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WORDS & PICTURES UNLIMITED

Archaeologist Mochanov makes a point.

Siberian Site Defies Theories on Peopling

Pebble Tools Are Dated to 3 Million Years

A vast archaeological site in Siberia is challenging anthropologists to reconsider theories of human evolution and dispersal. Because of his discoveries over the past 10 years at the Diring site on the Lena River, Yuri A. Mochanov, a prominent Russian archaeologist, has concluded that hominids lived in the far north in the Earliest Paleolithic, possibly as long as 3 million years ago.

Perhaps, he dares suggest, humans might not have originated in Africa.

Mochanov presented his findings at the 45th Annual Northwest Anthropological Conference in April at Simon Fraser University in Burnaby, British Columbia. Mochanov, a member of the faculty of the Academy of Science at Yakutsk, Siberia, was making his first appearance at a scientific meeting in North America. His presentation obviously perplexed American and Canadian anthropologists and archaeologists. Siberia is not supposed to be a place to look for stone tools more than maybe 35,000 years old—certainly not more than a million years old.

Mochanov's initial discovery was made in 1982 in a region where archaeological investigations had been in progress for many years. Work there produced several Late Paleolithic sites of the Diuktai tradition (see article on page 5). His wife, archaeologist Svetlana Fedoseeva, was excavating a site of the Ymyakhtakh (pronounced you-me-AK-tach) culture of the Late Neolithic period—dating to 3,000–4,000 years ago—that contained an interesting tomb and burials. Below the burials they made a startling discovery.

"We found absolutely unusual stone tools," he

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LINGUIST FINDS EVIDENCE FOR EARLY PEOPLING OF AMERICAS

Diversity of Languages Indicates Long Duration

A new method of linguistic analysis has cast doubt on conventional time frames for the earliest peopling of the Americas. In an unusual turnabout, it is linguistics rather than archