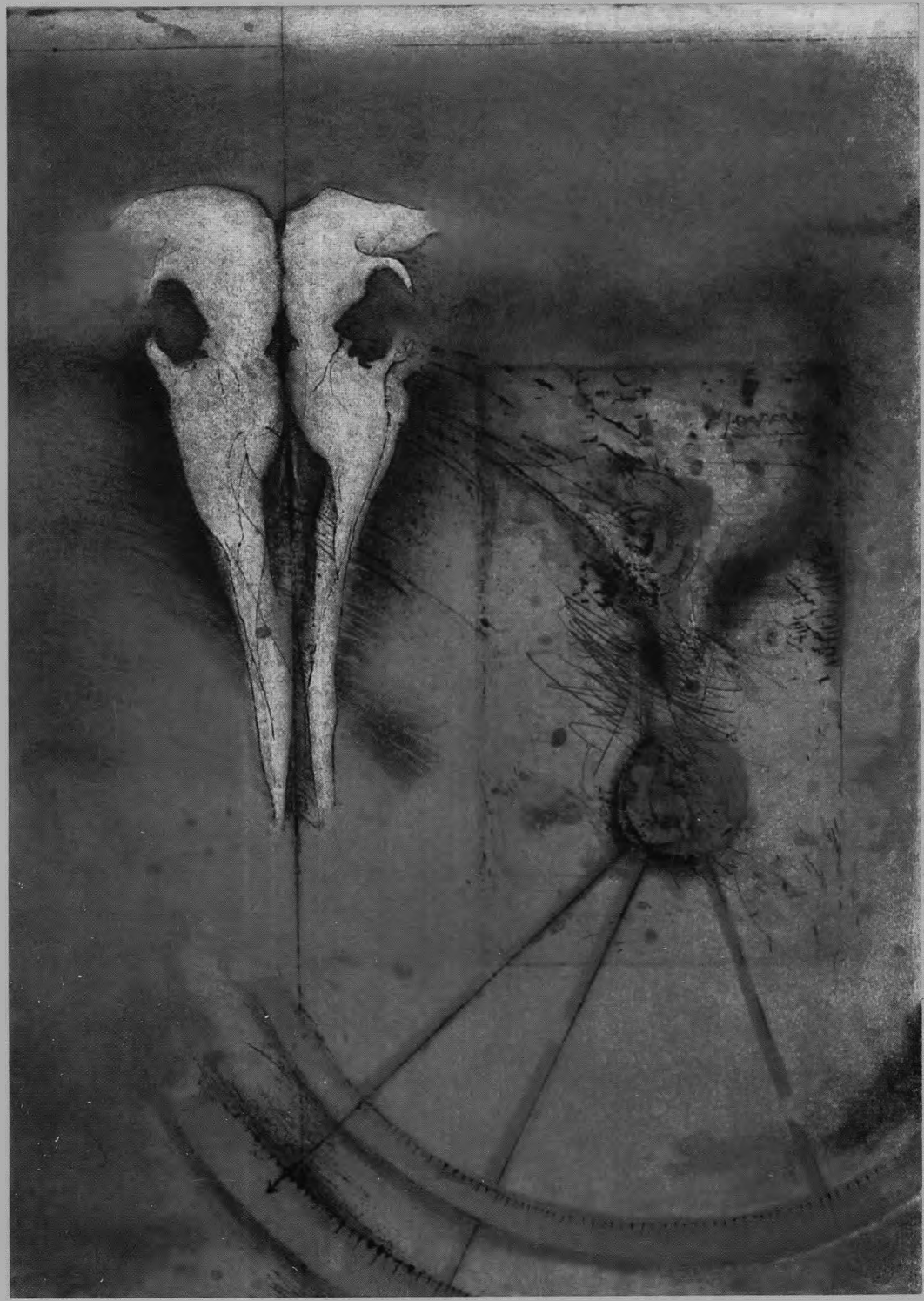
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April 1985

EXPLORATIONS

A JOURNAL OF RESEARCH
AT THE UNIVERSITY OF MAINE AT ORONO



Cover

The cover print is a multi-plate colored etching entitled Skull and Sun Dial, by Susan Groce, Associate Professor of Art at the University of Maine at Orono, where she teaches Printmaking and Drawing.

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EXPLORATIONS

A JOURNAL OF RESEARCH
AT THE UNIVERSITY OF MAINE AT ORONO

Volume I

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Number 2

Welcome to **EXPLORATIONS**, a Journal of Research at the University of Maine at Orono. The focus of this issue is the Center for the Study of Early Man, an affiliate of the Quaternary Institute at UMO. Join us as we explore the several disciplines contributing to our understanding of early man, the plants and animals in his environment, and the changing landscapes which formed the backdrop for his arduous life. We begin with the Quaternary, a geological period comprising the past two million years: time of ice and time of man.

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THE QUATERNARY

Change. It is the word most accurately describing the Quaternary Period: the last two million years of the Earth's four-and-a-half billion year history. It is a small step in the total history of the Earth, a mere blink in the temporal progression of our planet. Yet that pulse in the intractable dimension of time has witnessed the accelerated development of the creatures with which we are most intimately involved: the human species. Because of that intimacy, we know a persistent interest, a recurring visceral tug, to search the past. To learn what we once were, perhaps to understand better what we are, we study the Quaternary Period.

TIME OF ICE: *The Pleistocene Epoch*

A time of immense glaciation, the Pleistocene Epoch saw some of the most complex and intense changes ever known. Huge compressed bodies of ice grew to a thickness measured in miles; the earth groaned and bent to the tremendous weight of those solid grinding masses, the planet's surface was changed and molded as the frigid glaciers grew and diminished and grew again, forever leaving marks of passage in their wakes.

And it was cold. The climate was determined by the complex interrelationship of air, sea, and ice, and each responded to the others. Planet Earth is basically a closed system with given amounts of various elements; consequently, moisture forming the ice in the glaciers was extracted from the oceans, and as the glaciers increased, the oceans decreased. Sea levels went down.

Glaciers were not static. They retreated, sometimes by melting at their margins, sometimes by calving huge chunks of ice into the surrounding oceans. As their mass became less, much of their moisture was again in the form of water, and that water surged back to the seas. The now-bared land had been compressed by the relentless glaciers and was lower than the seas which flowed out in their quest for balance and equilibrium. But the land which had leaned in on itself to accommodate the incredible pressures of the ice sheets, began to rebound and rise to its former level. The waters again drained as earth and ocean sought a new balance.

What of the plants and animals? They, too, responded to the changing landscape and changing temperatures. Aquatic life could not, of course, remain in habitats which

drained, and land-bound specimens retreated before advancing water levels. Each left traces. As the glaciers advanced, climates became too cold to support most life forms, and violent swirling winds near the glacier fronts discouraged proximity.

Occasionally during the advance of glaciers might be found a refugium: a relatively unaltered area inhabited by persistent relics of plants and animals which served as a center for life forms from which a new dispersion and speciation might take place after the climate readjusted and warmed.

As the glaciers grew and retreated, their massive power altered the landscape. In immediate terms, the ice carved massive canyons; pulverized rocks; rearranged waterways and watersheds and dropped odd erratic chunks of stone miles from their points of origin. In slower terms, the glaciers changed the seas, and climate. And they determined where rich and poor soil deposits would be found. The rich soils of the middle American farmlands were formed from materials blown on prevailing winds from many miles away where glaciers were melting and freeing the fine material of immature soil from an icy grip.

In continental areas of the United States, the north-south orientation of the major mountain chains meant that biota, plants and animals, might move south as glaciers advanced, and return northwards as glaciers retreated. Those dispersion patterns could be interrupted by new waterways. Again, they all left their traces, and sometimes, as with some soils and pollens, the winds blew those traces away from their points of origin to new and sometimes peculiar locations where they would later puzzle scientists.

TIME OF HUMANS

Into this riotous complexity of change in the Americas humans came with their own responses to the environment and their own variations of advance and retreat. They are usually described by scholars as arriving in the Americas via the Bering Land Bridge: that strip of land between Siberia and Alaska which itself emerged from the sea floor and later submerged because of the cyclic advance and retreat of the glaciers.

Exactly when humans arrived in the Americas is a matter of scholarly dispute, but whether they arrived at the earliest or latest postulated date, they found a landscape of promise and a landscape of hardship and terror. The open vista of windy tundra with its scrubby, grassy vegetation extended for hundreds of miles near the retreating glaciers. Mixed woodlands and forests appeared in ever-warmer contours as the changing climate met their species' requirements. And the vegetation supported life.

Mammoths and mastodons, dire wolves and sabretooth cats, giant short-faced bears and giant beavers, skunks, rodents, rabbits, foxes, badgers, lions, pumas, horses and giant ground sloths were but a few of the mammals in residence. Human hunters learned to face the large mammals and prevail. Indeed, some scholars posit that skilled hunters became a major factor in the extinction of many of the large mammals, whose continued well-being was in a precarious balance. Ironically, many of the large mammals had migrated to the Americas across the same land bridge which carried their pursuers.

THE LAST 10,000 YEARS: *The Holocene Epoch*

The beginning of the Holocene Epoch was much like any other day in the continuum of time and its attendant complexities: except for giving the day a special name, it was impossible to distinguish it from the day before or the day after. The massive ice sheets extending south from the polar ice cap were melting, disintegrating, retreating. In their wake, the beginnings of young soils, some of which would be blown for thousands of miles on prevailing winds, were appearing on the drift in the glacier's wake. The sea level was rising and permafrost was losing its iron grasp of the land immediately around the glaciers. As ice retreated and land thawed, the climate warmed and became hospitable to more and different varieties of plants, animals, microbes.

Changes continued, and those changes left traces of their passing, remnants of their flowerings and deaths. As we study the Holocene Epoch, the name we choose to call the last 10,000 years of Earth history, and the closer we come to the present, the less murky the record. There is a plethora of data to find, to study, and to piece together.



THE INSTITUTE FOR QUATERNARY STUDIES: *Maine's Unique Approach to the Puzzles of the Past*

The very nature of the Quaternary Period determines the way in which it may be effectively studied: the complex environments of the Quaternary demand an interdisciplinary approach. No single discipline embraces *all* the components of those two million years. Geology and glaciology are essential to understand the movement and formation of many of the physical aspects of the Quaternary; botany and zoology are required to understand what plants and animals emerged, changed, and, in some cases, disappeared; anthropology is necessary if we are to comprehend anything about human societies and their cultural and biological development. To these we must add ecology with its own interrelated components; meteorology and climatology with their forceful influence on the environment, and of course, history.

The Institute for Quaternary Studies at the University of Maine at Orono was established in 1972 to bring together scientists from the many disciplines addressed to problems of the Quaternary Period and to provide them with an integrated academic environment in which to pursue their research. The Institute goes a step further, and, through its graduate study and granting of a master's degree in Quaternary Studies, has begun to provide the world market with young scholars whose cooperative orientation and interdisciplinary attitude toward studying the Quaternary are formed as they earn their degrees.

Because the Quaternary Period is the most recent in Earth history, the potential for reconstructing its environments is much greater than for those of the more distant past, and the potential for understanding is further enhanced because the *environments which currently exist reflect the events of the Quaternary*. As data are accumulated and interpreted, Quaternary scientists compile more and more instances of causality. A properly grounded atlas of causality can lead to a better grasp of future environments.

Research interests and activities within the Institute focus on problems which overlap and complement each other in an interdisciplinary mode. While many projects are conducted in New England and adjacent Canada, Institute staff reach beyond any suggestions of geographical limit and pursue research work around the globe. The western United States is the site of many research projects, and others are currently being conducted in Africa, Antarctica, Greenland, India and Scandinavia. Other projects are underway in the North Atlantic Ocean and the Ross Sea.

Formal and informal ties with international centers further enhance the Institute's scope. A formal exchange program is maintained with the University of Bergen, Norway, and informal relationships are nurtured with scientists at the Smithsonian Institution; the University of Washington; Columbia, Ohio State and Brown Universities; the University of Oslo, Norway; the University of Stockholm, Sweden; the British Museum, London; the Illinois State Museum; the Indian Statistical Institute, Calcutta; the University of the Witwatersrand and the Transvaal Museum, South Africa, and the University of Alberta. The international ties greatly benefit research efforts, and they frequently provide the raw materials for new research projects.

The research projects go on: rock formations, biota, ore deposits, oceanographic information, future climates, earthquakes and the beginnings of a new Ice Age are pursued relentlessly as the Institute's scientists gather and sift information as part of their commitment to greater understanding and new knowledge.

Scientists at the Institute are involved in research projects with clear and distinct importance for the quality of human life and the future environment. Paleoecologists are reconstructing lake acidification sequences in the northeastern U.S. and Norway; projects are underway to determine what effect climatic warming, induced by excessive carbon dioxide from industrial burning of fossil fuels, will have on the Antarctic glaciers and ice sheets, and ultimately, on sea levels. Other projects focus on crustal warping in Maine and its effects on nuclear power plant sites, as well as earthquakes and their effects on homes and businesses built near the easily shifted coast. Coal-bearing deposits in India are under study, and the results will provide information about the climatic, paleogeographic and tectonic history of the Indian plate just prior to and during the breakup of the Gondwana Ice Sheet; much of the data will be compared with parallel data from Maine studies. The research projects go on: rock formations, biota, ore deposits, oceanographic information, future climates, earthquakes and the beginnings of a new Ice Age are pursued relentlessly as the Institute's scientists gather and sift information as part of their commitment to greater understanding and new knowledge.

And they study ancient humans.

CENTER FOR THE STUDY OF EARLY MAN:

*"Numberless are the world's wonders, but none
More wonderful than man . . ."*

Antigone, from Sophocles'

Oedipus Cycle, translated by

Dudley Fitts & Robert Fitzgerald

July of 1981 saw the commitment to answering the most basic, and misleadingly simple, question of human history recognized with the establishment of the Center for the Study of Early Man. The unique nature of the Institute for Quaternary Studies and the internationally recognized stature of its faculty and research scientists was the determining factor for the William Bingham Trust for Charity's decision to award a five year grant for the establishment of the Center, an affiliate of the Institute for Quaternary Studies.

While dedicated to answering the basic question *When and how did the human species arise and spread across the earth?*, Center staff are aware of several problems slowing the resolution to that question: communications and training are pivotal points.

The study of early humans is conducted in widely scattered areas of the world, and results appear in several languages; research often takes place in nations where communications among scholars is minimal; a systematic dissemination of significant research results to both scientists and the general public is rare, and finally, most institutions of higher learning lack an appropriate staff and an organizational framework within which to train researchers intent on the early history of humans.

The Center for the Study of Early Man has put programs in place which serve to alleviate these shortcomings. As an academic resource center for conducting research on Pleistocene peoples of the Americas, the Center continually develops prerequisite library resources and important specimen collections which are available to Center staff and interested scholars. As a research center, an emphasis is placed on multidisciplinary research focusing on the earliest Americans, their lifestyles and the environments in which they lived.

In addition to research and resources, the Center helps to provide students with training in the latest ideas on the relationship between global environmental change, human development and cultural change. Four departments at UMO provide the faculty and curricular responsibilities for relevant courses. Close cooperation among the Anthropology, Geological Sciences, Botany and Plant Pathology and History Departments and the Institute for Quaternary Studies and the Center for the Study of Early Man makes a substantial contribution to an interdisciplinary orientation. The coursework is done in an interdisciplinary mode; the subject material is interdisciplinary, and, as students learn, their own attitudes are formed with a healthy respect for the place of all the separate com-

ponents inherent in studying humans. Their perspectives focus on the bringing together of parts to form a coherent and rich whole, rather than an endless and unredeemed analysis breaking studies into smaller and smaller and more isolated bits.

Public outreach is another commitment of the Center and its staff. Both the scholarly community and the interested public are enriched by programs and displays about research projects, and the Center's publication program provides books, journals and a newspaper of information about early human prehistory.

At the heart of the Center's existence pulses the quest for new knowledge: the lodestar of research. The interdisciplinary orientation of the Center's parent Quaternary Institute is intensified and reinforced as Center staff focus on ancient humanity and its ways of life. The Institute further serves to provide a rich pool of specialists necessary to reconstruct the many facets of ancient environments and their impact on human populations.

The land itself . . . the climate . . . plants and animals . . . rivers and lakes . . . sea levels and mountains . . . the richness of the soil are all components of the puzzle of ancient humans. They provided the raw materials with which people worked; they provided the full context within which they could fashion a life. And all of these components hinge on the changes brought about during the Quaternary Period.

While archaeological methods are used to collect and analyze different traces and remains left by ancient humans, it is anthropological theory which provides the integrative

framework for reconstructing human relationships to past environments. To make the puzzle more challenging, some of those environments lack modern counterparts. Understanding human biological and cultural development is intimately linked with global and local environmental changes that occurred during the past two million years.

In the study of early humans, Quaternary geology provides a context in the continuum of time; paleoecology provides the biotic context; climatology provides the physical context. And archaeology interprets traces of early humans left in the wake of their passage through those times and climates along with the plants and animals they supported.

Center personnel go further in the study of early human prehistory. They entertain theories of the relationships within early societies; they trace the aesthetic values suggested by the quality of tool manufacture and painting; they take humans from a place apart where they are represented by a few tools and some bones and hypothesize interactions and interrelationships.

Ancient humans experienced all the complexities of subsistence, values, personal and cultural expression, family and clan. Through careful study, we see early humans, not as isolated bones or tools, but as human individuals presented so that *we may imagine* we feel the wind in our hair; smell the sweat of fear or triumph; taste the putrifying remains of meat from an old kill. Early humans become individuals whom we may know as they conducted their lives with a shoulder pressed next to death.



ICE AGE PLANTS AND ANIMALS

Secrets of the Colorado Plateau

The Colorado Plateau is an ideal area in which to find clues to the distant past. It has an arid environment and its many caves have sheltered the remains of plants and animals for thousands of years. Within these caves, Jim and Emilee Mead have spent many weeks searching for clues to now-extinct forms of life, both plant and animal. From their finds, they are piecing together a picture of the landscapes of the late Ice Age and fitting in the clues of now-extinct animal life. Mammoths, mountain goats and giant ground sloths, as well as camels, native American horses and muskoxen, are all parts of their objective: a clear understanding of the plant and animal relationships of ancient America.

by Jim I. Mead and Emilee M. Mead

North America had a rich, diversified, and ever-changing biotic community long before the first Americans set foot in the hemisphere. Whether early humans first entered during the late Pleistocene (Ice Age), whether it was 12,000 years ago or much earlier, they had to rely on the

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available frontier environments, animals and plants, for subsistence. There is no question that the first humans in the Western Hemisphere were formidable predators, but like the other animals and the plants, they had to cope with the changing climates and environments of the glacial age.

A debate prevailing since the mid-1960s has been whether or not these immigrating hunters killed, or *over-killed* as it is often termed, all the large animals on the continent. For thousands of centuries, animals, large and small, had been adapting to the changing environments. Through time some animal groups would die out, leaving a void for evolving new species to fill. But something different appears to have happened at the end of the last major glacial 11,000 years ago; almost all the large mammals, but very few of the small ones, became extinct essentially simultaneously. What could have happened at this time that would have been so devastating? The glacial age was coming to a quick end; climate was changing and forcing the plants, therefore the food chain, to alter their geographic distributions. A rapid movement of the available food could have been chaotic to many large mammals. But was it? Another possibility is that the first Americans entered greater North America at this critical late glacial time and found a vulnerable animal community.

How does a researcher know if a population of these large mammals (megafauna: those animals that weigh in excess of 100 pounds, 44 kilograms) succumbed to the two-legged predator, or to the changing plant communities, or both? The researcher must first understand the plant-animal relationship that occurred through time. Once it is known what the *normal* association was, then the researcher looks for animals with *diet in distress*.

COMMUNITY RECONSTRUCTIONS

Skeletal remains of animals are found from the Arctic Circle to the hot, dry deserts of Mexico, and from the Pacific to the Atlantic Oceans. It is not particularly difficult to construct a list of the fossil fauna for any particular region, although many areas of the west are greatly understudied. Sedimentary cores taken from lake bottoms and bogs usually have provided adequate fossil plant remains to provide a general reconstruction of the regional plant community during the Ice Age. However, the paleoenvironmental studies of many areas of the arid west are still incomplete.

Microscopic pollen grains are for the most part the fossils needed for reconstruction of the regional plant communities that occurred during the late Ice Age. Until the late 1960s and early 1970s, pollen analyses were the only direct way to understand the vegetation of the past. The pollen evidence, although important in its own right, is usually too broad to allow a thorough understanding of the plant-animal relationships at a more local level. The paleoecologist is looking for specifics: exactly which species of plants were located in a given area, a canyon or mountain slope. In addition to knowing what was available, one must know exactly what plants were eaten by which animals. We are looking for more than the pollen: we need the entire flower with leaves and twigs associated. We need more than only the animal's skeleton: we need fragments of hair, tissue, and dung. It is these types of remains, which if found, can help answer the seemingly simple questions: *What were ancient plant-animal relationships? Was it the changing environments that killed some 30 genera of megafauna 11,000 to 10,000 years ago?*

These questions are very difficult to answer given the type of fossil record usually found on the continent. The



Where mammoths, Harrington's mountain goats, and giant ground sloths used to roam.

process of fossilization is detrimental to organisms. What type of environment in North America will preserve delicate flowers and leaves, hair, hooves, and dung? Usually these elements are decayed away by microorganisms, water, and the action of the sun. But, if these remains are deposited in a dry cave, safe in an environment of very low precipitation (xeric), they will last as long as the shelter itself exists. Such rare and ideal locations can be found in the arid west. What makes this even more enticing is that this region must have been the gateway to Central and South America for plants, animals, and humans.

COLORADO PLATEAU

The Colorado Plateau is one of the major physiographic regions of the United States. Covering approximately 130,000 square miles (338,000 square kilometers) of Arizona, Colorado, New Mexico, and Utah, the plateau is more than just a desert between the Rocky Mountains and the Basin and Range provinces. This highly dissected block of the Earth's crust reveals the four geological eras, with the most recent of these the least understood. Geologically the plateau has the general structure of a stack of dishes, tilted toward the northeast. Many of the rock strata that form the basement of the plateau are limestones and sandstones, deposited when inland seas and great sand dunes along the coast were common. During the past 60 million years, the land has risen about three miles, exposing it to the effects of erosion by wind and rain. The general plateau surface is now higher than 5,000 feet (1500 meters) in elevation; some plateaus and several peaks are more than 11,000 feet (3,300 meters) above sea level. Aridity and sparse vegetation are common in this land of extensive bare rock.

Researchers hunting the secrets of the past have, for the most part, not explored the Colorado Plateau. The arid west is immense, with some regions more remote than others. The plateau has been left alone.

PACK RAT MIDDENS

Unless pollen is deposited in a dry cave environment, it is destroyed in the harsh desert. Fortunately for the researcher there is a medium-sized rodent named the pack rat (some eight species in the genus *Neotoma* in western North America). Like most small mammals, the pack rat works on two major premises: eat and avoid being eaten. Of the first, the pack rat will eat almost any available vegetation: cactus, juniper, pine, saltbush, etc.

The pack rat is an ardent collector. During the night and twilight hours, it can be found eating and foraging vegetation from as far away from its nest as 330 feet (100 meters), its natural home range limit. Most items the pack rat collects are carried back to its den. The home is usually constructed at the base of a tree or thick bush, or fortunately for the paleoecologist, in caves and rock shelters. The pack rat piles enormous amounts of sticks, twigs, cacti pads, and a variety of other plant fragments around its nest; sometimes these mounds are 3.3 feet (one meter) high and almost 6.6 feet (two meters) in diameter at the base. The mound essentially becomes a reference collection of the local plant community. To add to this vegetable-heap fort, the pack rat will invariably bring in small stones and animal remains (disarticulated skeletal elements, dung from nearby piles, and owl pellets). All these items act as a barrier to help keep predators away from the nest. Periodic cleaning of pack rat dung pellets from the nest adds to the ever-accumulating pile of debris

The sticks and dung matrix of a fossil pack rat midden constructed during the late Pleistocene or early Holocene Epochs.



covering the nest. In caves and shelters, pack rats urinate on this debris slope (middens), which acts as a scent post for other exploring pack rats and as runway markers in areas of total darkness.

Homes, as just described, built outside and exposed to weather will deteriorate over a period of a few decades. But those that are built in caves and rock shelters have a different future. The urine deposited on the midden in caves does not wash away with rainstorms: it accumulates. Little by little, after generation on generation of pack rats, the urine permeates the midden and cements it rock-hard. As long as the rock shelters the cemented midden from the adverse effects of weather, the midden is preserved.



The skull from a juvenile Harrington's mountain goat embedded in a pack rat midden.

Urine-cemented (indurated) middens are commonly found throughout much of the arid west, filling the void where pollen profiles were not preserved. The paleoecologist knows that the pack rat midden is an excellent source for reconstructing the local vegetational community. The plan is to recover a variety of middens from a given area, for example, in one canyon, so that all elevations and slope aspects (*i.e.*, south facing vs north facing) have been sampled. The trick is to have similar-aged samples of the paleocommunity from all or most of the fossil localities.

Chunks about 4½ pounds (two kilograms) in weight are collected from each fossil midden. Sometimes a single midden may actually have multiple layers representing a wide range of depositional ages. In the laboratory each observed unit or layer of a midden sample is treated separately. Soaking in water disaggregates the urine cement, allowing all the fossil contents to be separated and washed. After oven drying and sorting, the most time consuming step is taken: identifying all fossils. This process requires the use of unusual comparative collections, such as a seed-twig-leaf collection, a reptile scale-skeleton collection, and a dung collection.

The final step in the analysis of a midden is to determine its radiocarbon age. Although there are a variety of approaches to sampling the midden contents for dating, usually a single taxon for example, 3.5 ounces (10 grams) of juniper twigs, is submitted for analysis. Some particularly interesting or complex midden layers may require multiple radiocarbon dates. With a list of plant and animal names and an associated age, the paleoecologist turns to pulling together all the plant data for a given date and a given slope: reconstruction of the changing biome through time.

GRAND CANYON

The Grand Canyon of the Colorado River is a land of extremes, an immense river-cut gorge winding approximately 278 miles (442 kilometers) through the southwest corner of the Colorado Plateau. In a relatively small horizontal distance, one can proceed from about 2,400 feet (720 meters) elevation in a hot, dry desert plant and animal community, up to a cool fir forest at 8400 feet (2,520 meters) elevation. The western half of the canyon, where the Colorado River empties into the Basin and Range province near Las Vegas, Nevada, is characterized by plateaus with relatively low elevations and a winter-dominated precipitation pattern. In contrast, the eastern end, with its very high forest-covered plateaus, is dominated by a summer rainstorm regime.

Approximately 100 fossil pack rat middens from the Grand Canyon have been radiometrically dated and the plant and animal contents identified. The middens, dating from 30,000 to 8,000 years before present indicate some interesting facts about the last Ice Age. Speaking in general terms, the record from the east end of the Grand Canyon is different than that from the lower, western end. Surely this represents the precipitation differences as observed there today.

What is now a low, hot desert with scarcely a tree in sight (and that is only the catclaw acacia, *Acacia greggii*,) was during the Ice Age an open juniper and single leaf ash (*Juniperus cf. osteosperma* and *Fraxinus anomala*) woodland.

Today the same junipers grow as a community 3,000 feet (900 meters) above the fossil sites. From 30,000 to 24,000 years before present the open woodland dominated the inner canyon, rim to river. During the full glacial, 24,000 to 14,000 years before present, more wet-tolerant species, mesophytic, were present; single leaf ash and joint fir (*Ephedra* sp.) were absent. From 14,000 to about 11,000 years before present there was again an open woodland with juniper and single leaf ash as dominants. The period 12,000 to 10,000 years ago was a time of relatively rapid change. Certain taxa began to disappear from the local flora, such as shadscale (*Atriplex confertifolia*) and black-brush (*Coleogyne ramosissima*). As some taxa retreated from the region, others such as the creosote-bush (*Larrea tridentata*), migrated in. But some species, like the sandpaper-bush (*Mortonia scabrella*), were present in the local community throughout the Ice Age and are still in the area today. There is no modern analog to compare with the Ice Age community. At any given time, each species adapted to the climate providing a continuously changing mosaic of plant species.

Gradually over a period of 4,000 years, the woodland lost its Ice Age appearance and began to look more like the modern desert environment. Inferences from the midden assemblages indicate that the climate was different than that of today. The presence of desert species not, or rarely, found in the woodlands on the rims today suggests mild temperatures in winter, perhaps only slightly cooler than today. The distribution of annual species which are strongly associated with a single rainy season indicates that during the Ice Age, as today, the balance was strongly in favor of winter rainfall. By approximately 8,000 years before present, the woodland was totally absent from the inner gorge of the western end of the Grand Canyon.

The eastern end of the Grand Canyon reacted entirely differently during the Ice Age. Data from ten middens suggest that during the full glacial, low-elevation xeric slopes were dominated by juniper, and shadscale, with sagebrush (*Artemisia* cf. *tridentata*) on the mesic slopes. High-elevation xeric slopes were dominated by limber pine (*Pinus flexilis*), with Douglas fir (*Pseudotsuga menziesii*)



A typical stretch of the Grand Canyon where now-extinct mountain goats grazed during the Ice Age thousands of years ago.

and white fir (*Abies concolor*) on the mesic slopes. One interpretation for this region of canyon was that a colder and drier climate existed during the glacial period.

Pack rat middens do not hold only a record of plants. A wealth of information concerning small mammals and reptiles has come to attention by analyzing the same glacial age middens. Certain cold-sensitive animals, such as the tortoise (*Gopherus agassizi*) and the chuckwalla (*Sauromalus obesus*) appeared in the western end of the canyon about 14,000 years before present, again indicating that at least in that region, winters were no colder than at present. Middens have provided representatives of reptiles and amphibians that were not known previously in the fossil record (*e.g.*, banded gecko, *Coleonyx variegatus*). Because the animals are found associated with plant remains, it is now possible to determine the actual Ice Age community in which they lived. As with the plants, the animal associations were different, disharmonious, than they are at present.

The same caves that have preserved the fragile plant and small animal remains have also saved a record of the megafauna. Rampart Cave, in the western portion of the Grand Canyon, has preserved countless cubic meters of ground sloth (*Nothrotheriops shastensis*) dung in addition to numerous skeletal remains along with hair and hide fragments. Analysis of the dung contents indicates that this six-foot-long sloth ate predominantly joint fir and globe mallow (*Sphaeralcea* sp.). Interestingly, the pack rat midden record indicates that these two plants were present throughout the glacial period and right on through the early Holocene to the present. In other words, presumably the sloth could live in the western end of the Grand

Canyon today. However, radiocarbon dates from all localities containing sloth remains indicate that this edentate became extinct 11,000 years ago.

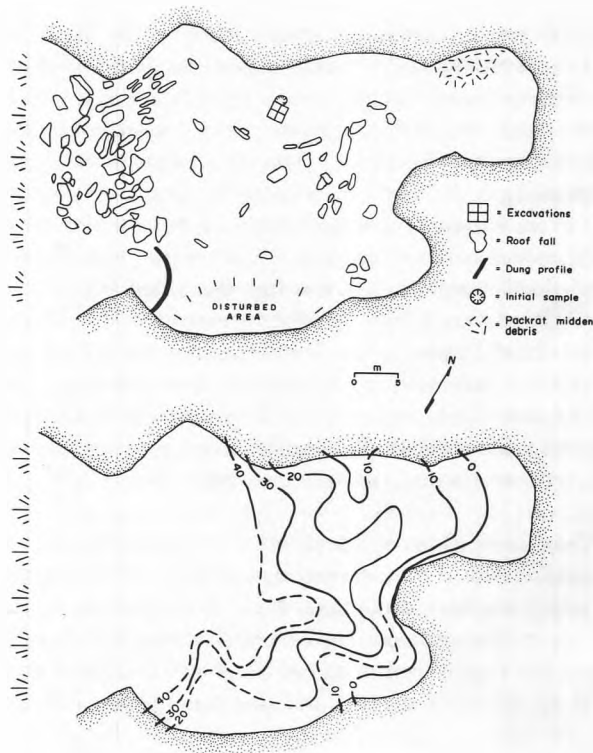
Certainly the most common large mammal in the Grand Canyon during the Ice Age was Harrington's mountain goat (*Oreamnos harringtoni*). Almost every dry cave in the canyon contains remains of this smaller-than-contemporary mountain goat. Very little was known about this species when it was first described from a few remains recovered from a cave in east-central Nevada. Again, the dry caves of the Grand Canyon have preserved a wealth of information. Almost the entire skeleton can now be described, including the keratinous horn sheaths. Hair remains indicate that for the most part, this mountain goat was white, as is its modern counterpart (*O. americanus*).

What is so unusual about many of the caves in the Grand Canyon is that the remains of the mountain goat, including copious amounts of its dung pellets, occur directly on the surface of the cave deposits, as if they were only a few tens of centuries old. Radiocarbon dates analyzed on the horn sheaths and the dung pellets indicate that the mountain goat, like the ground sloth, became extinct 11,000 years ago.

Analysis of the dung pellets indicates a seasonal diet for mountain goat. In winter when nutritious plants were at a minimum, the mountain goat ate the juniper and the spruce (*Picea* sp.) among other plants. During the spring and early summer, it ate a wide variety of flowers and bushes. The pack rat midden record and the reconstructed diet indicate the types of plant communities in which the mountain goat lived. The dung contents do not seem to indicate a diet in distress.

A Grand Canyon cave floor surface with the skull of an extinct Harrington's mountain goat, other bones, dung and a horn sheath. The materials are 11,000 years old.





Bechan Cave.

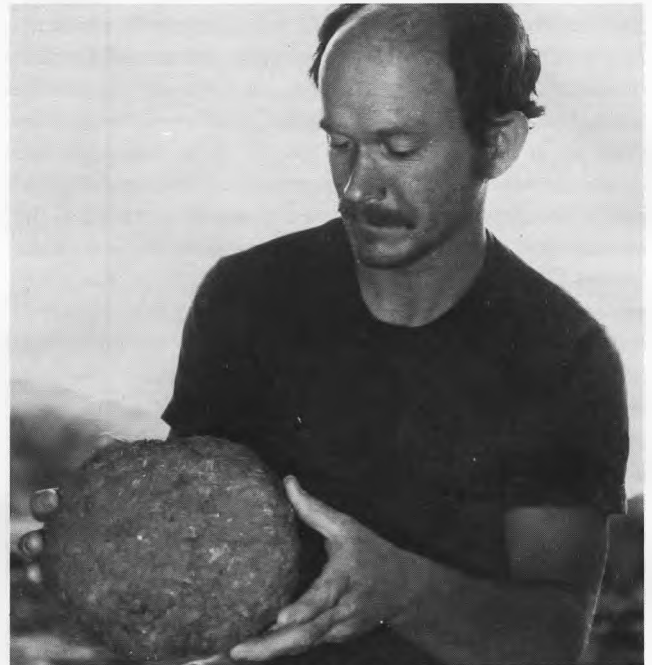
BECHAN CAVE

North and east of the Grand Canyon, in the land of the pink sandstone cliffs, is Bechan Cave. At present the cavern measures about 173 feet (53 meters) long, 103 feet (32 meters) wide, and 30 feet (9 meters) high. The large mouth entrance permits sunlight to shine into the cave for most of the daylight hours. A rich organic unit can be found 8 inches (20 centimeters) to 40 inches (100 centimeters) below the sandy floor surface. Excavations indicate that this unit, more than 390 cubic feet (11 cubic meters) is almost entirely dung. For this reason the cave was named *bechan*, the Navajo word for *big feces*.

Closer examination of the dung unit indicates that at least eight different mammals are represented by dung remains. By far the most numerous dung is from one type of animal. Although most of this single type is broken, trampled, and compacted, 15 complete to nearly complete dung boluses have been recovered. Two of these unaltered boluses measure 9.2 by 6.8 by 3.4 inches (230 by 170 by 85 millimeters) and 9 by 7 by 3.2 inches (225 by 175 by 80 millimeters) (length, width, and thickness). The overall size alone indicates that the animal that produced these feces was very large. Most large mammals that occurred in the region during the Ice Age void dung pellets, as did the mountain goat. Only the giant ground sloth,

Mylodon (larger than *Nothrotheriops*) could produce a dung bolus close to the size found in Bechan Cave. But sloth dung is segmented, forming vertical lobes, and the contents are all clipped very short, generally less than .2 inches (5 millimeters) in length.

The only animal alive today that produces dung similar to that discovered in Bechan Cave is the elephant (*Loxodonta*, African; *Elephas*, Asian). Elephants void boluses in mirror images to those from the dry cave. Even the coarse contents, stems and twigs 2.8 inches (70 millimeters) long and .2 inches (5 millimeters) in diameter, of the elephant dung is similar to that from Bechan Cave. The elephant that inhabited the Colorado Plateau was the mammoth (*Mammuthus*).



Research Associate Jim Mead and an 11,000 year old mammoth dung bolus from Bechan Cave.

The full analysis of the fossils recovered from Bechan Cave will take a few more years to complete. Only the mammoth dung has been examined, and a familiar story is emerging. The diet of the mammoth was predominantly grasses, although sedge (*Carex* spp.), birch (*Betula*), saltbush, and spruce were also eaten. These plants still grow in the region today, only at higher elevations and in somewhat reduced distributions.

Additional fieldwork is planned for upcoming summers so that we can find and collect the pack rat middens around Bechan Cave. The canyons contain upwards of 49.5 feet (15 meters) of alluvial fill and soil developments. Many of the sediments contain large quantities of land and freshwater mollusks, yet another independent reconstruction of the past environments.



An Ice Age barnyard is found inside the mouth of Bechan Cave.

THE PAST — THE FUTURE

Dry cave deposits containing unusually preserved animal remains and pack rat middens are being discovered in the arid west, particularly on the Colorado Plateau. A decade of studying the pack rat midden assemblages has provided a framework for reconstructing past environments. But the animal interaction with these changing plant communities is only beginning to emerge. The diet and the timing of extinction are accurately known only for the ground sloth, Harrington's mountain goat, and the temperate species of mammoth. Skeletal remains from alluvial deposits indicate that a host of other megafauna

also lived on the plateau. We need to better understand the camel (*Camelops*), shrub-ox (*Euceratherium*), mastodon (*Mammot*), and the tapir (*Tapirus*), to name but a few. When did they die? Why? Was it something they could not eat? Perhaps it was the actual temperature changes that affected the megafauna. If so, why did the pronghorn (*Antilocapra americana*) and the bighorn sheep (*Ovis canadensis*) survive? Maybe it *was* the human hunters who overkilled their protein resource. Very little if anything is known about the presence of the first Americans on the Colorado Plateau.

FINDING THE FACTS:

Pieces of the Puzzle

Research projects to provide the data from which understanding may be drawn fall into three basic areas: cultural and environmental reconstruction; stone and bone modification studies; human skeleton analysis and dating. Each provides information to help solve the enigma of the past.

RECONSTRUCTIONS

Cultural and environmental reconstruction is currently represented by six major research projects involving University of Maine at Orono scientists.

The Munsungun Lake Region has been the site of three seasons of archaeological survey and testing and four years of excavation work, sponsored by the National Science Foundation, Earthwatch, and the Maine Historic Preservation Commission. The Munsungun area contains significant lithic sources where prehistoric hunters and gatherers came to quarry stone for tool manufacture since the end of the last Ice Age. More than 100 sites and three centers of activity have been located, including clusters of quarry and workshop-habitation sites. Early stages of core and biface reduction are commonly found at both outcrops and pit mines excavated into bedrock. The workshop-habitation sites are located along ancient and modern terraces, on lake and kame terraces and on benches associated with glacial spillways between basins. The basic objective of the research is to reconstruct the settlement patterns, subsistence and lithic procurement patterns, and past environments. The present interpretation of the Paleoindian sites is that human occupation occurred on kame terrace sites while glacial ice was still in two local basins. (See story page 22.)

The Pryor Mountains are the site of research designed to develop a new understanding of human adaptation to mountainous environments. Supported by the National Geographic Society, the University of Alberta, the Montana Historic Preservation Office and the Bingham Trust for Charity, excavations were carried out on a transect of cave sites at low, medium and high altitude in south central Montana. Archaeological and ecological remains from the digs include an exceptionally large sample of small mammal remains, as well as site sediments and landform data. When the material is analyzed, its application to the artifactual remains from the sites will be used to interpret the sequences of human occupation reflecting human adaptations to a variety of mountainous settings.

The Great Basin Testing and Excavation Program focuses on the hunt for evidence of human occupation at the Rye Patch Reservoir site and Snake Range in Nevada. The project offers the possibility of evidence of human presence during the Pleistocene. At the Rye Patch Reservoir in northwestern Nevada and a series of caves in east-central Nevada, bone remains from mammoth, horse, camel and bison are being analyzed to determine the physical, biological, and possibly cultural processes which have altered the bones since the death of the animals. A number of bones, dating to about 23-29,000 years before present, were broken while still quite fresh and show impact scars associated with spiral fractures. Other bones have flake scars on their cortical surfaces. The bones suggest that human activity may well have caused the bone modifications.



The Colorado Plateau is home to Bechan Cave. Large quantities of ancient animal dung, deposited by now extinct mammoths and giant ground sloths, have been discovered in Bechan Cave in southern Utah. With funding from the National Geographic Society, researchers are analyzing the contents of that dung to gain data about the plant and animal life extant during their lifetimes. The information and analysis results should provide information relevant to reconstructing the Pleistocene environment and may provide answers to why so many large mammals became abruptly extinct toward the end of the Pleistocene. (See story page 6.)

The Anzick Clovis Burial Site is located in southwestern Montana, and it is the only known Clovis age burial site in the Americas. The site was found by accident, and contained more than 100 artifacts including bifaces, fluted points, bone foreshafts, a scraper, and a few flake tools as well as the skeletal remains of two children. Most of the artifacts were found covered with red ochre. A human bone from the site was dated with the tandem particle accelerator at 10,600 years before present. The artifacts are currently being analyzed in terms of their material, shape, size, technology, and use-wear patterns.

STONES AND BONES

Stone and bone modification studies are based on the fact that Pleistocene people used both stone and bone to adapt to and exploit their environments. In environments where stone resources were rare, bone from mammals could be used, and the same shaping techniques used for stone tool preparation could be adapted to making bone tools. Consequently, understanding *stone tool* manufacture can extend to *bone tool* manufacture. Early humans may also have cracked large bones to extract marrow for nourishment. It has been hypothesized, and is hotly debated, that bone modification by humans can be distinguished from bone modification due to other agents. Should the hypothesis stand, human presence could be determined by dating human-modified bone fragments in the absence of human skeletal remains.

Bone modification research currently includes the documentation and study of carnivore (wolf) modification of bones in a modern, controlled environment in Nova Scotia; human modification of modern mammal bones using elephant, moose, deer and cattle, and an analysis of similarities and differences between the two (wolf and human) types of modification and the development of a method to discriminate between them.

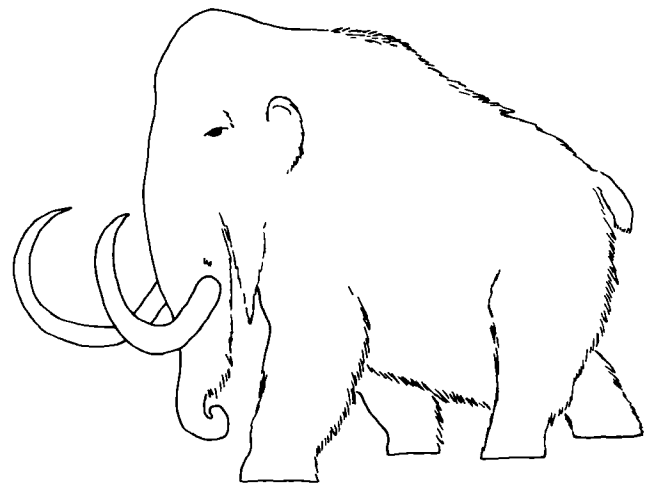
The First International Bone Modification Conference, funded in part by the National Science Foundation, was held in late summer, 1984. The conference brought together scientists and samples of bone collections from around the world; opened lines of communication among these geographically separated professionals and established the beginnings of a systematic approach to discriminating between human and animal modified bones.

The Ginsberg Project involved a cooperative effort by a research team from the University of Maine at Orono, the Smithsonian Institution, and the National Museum of Man, Canada. The team conducted butchering and flaking experiments on the remains of Ginsberg, an elephant which died at the Boston Park Zoo. The experiments were conducted at the Front Royal Zoo in Virginia and later in Ottawa, and analyses of the experiments are being conducted.

HUMAN SKELETAL DATING

The Human Skeletal Dating Project involves a new technique for dating very small portions of human skeletons, and its methods rest with a tandem particle accelerator located at the University of Arizona Laboratory of Isotope Geochemistry. (See story page 29.) The project is part of a larger interdisciplinary effort to review human skeletal material from the new world in terms of its dating, morphology, and Quaternary context.

Each of the research projects provides complementary information about our reconstruction and knowledge of the past.



ON LOCATION:

in Search of the First Americans

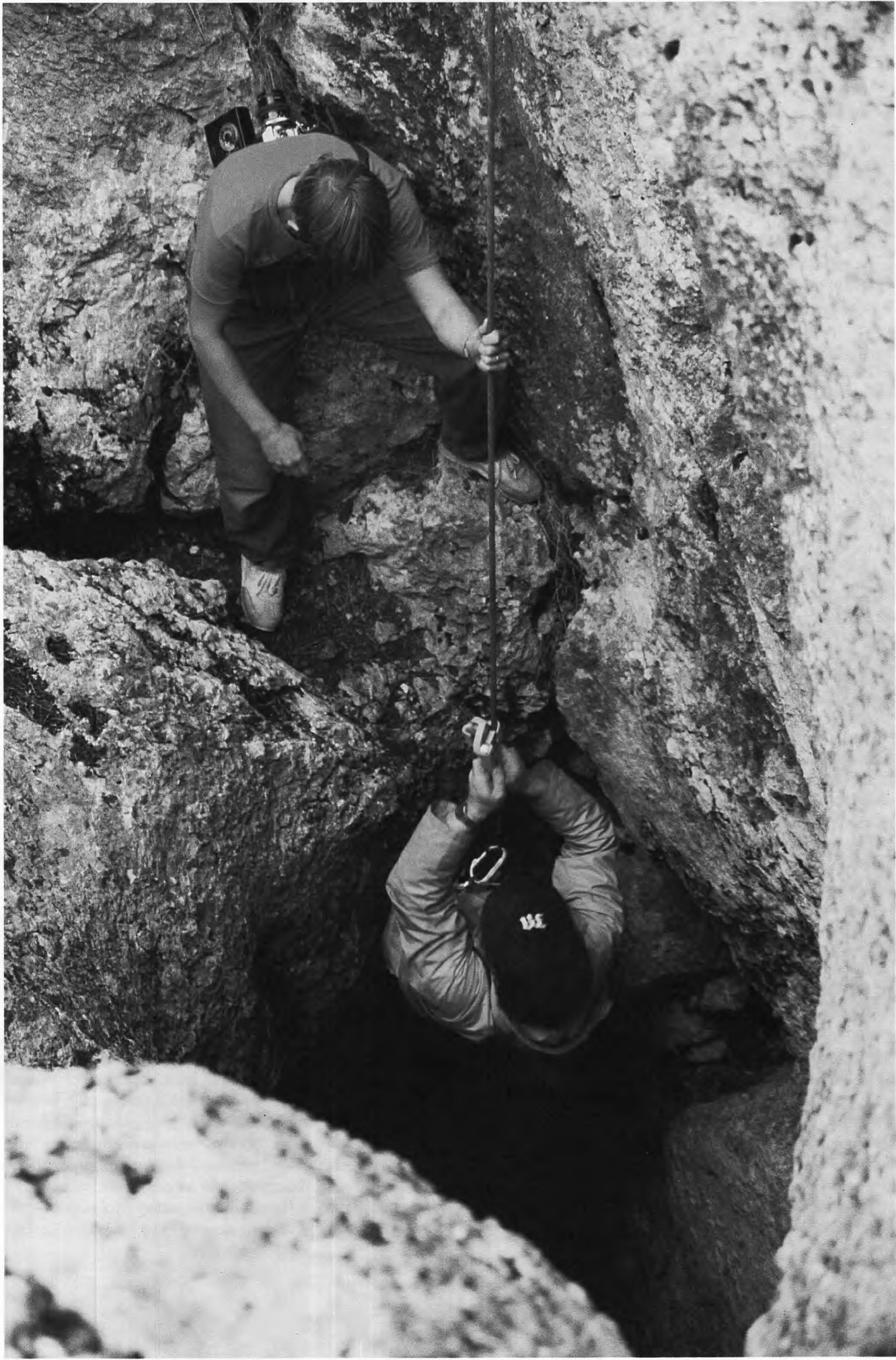
For seven weeks during the summer of 1984, researchers from the Center for the Study of Early Man at the University of Maine at Orono were trailed by Henry Nevison, Radio-Television Producer at UMO, and his assistant Greg Knox, a UMO work-study student. Moving from site to site to videotape the scientists at work, Nevison travelled 1,000 miles a week to capture on videotape the work in progress at sites in Arizona, Nevada, Utah, Wyoming, South Dakota, Idaho and Montana. The project has resulted in a 50 minute documentary program, *In Search of the First Americans*, scheduled to be aired on commercial television.

Opposite: Nevison is lowered 60 feet into Burial Cave, a natural trap cave in the Snake Range. Three descents were required to move the necessary video equipment into place in the cave bottom for taping. Bats, rattlesnakes and occasional bones slowed progress.

Below: Researchers were taped preparing to take a sedimentation sample from the bottom of a lake in the Black Hills. The double canoes are roped to shore to keep them steady while the long metal borer pipe, visible on the canoes, is lowered into place for sampling. The ancient environment of an area may be ascertained from examination of the core samples.

Right: Nevison videotapes part of the Great Basin, while volunteer Joanne Turner takes still photographs.





A desert will not support an Eskimoan lifestyle, and a Polynesian type culture will not be found in the high Arctic. The lifestyles people develop depend largely on what is available for them to work with, just as a group's technology is anchored to its available raw materials. While these propositions seem self-evident and simple, they are far more complex and elusive when we set out to understand the characteristics of a culture extant many thousands of years ago by depending on a reconstruction of environments which also existed many thousands of years ago. The challenge becomes more enigmatic when we try to reconstruct landscapes which existed during a time of rapid change. That is precisely what Ronald Davis and George Jacobson, Botany and Plant Pathology and the Institute for Quaternary Studies at UMO, did to help draw the limits of possible human activity at the end of the last Ice Age in northern New England and nearby parts of Canada. Those delineations provide a vegetational context for the Munsungun archaeological project. Special thanks are due Professor Davis for his generous donation of time telling us about the project and reviewing our retelling.

A TEMPORAL VEGETATIONAL CONTINUUM:

from Tundra to Forest

by Carole J. Bombard for Ronald B. Davis

Ronald B. Davis is Professor of Botany and has been a member of the Institute for Quaternary Studies since its inception. He earned his Ph.D. at Cornell, and his research in Maine began in 1958 with a major ecological study on the coastal spruce-fir forests. His research interests have since focused on paleoecology and lake studies including lake eutrophication, acid rain and lake acidification and Maine peatlands.

George L. Jacobson, Jr., is Associate Professor of Botany and Quaternary Studies and Acting Director of the Center for Marine Studies at UMO. He earned his Ph.D. at the University of Minnesota, and his research interests focus on plant ecology and terrestrial vegetation dynamics of eastern North America during the past 15,000 years.

Modern artistic expression often pays tribute to *the eternal hills* and sings praises of *the mighty oak* which has stood for two hundred years. From the perspective of a single lifetime, the hills may *seem* eternal and the oak an example of infinite stability. Yet the hills constantly undergo change, and mighty oaks are truly fragile parts of the environment. Indeed, environment and the components of its complex, and sometimes rapid, changes are key elements in an understanding of the past.

As demonstrated in modern paeans to the eternal hills and stable oak, the environment of a culture has an appreciable influence on how that culture may develop. Beyond its role as a source of artistic stimulation, the vegetation in a given area provides or precludes some vegetable food sources. That same environment supports only certain types of animals, both small creatures and megafauna. They too are a society's potential source of food, and raw materials for clothing, shelter and implements. Vegetation further is a reflection of elevation; the relative richness of various soils; the underlying bedrock and the geomorphology of an area. The landscapes, the environment, while only one aspect of the total context within which humans develop, is a potent influence.

How can scientists reconstruct landscapes which existed thousands of years ago? The key rests with the traces each species of plant occasionally leaves behind. In the remains of seeds, twigs, leaves and pollen, researchers find the information source they need to reconstruct past vegetation and to draw vegetational maps with a strong degree of confidence. And they add highly specialized and esoteric bits of working knowledge from their professional experience.

THE INTRICACIES OF THE CHALLENGE

Painting the past landscapes of northern New England and adjacent Canada presented particular difficulties in several forms. The topography of the area can be described as heterogenous: landforms, elevations, ancient lakes and seas present the researcher with a multitude of different conditions to integrate into any study results. A single, uniform area has far fewer challenges to an historical landscape reconstruction than an area presenting variation upon geographical variation. And the differences provide a number of factors with which the researcher must contend: ice sheets remain longer in valleys than at higher elevations; soil quality ranges widely from elevation to elevation; mountains present intrinsic difficulty of access and movement; watersheds are an agent helping to control dispersion rates and directions. The researchers at first were also challenged with a relative paucity of well-dated sites from which to establish base lines.

Water movement and mixing of sediments in many of the water bodies prevent the accumulation of distinct annual layers in the sediments. Called *varves*, such clearly differentiated annual layers are a sharp indication of the relative ages of deposits containing plant and animal remains. Varves are rarely found in northern New England. For this reason, researchers must date organic remnants by the carbon-14 process. (See dating story page 29.)

Looking for the pollen and macrofossil traces of long dead organisms is usually done by taking core samples from the bottoms of lakes. The reasons for this are that the lake serves as a collection basin that preserves organic remains in chronological sequence in its accumulating bottom sediments. Winds and flowing waters move the organic remains including pollen and other plant and animal parts away from the production sites to basins of deposition. The best basin of deposition in Maine is a lake bottom. Sediment coring allows the researchers to bore through lake bottom layers and retrieve those bored sections in lengths of a meter or so at a time. The retrieved sediments are extruded from the boring tubes or pipes, wrapped and returned to the laboratory, where they are examined for the presence of pollen exines, macrofossils and other matter in a controlled manner.

From the abundances of different types of materials in the core samples, scientists can reconstruct the type of landscapes which existed to produce those remains.

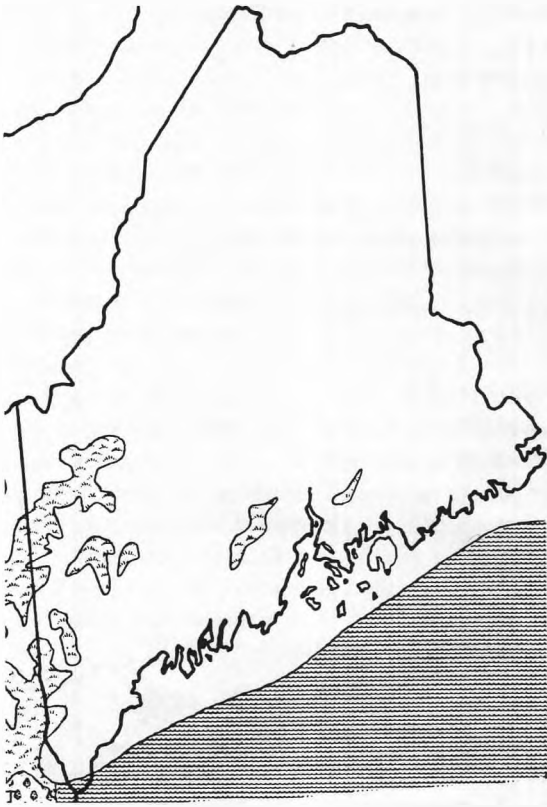
There are pitfalls to be avoided. By studying the characteristics of flowing water, glacial movement and winds, paleoecologists are able to correct for physical evidence which can mislead the amateur. For example, rock flour at the very bottom of a lake sediment core can be a surprise to the beginner, but the experienced researcher knows that the gray powdery material was produced by the grinding action of glaciers. Furthermore, professional researchers know that the rocks are ground up into flour as a glacier moves and carries the rocks in the ice mass and grinds them together. But when the ice melts, the rock flour flows out with the melt water and is deposited on the land or in lakes. That left on the land erodes quickly, and is added to the deposits in lake bottoms. While the presence of so much rock flour can be baffling to the uninitiated, the skilled paleoecologist can place it quickly in the timetable of a glacier's retreat: the mystery has a clear message.



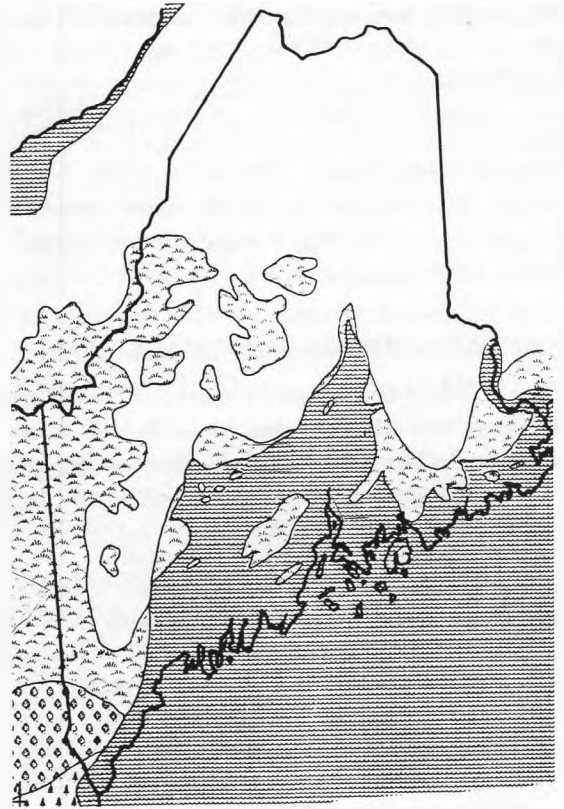
As a glacier moves further away from a lake area, living things colonize in the lake left behind. As life forms increase in abundance the sediment layers become more organic: the paleoecologist recognizes this. Materials from the watershed drain to the lakes, and living and dead plants and animals in the immediate area of the lake lose fragments to the lake itself. All of these biological traces become part of the scientists' core samples.

Other factors enter the picture: charcoal from man-made or natural fires washes into the lake. A fire storm or a wind storm accelerates the erosion and transport of material from its normal place to the bottoms of lakes in the area. Some species of trees leave very few pollen traces behind them; others leave a proportionately large number of traces. The experienced paleoecologist continually corrects for potentially misleading amounts of trace matter.

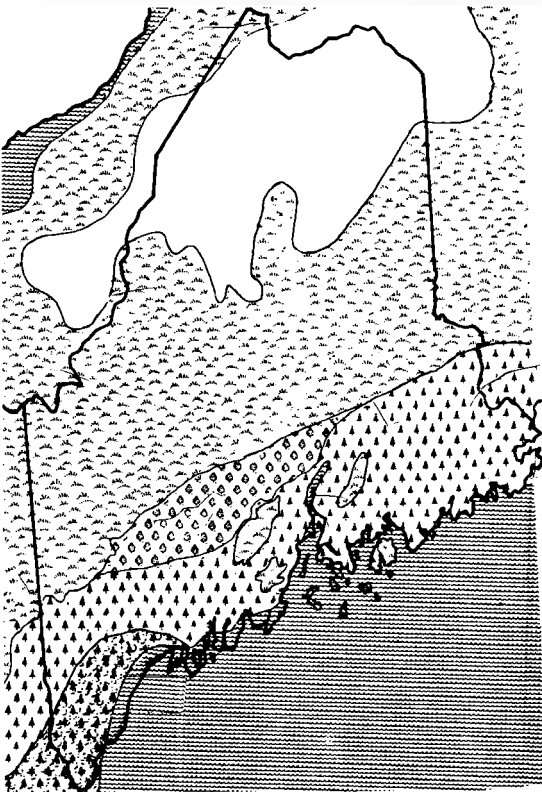
And so it was with the Munsungun Lake area. Davis worked with laboratory analyses of core samples from the bottom of Chase Lake, and from that work, was able to posit the historical landscapes which existed in the Munsungun area thousands of years ago. Together with Jacobson, Davis integrated the Chase Lake results with information from 50 other sites in northern New England to provide a series of maps demonstrating the types of environments extant at thousand year intervals between 14,000 and 9,000 years ago.



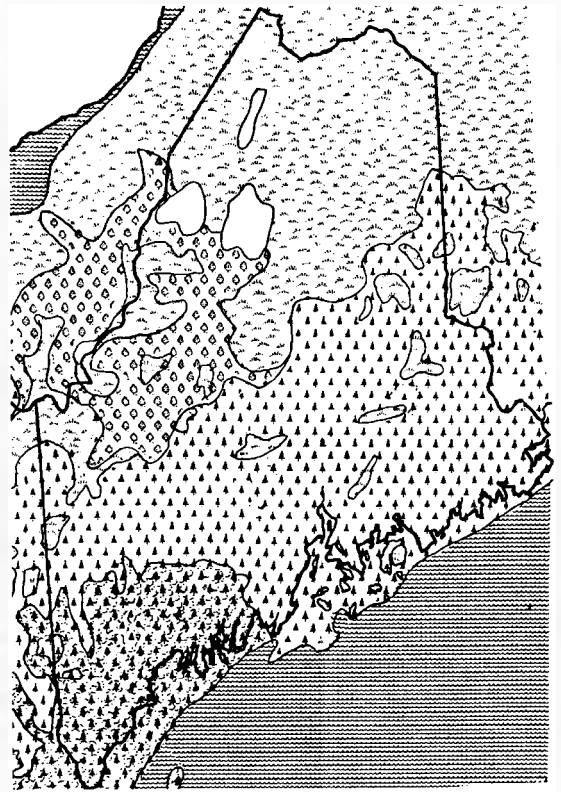
14,000 years ago



13,000 years ago



12,000 years ago



11,000 years ago

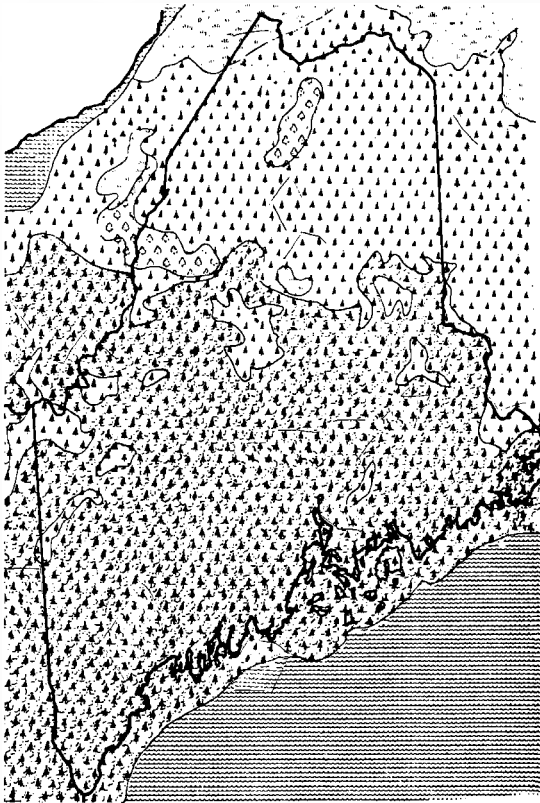
FIVE THOUSAND YEARS OF GARGANTUAN CHANGE

Between 14,000 and 9,000 years ago, northern New England and adjacent areas of Canada underwent massive change. Prompted by a declining ice sheet, sea levels, watersheds and climates changed. As these changes took place, the vegetation slowly transformed from tundra through intermediate stages to a closed forest.

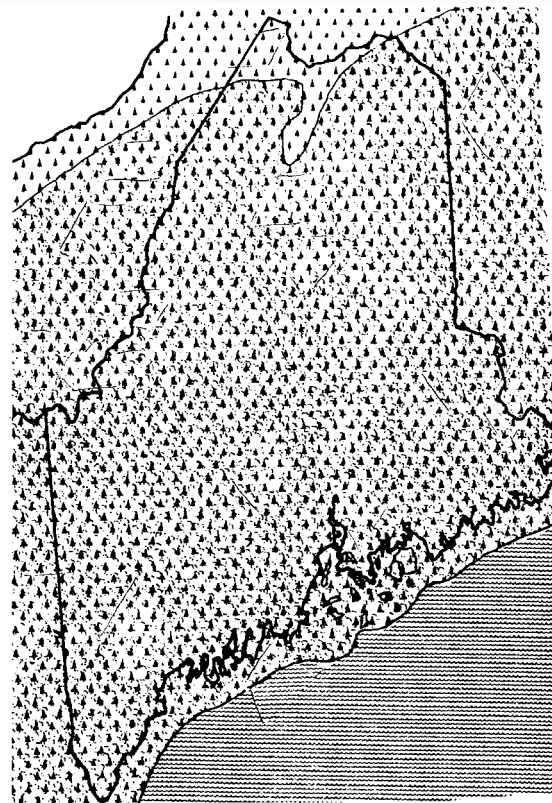
Davis and Jacobson used data from 51 carbon-14 dated sites from a variety of elevations to map ice and sea positions, vegetational zones, and the spread of individual species of trees in the region. In general, a continuum of tundra to open woodland to closed forest passed northeastward and northward without major hesitation or reversal. The rate of progression increased from 11,000 to 10,000 years ago suggesting that in that period a more rapid climatic warming occurred than in the previous two to three millennia. Elevational gradients controlled the patterns of deglaciation and vegetational change.

The earliest spread of various trees was via the lowlands of southern Vermont and New Hampshire, and along a coastal corridor in Maine. Beginning about 12,000 years ago, the tree species began to spread northward through the rest of the area.

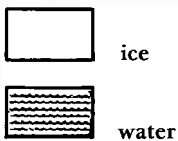
Davis and Jacobson have determined the approximate arrival order of various tree species. About 13,000 to 12,000 years ago, beginning in the southern part of the study area and working northwards, poplars, spruces, paper birch, and jack pine arrived and were followed by balsam fir and larch, and possibly ironwood, ash, and elm; followed somewhat later by oak, maple, white pine, and then hemlock. The species made their approximate first appearances in the south and ranged northward as the waning ice sheet and consequently warmer temperatures allowed. During those 5,000 years of dramatic change, the landscape went from a windy, cold, treeless tundra through the development of poplar woodlands, mixed woodlands and finally a closed forest similar to what is found today.



10,000 years ago



9,000 years ago



ice

water



tundra



poplar woodland



mixed woodland



forest

Archaeological digs are labor intensive undertakings, and available funding rarely meets the need for paid labor. EARTHWATCH, a nonprofit organization based in Belmont, Massachusetts, offers its members the opportunity to support scholarship and join worldwide research expeditions. Acting as a bridge between the public and noted scholars in the field, EARTHWATCH serves as a clearinghouse to provide eligible workers for expeditions. The volunteers pay their own way while in the field, and that contribution is tax-deductible. The result is an exciting learning experience for volunteers and support for research. EARTHWATCH volunteers have been helping with University of Maine at Orono expeditions for several years.

ANATOMY OF

by Robson Bonnicksen

My watch read 4:05, August 1, 1983. Turning into South Stevens parking lot at the University of Maine at Orono, I could see my crew of Earthwatch volunteers. They would be assisting me for the next two weeks on an archaeological excavation at Munsungun Lake, one of Maine's more remote areas, 40 miles north of Baxter State Park.

Months previously I had submitted grant proposals to the National Science Foundation and the Center for Field Research seeking funds to support archaeological and environmental research. This was my fourth and last year (1980-1983) of a major excavation program designed to understand regional, cultural and environmental history in remote northern Maine.

Our excavations had been preceded by three years of intensive field reconnaissance (1977-1979). My students and I had located approximately 100 archaeological sites in this densely wooded environment. The occurrence of beautiful red, gray, black, green and mottled fine-grained rocks, called cherts, apparently attracted native populations to the area thousands of years ago. Materials which are aesthetically pleasing and well suited for manufacturing flaked stone tools have a limited distribution in northern New England. The Munsungun Lake Formation cherts and volcanics served as a magnet attracting prehistoric peoples to the area since the end of the last Ice Age.

Our survey teams had found abundant evidence of prehistoric tool production activities. Small pit mines, usually not more than two meters in diameter, mark locations where aboriginal miners extracted raw materials from mountainside outcrops. Additionally, we had discovered a series of sites adjacent to both modern and ancient drainages containing evidence of tool manufacturing and habitation activities. These sites occur on a series of modern and ancient landforms found along the perimeters of Chase and Munsungun Lakes. The combination of archaeological sites of different ages associated with modern and ancient landforms, lake sediments with pollen suitable for reconstructing the history of vegetation, and evidence of aboriginal mining of chert and volcanic rocks presented an ideal opportunity to reconstruct the cultural and environmental history of an unknown, lithic resource center.



Robson Bonnichsen is Associate Professor of Anthropology and Quaternary Studies and Director of the Center for the Study of Early Man at UMO. He earned a Ph.D. in Anthropology at the University of Alberta, and the central theme of his research has been in reconstructing early human prehistory in the Americas. He has conducted field research in the Yukon, Montana, Idaho, Nevada, Maine and Alberta and has developed outstanding flint knapping abilities to better understand tool making and using by the earliest Americans.

AN EXCAVATION

The seven individuals standing in the parking lot recognized my van as a field vehicle. I stopped, and a tall middle-aged lady with a Texas drawl asked, “Are you Professor Bonnichsen?” Earthwatch had provided me with a series of fact sheets on the interests and skills of each of the volunteers: I answered, “You must be Mrs. Grengo, an elementary school teacher from Lubbock, Texas.” The other volunteers approached us and introduced themselves. As I looked over the group, I thought to myself, “You have been lucky again, it looks like a good group.” The volunteers had come from all over the country and were paying their way to work with me on my research project. I handed out meal tickets and led the team to Estabrooke Hall where they would spend the night.

During the evening orientation lecture, I attempted to prepare everyone for what was about to happen in the northern Maine woods.

Insects are so numerous they have grazing strategies and they take turns feeding: remember to bring your insect repellent.

We can count on damp wet tents; make certain you have plenty of warm clothing and an extra blanket.

Anyone caught using drugs will be given a one-way free trip back to town.

Garbage must be burned daily to keep bears away from camps.

Only Ken and his wife Gert, (who are wonderful cooks), are allowed in the kitchen.

Do not speak to Ken before his first cup of coffee in the morning: the nearest medical facility is at Ashland, more than 50 miles away.

The next morning we would travel to our base camp; excavations would begin the day after. As our caravan, loaded with equipment, seven professional staff, and seven volunteers, pulled away from the University on its four and a half hour drive to base camp, my mind turned to the project.

The Munsungun excavations have a unique place in the prehistory of New England and the maritime provinces. A major lithic resource center has not previously been investigated in this region. Prior to the Munsungun discoveries, Maine prehistory was known primarily from coastal shell midden sites, excavations at the Hirundo site located on Pushaw stream about 15 miles from Orono, and collections of specimens gathered by amateurs. Sea levels, rising since the end of the last Ice Age, have drowned coastal sites more than 6,000 years old. Sites found at Munsungun bracket the entire post-glacial period. Several sites older than 5,000 years before present have been discovered providing an opportunity to fill in gaps in early regional chronology.



Gouging
11,000–11,500
years old

Our research objectives at Munsungun entail reconstructing the settlement, subsistence, and lithic procurement patterns from recent to late Pleistocene times and understanding the relationship between cultural and environmental change. My task as the project coordinator has been to develop a multidisciplinary team approach for investigating the area; prepare grant proposals; coordinate the team effort; supervise the archaeological excavations, and integrate research results. Our goal during this last year of field investigation concentrated on the excavation of the early sites.

Our caravan of vehicles slowed approaching the base camp, and my first chore was to make certain that our large National Guard squad tents were still standing. Our base camp, located on a gravel pad developed for logging purposes, was subjected to periodic gusts of wind. We had established our field kitchen and eating area in one large tent and field laboratory and storage area in the other. Without these tents, we would have found working in this wet country very difficult.

Nevertheless, the tents had been a constant worry. Canvas shrinks when wet, and tent pegs can pull out. Many rainy nights during the last four years had found me checking the tension of tent ropes in the middle of the night.

We were finally at the project area and a sense of excitement spread. My staff, mostly graduate students and Dick, a retired IBM executive who worked closely with me on all aspects of the project, helped the volunteers find tents vacated by the previous team. Most of the volunteers simply dumped their gear and headed to the lake for a cool swim before dinner. Following a brief meal, the usual evening campfire was lit. Not only does this social convention allow one to avoid the ever-present evening insects, it is a great social facilitator. Soon Dick was telling stories about the accomplishments and personalities of former team members. For our work, this sort of interaction is a significant component of team building. Soon my watch beeped. It was nine o'clock and time for me to head for the sleeping bag.

From a deep sleep, I awoke to the sound of a car horn: the signal we used at 6:30 to wake camp. Breakfast was usually served at 7 a.m. I dressed and headed for the cook tent.

The weather was beautiful. Following breakfast, I led the new recruits on a fieldtrip to the Thoroughfare: the name we had given the excavation area between Chase and Munsungun Lakes. We had found 27 sites of different ages on the divide between the two lakes.

As we congregated before leaving camp, I explained that the Munsungun Lake Archaeological Research Project is a multidisciplinary effort involving specialists, primarily but not exclusively, from UMO's Institute for Quaternary Studies. Stephen Pollock from the University of Southern Maine is mapping the distribution of the Munsungun Lake Formation cherts and volcanics and documenting areas mined for tool materials. Harold W. Borns, Jr., UMO, is responsible for characterizing the physical environments in the project area; this includes reconstructing the late glacial and post-glacial events that shaped the local topography and led to the creation of landforms on which the archaeological sites are located. Ronald B. Davis, UMO, is reconstructing the area's paleoecological history through the use of palynological techniques. (See story page 18.) I am responsible for conducting the archaeological excavations and cultural reconstructions. Victor Konrad and Robert Black, UMO, specialists in soils chemistry, and Terry Gibson, University of Alberta, Edmonton, an expert in the use of proton magnetometers, are experimenting with their respective chemical and magnetic remote sensing techniques to help us determine where chemical concentrations and magnetic anomalies occur on sites that might indicate the location of human activity areas. Information of this nature is helpful in determining where to place excavation units. Central to the overall endeavor is



Graving



Scraping / Graving
11,000-11,500
years old



Cutting / Scraping
11,000-11,500
years old



Spearing
11,000-11,500
years old

Robert Stuckenrath, a radiocarbon specialist with the Smithsonian Institution. Through the use of radiocarbon dating, we can link the independent records developed by the physical, biological and cultural scientists into integrated reconstructions. (See dating story page 29.)

Several students are also conducting original research on the project. Vicki Clay has written a thesis on the soils chemistry of four of the sites at the Thoroughfare; Pauleena Seeber is writing a thesis comparing the production technology of two Ceramic Period (2,000 year old) sites; and Lawrence Goldberg is investigating the role of Munsungun cherts in prehistoric commerce. By looking at the percentage of Munsungun cherts used for tool production relative to other materials at other New England and maritime archaeological sites, he hopes to determine how significant the Munsungun source center was in regional aboriginal economies. With the objective of understanding the early human colonization of northern New England, James Payne is comparing the earliest artifacts from Munsungun with specimens from the Debert site in Nova Scotia and Vail site in western Maine.

The cool early morning humidity was penetrating. I could sense the team was anxious to get on the trail. Raspberry bushes now partially masked the trail to the site. Four years previously the area had been extensively logged in an effort to salvage timber from the effects of spruce bud worm infestation. We were wet up to our shoulders by the time we approached our site location, the divide separating the two lakes.

If we could look down on the bedrock ridge as an eagle might, we would see a series of ancient glacial spillway channels linking Chase and Munsungun Lake basins. At the end of the last Ice Age, when warming occurred and meltwater was released from stagnant ice, water flowed along the ice margins spilling over the bedrock constriction into Munsungun basin. As the base level of the stagnant ice dropped with melting, meltwater cut new channels lower down on the bedrock divide. Associated with each lowering event was the deposition of river gravels in the meltwater channels. These river beds were deposited along the margins of the basin and are called kame terraces. Following deglaciation, clay and gravel deposits left by the glacier, known as outwash and till deposits, were dissected by down-cutting of the local drainage system. At least seven separate benches or terraces were created by changes in drainages at the Thoroughfare. These surfaces were used by prehistoric populations. The oldest sites occur on the highest landforms adjacent to the ancient spillway channels, and the youngest sites are found next to Munsungun and Chase Lakes.



Cutting
11,000-11,500
years old

We stopped at the outlet of Chase Lake at the base of the basalt ridge. Fortunately, several years before, the U.S. Geological Survey had placed a benchmark in a critical location right on the edge of the project area. The benchmark with legal coordinates and an elevation of 822 feet above sea level had served an important function on our project. Working from this point using transits, we had developed a grid system with a one meter interval over the entire Thoroughfare area. The north-south and east-west trending coordinate system provided a framework for laying out our excavation units and documenting the locations of all specimens and features.

Gesturing to the west, I said, "That willow-covered point projecting into Chase Lake is a small delta created where Atkins Brook dumps into Chase Lake. January 15, 1981, Ronald Davis obtained a core from near the center of the lake opposite the willows." I remember well that day. Temperatures had dropped to -25 F. From the surface of the ice, we extracted an excellent core six meters long and ten centimeters in diameter. In addition to pollen preserved in the lake sediments, were terrestrial and aquatic plant macrofossils and charcoal which are

providing insights into past environments. Professor Davis has determined that when glacial ice was in the process of leaving the area approximately 11,500 years ago, a tundra occurred until it was replaced about a thousand years later by a woodland/parkland; this pattern in turn was replaced by a forest about 9,000 years ago.

Moving along the trail next to the small stream between the two lakes, we soon came to a clearing with a panoramic view of one of Maine's most beautiful lakes: Munsungun. From this vantage point, we could see where Steve Pollock had spent parts of the last two summers attempting to trace the elusive Munsungun Formation which is often masked by dense vegetation. From this point the Munsungun Lake Formation occurs approximately one half kilometer down the lake and runs under the lake as well as along the north flank of the basin.

Turning and pointing to the west, I indicated that the Thoroughfare area on the other side of the stream is where our excavations had focused during the last four years. Returning back up the trail to our stream crossing point, I took off my shoes and walked barefooted through knee-deep water on the sharp slippery rocks. I stopped half way across to help the tender-footed.

On the other side of the brook, we travelled along a well-worn trail to the bottom terrace overlooking Munsungun Lake. Standing on the edge of a small clearing, I explained that we had excavated here in previous years. Upon completing excavations, we have restored the site surface to its original topography.

Several years ago we developed a tradition of having crew members name sites. Venus of Munsungun was named in honor of a shapely rock located on the shoreline.

Excavations here have yielded Ceramic period (recent to 2,000 years before present) and late Archaic period (2,000 to 5,000 years before present) artifacts. Numerous fire-cracked rocks occur just below the humus mat. These suggest the use of fire-heated rocks for cooking and heating. Broken pot sherds, triangular, small side-notched, and stemmed projectile points and numerous small scrapers characterize the flaked stone artifacts. The recovery of deer, beaver, and moose bone fragments suggest the prehistoric occupants found an ecology similar to the one today.

From the Venus of Munsungun, we travelled approximately 150 meters to the west along a winding trail and stopped on a fluvial terrace (stream deposited) surface six meters above the pool level of Munsungun Lake. Excavations at the Blue Ribbon site (1980 and 1981) had revealed evidence of a little known archaeological culture. By excavating a series of adjacent squares, we had exposed two large, semicircular mats of fire-cracked rocks: probably hearth areas. Charcoal from one of the hearths dated by the radiocarbon 14 method suggests an occupation about 5,000 years before present. These features were probably associated with prehistoric houses, perhaps large wigwams. Unfortunately, organic remains do not preserve well in acid forest soils, and additional evidence that would support this interpretation is lacking. From the hearth, we also recovered numerous burned bone fragments, all beaver. A substantial collection of stone artifacts and flakes left behind from manufacturing activities included long lanceolate points (probably used for atlatls or spears); stemmed points (possibly for hafted knives); large oval to crescentic shaped bifacially flaked items (probably knives); and large ovoid scrapers. In addition to the tools made from several varieties of Munsungun Lake Formation cherts and volcanics, quartz crystal flakes shaped by bipolar flaking techniques were recovered. Their purpose remains enigmatic.

From the Blue Ribbon site, the trail climbs the toe of the first large kame terrace 14 meters above the pool level of Munsungun Lake. Rather than climb im-



Spearing / Cutting



Cutting / Scraping
5,000 years old

mediately to the early Fluted Point site on the terrace, we walked northwest to examine ongoing excavations at the Knob site. Wayne, the site dig foreman, explained to the new recruits that at eight meters above pool level, the Knob site was producing a fascinating assemblage of flaked stone artifacts. The most characteristic include a leaf-shaped lanceolate point; boat shaped cores with side struck flake scars, and end scrapers made of beautiful red, green and gray cherts. All remains are localized in an area measuring no more than 6 x 8 meters. Our current interpretation is that the small bench, on which the Knob site occurs, was shaped by streams as the last ice in Munsungun Basin was melting. Occupation occurred at this site before the larger terrace at the Blue Ribbon site was formed. Our guess is that this occupation is about 9,000 to 1,000 years old.



Cutting
5,000 years old

Returning to the main trail which crosses the Blue Ribbon site, we climbed to the Fluted Point site. Fluted points are generally regarded as diagnostic indicators of the earliest human occupants in much of America including the Northeast. Excavations into the surface of this large kame terrace over the last four years indicate that a 2,000 square meter area contains evidence of human occupation. As we approached five open 2 meter squares I asked Bob, the crew chief, to provide an overview of ongoing work. He explained that as with the later period sites we had been examining, tree throw activity and frost heaving had disturbed the stratigraphy. On the basis of kame terrace location and the fact that fluted points sites in the Munsungun Lake area occur only on kame terraces, we suspect that the people who resided here did so before glacial ice was gone. It is probable that these early peoples lived in a tundra environment. Our efforts to locate a hearth with charcoal for radiocarbon dating had met with frustration. The charcoal that we had located was from recent forest fires.

Artifacts forming the tool kits of the fluted point people include bifaces, fluted points, spurred graters, scrapers and retouched flakes. These tools suggest both habitation and workshop activities. No skeletal remains have been found, and we do not know if these people hunted now-extinct animals such as mammoth, horse, and muskox which moved into Maine during late Pleistocene times.

Our morning was nearly gone and time would not permit us to review all of the sites before lunch. Since it was the beginning of an excavation session, we returned to camp for lunch and an afternoon lecture.

A central problem in archaeology is that excavation is labor intensive. Given the high costs of labor, few archaeological digs would occur without the assistance of volunteers. Learning by a trial and error process, we had developed a streamlined educational system to provide volunteers with essential information. By using a combination of lectures, handouts, and knowledge gained about the project from the orientation field trip, most volunteers rapidly learned their roles. Sheryl, my field laboratory supervisor, explained, using a handout, how to document the location of artifacts found in each square and how to prepare drawings of each five centimeter level excavated. Following the usual question and answer period, the moment that all of the volunteers had been wondering about drew near. What excavation would they be working on?

Crew assignments are one of the most complex decision making activities on the project. Whereas the scientific procedures are straightforward, determining what people are best suited to work together is not so clear-cut. Our organizational framework entails not only the use of dig foremen, but combines seasoned personnel with inexperienced personnel so that there are always knowledgeable people present at the site. For this session, we split our crew into three teams to continue work on the Knob site, the Fluted Point site, and the Windy City site, a Paleoindian site we had not been able to visit during the morning tour. Once the crew assignments were made, the teams



Scraping



Spearing
5,000 years old

went into the field. It was the responsibility of the crew leaders to provide a demonstration illustrating proper excavation etiquette.

After the teams were trained, work settled into a daily routine. Each day the teams went to the field by 8. Two individuals worked together on each two meter square excavation unit using a trowel-to-dustpan-to-bucket-to-screen method for processing all sediments. All materials recovered were placed in plastic bags and field labels were prepared. The specimens were then returned to the field laboratory for cleaning and cataloging.

My routine involved working back and forth among all of the sites being excavated. By regularly consulting with the team leaders, I assist with developing excavation strategy. Additionally I routinely monitor for potential excavation and personnel problems. As discoveries of interest are made, I take color and black and white photographs of specimens and features before they are removed. Thus we ensure a permanent record of discoveries in context.

Midway through the session, Dick's team at the Windy City site made an important discovery. Located on the Chase Lake side of the Thoroughfare on the surface of the 14 meter kame terrace, the young man from Virginia had located a complete fluted point broken in three parts during manufacture. He beamed as Dick said, *Just think, you are the first person to touch that specimen in more than 10,000 years.* As I made my daily rounds following excavation activities, Dick pointed out what had first appeared as a charcoal stain was indeed much more. A pit with flecks of charcoal was emerging. At long last, we had found a datable hearth on one of the kame terrace sites. Not only would a date on the hearth allow us to place an age on the site, but it would allow us to relate human occupation to Ronald Davis' vegetation reconstruction. At this writing the date of the hearth is pending.

Good weather lasted, and we were able to complete the full two weeks of excavation without interruption. The last evening in the field, our cooks prepared an outstanding dinner: barbecued steaks, baked potatoes, fresh salad, and fantastic apple strudel. As darkness approached we all gathered around the campfire. Celebrating new friendships, each campfire orator attempted to outdo his predecessor by recounting highlights and new stories based on the last two weeks.

On the way back to the University next morning, I reflected on the discoveries we had been making and their potential significance. Once the data from the project is fully analyzed, there will be two anthropological contributions to hunter and gatherer studies. We are learning a great deal about how human groups organized themselves for obtaining and processing raw materials used in a variety of environmental settings through time. Additionally, the early sites on the kame terraces relate to the questions of when and how New England was originally colonized at the end of the last Ice Age. Over and beyond these trends, a systematic body of archaeological and environmental data has been gathered in a poorly known region and will provide a beginning point for additional studies.

Once back in civilization, dressed in clean clothes with newly acquired tans, the volunteers joked and talked with one another as we went to a local restaurant for dinner. When the volunteers left the next morning, they had my respect for their unselfish contributions to our project.

The most common question asked about a piece of a skeleton or an artifact is *How old is it?* followed by *How do you know?* There are a number of ways to arrive at the age of an object. Some methods can provide relative age values, the age of an object in respect to the age of another; some methods date an unknown object by its proximity to, or identical chemistry with, an object with a known age. Some methods of approximate dating involve sophisticated deductions from known limits and possibilities; some rely on approximate dating through observations about what has happened to a specimen since its death. These types of dating provide approximate and relative ages. Radiocarbon dating is a technique which has been used for about 35 years, and it provides the dates of organic objects within a reasonably tight range of error. Dating organic specimens, especially very small pieces of ancient human skeletons, can now be done using a new technique and a sophisticated piece of equipment: the tandem particle accelerator.

WHAT THE BONES TELL US



A complete lower human jaw or mandible from a salt marsh area on the coast of Georgia is in the process of being dated using the tandem particle accelerator at the University of Arizona Laboratory of Isotope Geochemistry. As with other ancient specimens, before being sampled for dating, it is extensively photographed and examined and high resolution casts are made. Its dark color is due to the incorporation of minerals over thousands of years. (Actual size)

by Marcella H. Sorg

Controversy surrounding the timing of human colonization of North and South America has revolved around problems of dating, and those problems are especially acute when sites contain human skeletal remains. Some scientists have supported a more recent peopling of the Americas dating about 12,000 years ago. Others have supported an earlier arrival dating about 40,000 years ago. A small number of specialists suggest people may have been here for several hundred thousand years.

Placing a date on the arrival of humans into the Western Hemisphere is not an easy task. Although it is often possible to determine a geological date for a given site based on the surrounding sediments, these dates are usually not specific. To obtain a more exact date, radiometric dating is employed. This method takes advantage of the fact that certain radioactive elements *decay*, lose electrons, at a known rate. For example, living organisms contain two isotopes of carbon, that is, forms of carbon that have different numbers of electrons. These isotopes of carbon-12 and carbon-14 are found in a specific ratio in all living plants and animals. When an organism dies, the carbon-14 begins to decay to carbon-12, changing the ratio at a known rate. Carbon-14 dating measures the ratio in organic remains, and statistically calculates the number of years since death. This date is reported with a statistical error figure, the *plus or minus* part. The real date is judged to fall within the bounds of this range with a high level of probability.

This conventional method of radiocarbon dating has been in use only about 35 years. To use it, ideally one must have remains of plants or animals which still contain enough organics (carbon and its compounds) to produce at least one gram of carbon. Depending on how much fossilization has taken place, this might mean enough to fill one 35mm film can to the brim.

To obtain this sample size, the archaeologist must carefully pick out flecks of charcoal or other organics from a wide area of the site, being careful not to contaminate the sample with younger or older materials.

Dating organic samples by the conventional radiocarbon method entails destroying the sample itself. Because

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of this some people have been reluctant to give up fragmentary human skeletal remains to obtain a radiometric date.

In fact, human skeletal remains from the Americas which are potentially older than 10,000 years are extremely rare and nearly always fragmentary. Although the reason for this scarcity is unknown, it may be related to the cultural death practices of the earliest Americans. For a skeleton to survive intact it usually has to be buried, either culturally or accidentally, thus protecting the bones from agents of decomposition and damage such as moisture, oxygen, acidity, scavengers, and the weather. When bodies are disposed of by cultural practices other than burial, they are less likely to survive the rigors of time.

A new form of radiocarbon dating using the tandem particle accelerator has been a breakthrough for those who study the Paleoindian Period, before 10,000 years ago. This new method requires only a tiny sample of carbon: only 0.01 gram, compared to the 1.00 gram required by the conventional technique.

Two now-standard approaches are used in the conventional method. Both are based on measurements of beta particles emitted by the carbon-14 nucleus in the process of decay. One technique creates carbon dioxide by burning the sample in an oxygen-filled environment (or, in the case of bone samples, dissolving it in acid), and uses a particle counter to estimate the carbon-14 concentration in the sample. The liquid scintillation technique, on the other hand, converts the carboniferous material to benzene and counts light emissions created by beta particles as they pass through a phosphorescent liquid.

The new method uses a linear accelerator and a mass spectrometer to measure the mass of carbon-14 present in the sample. Because the carbon compound to be dated is a negative ion, the mass spectrometer can be employed to isolate the carbon-14 isotope. This new method can be used on even small specks of charcoal or fragments of bone from Pleistocene sites as early as 40,000 years ago.

The Center for the Study of Early Man is taking a leadership role in gathering samples of potentially early human skeletons for carbon-14 dating on the tandem particle accelerator at the University of Arizona Laboratory of Isotope Geochemistry. None of these remains have been dated before; some of the specimens are from sites located very recently.

One specimen, for example, comes from a salt marsh area on the coast of Georgia: a complete lower jaw or mandible. It is heavier than modern mandibles because minerals have been incorporated into the bony structure over thousands of years, replacing some of the lighter organic matter. The mineralization process has turned the bone a dark grey and the teeth shiny black. A sample of bone will be removed from the bottom edge of one side of the jaw. This is where the bone is the most dense and

most likely to have retained organic matter. Before the sample is taken, the mandible will be extensively photographed and a high-resolution cast will be made.

This specimen, as well as all others, will be carefully examined before sampling by physical anthropologist Marcella Sorg, as well as an independent physical anthropologist, to assure its human identity. This is necessary because some bones, ribs for example, can sometimes be difficult to identify as to their species.

With the assistance of Maine archaeologist Dr. Theodore Bradstreet, a systematic search was done to locate potential specimens that have been reported in the professional literature over the last century. Many specimens were originally discovered before the advent of radiocarbon dating. Some have never been adequately described. Some specimens were located in museum collections; others were in private hands.

Remains currently in hand include samples from Jaihuaico and Sacaha, Bolivia; Lake Chapala and Zacoalco, Mexico; Sumidouro, Brazil; Norfolk Gravel Pit, Nebraska; Lecanto Island, St. Mark's River, and Melbourne, Florida; Santa Rosa Island, California; Clear Fork, Texas, and coastal Georgia.

The Human Skeleton Dating Project is part of a larger interdisciplinary effort by the Center for the Study of Early Man to review the human skeletal material from the Americas in terms of its dating, morphology, and Quaternary context. Dating of these remains involves the continuing cooperation of many scientists and museum personnel who have agreed to participate. We would especially like to acknowledge the following who have already provided samples: Alan Bryan, University of Alberta; George Jefferson, Page Museum; Elizabeth S. Wing and S. David Webb, Florida State Museum; Douglas Ubelaker, Smithsonian Institution; Steve Holden, Nebraska State Historical Society; George Corner, University of Nebraska State Museum, and Clark Larson, Northern Illinois University.

This is a long-term project with critical implications for understanding the peopling of the Americas: both the *who* and the *when*. A date on human skeletal material is a date on the human presence: direct evidence that can provide significant pieces to the puzzle.

The dating process itself is slow and expensive. It takes one or two lab specialists to prepare the samples, and four physicists and geochemists to analyze each targeted date. But it is the only way of producing dates on very precious, limited samples. And it promises to open a very special window to our past.



PEOPLING OF THE AMERICAS

PUBLICATION PROGRAM

by Emilee M. Mead

A principle mandate of the Center for the Study of Early Man is to encourage research about Pleistocene people of the Americas and to make such new information about our early cultural heritage available to both the scientific community and to interested members of the general public. Books and monographs, a quarterly newspaper, and an annual journal are the current components of the Peopling of the Americas publication program. All these publications present up-to-date information in a very fast-moving, popular field.

The Center Editorial Board accepts a variety of book and monograph-length manuscripts for publication. All manuscripts are subjected to an extensive external and internal review process. Several series are included in the book publications: A monograph series presenting primary data on sites in North and South America which are more than 10,000 years old; a technical process series presenting new methods and theories for interpreting early remains; a series of edited volumes containing topical papers and symposia proceedings; a series of popular books making the most significant discoveries and research results available to the uninitiated, but interested, layman, and a bibliographic series.

Books published to date by the Center:

Understanding Stone Tools: A Cognitive Approach, by David E. Young and Robson Bonnichsen (published May 1984)

Archaeological Sediments in Context, edited by Julie K. Stein and William R. Farrand (released, March 1985)

Books forthcoming in 1985 and 1986:

Environments and Extinctions: Man in Late Glacial North America, edited by Jim I. Mead and David J. Meltzer (in press)

New Evidence for the Pleistocene Peopling of the Americas, edited by Alan Lyle Bryan (accepted, in final preparation)

Proceedings of the First International Bone Modification Conference (accepted, in preparation)

Animal Remains from Archaeological Sites, edited by D. Gentry Steele and B. Miles Gilbert (under consideration)

Late Pleistocene Human Adaptations in Eastern North America, by David J. Meltzer (under consideration)

An annual journal edited by Research Associate Jim I. Mead, *Current Research in the Pleistocene*, presents summaries of current research activities in the broad field of the peopling of the Americas. Submitted by specialists from a variety of disciplines, these note-length articles provide those interested in the topic with a means of keeping abreast of developments in an ever-changing field. Volume 1 was published in May, 1984, and included 31 articles on geosciences, lithic studies, bone modification, paleoenvironments, etc. Volume 2 (to be published in May, 1985) covers a similar range of topics in 41 articles, including several Canadian, two Chinese, and one Soviet contribution. Articles in *Current Research in the Pleistocene* fall between notes in a regular peer-reviewed journal and published abstracts from professional or society meetings to provide scientists with a unique publication alternative.

The *Mammoth Trumpet* newspaper is published quarterly and edited by Marcella H. Sorg, Associate Director of the Center. The premiere issue of this eight-page, tabloid size newspaper was published in early 1984; since that time, the international subscription base has grown to about 2200. The *Mammoth Trumpet* includes feature articles on sites being excavated, conference reports, research news, and interviews with prominent scientists. It is written in a style for specialist and non-specialist alike to enjoy and understand. A variety of types of publications, all written for different purposes and for different audiences, fills a void in the information available for studies of Pleistocene peoples in the New World.

Several types of publications are offered by the Center for the Study of Early Man. In addition to those resources, readers might enjoy the following: *Ice Ages: Solving the Mystery*, by John Imbrie and Katherine Imbrie, c. 1979, Enslow Publishers, Short Hills, N.J. 07078. (This is an introductory book intended for those with little or no acquaintance with the subject.) *The Pleistocene, Geology and Life in the Quaternary Ice Age*, by Tage Nilsson, c. 1983, D. Reidel Publishing Company, Dordrecht, Holland; Boston and London. *Late Quaternary Environments of the United States*, H.E. Wright, Jr., Editor, c. 1980, University of Minnesota Press. (Vol. 1, The Late Pleistocene; Vol. 2, The Holocene; Vol. 3, Late Quaternary Environments of the Soviet Union) Minneapolis, Minnesota 55414.



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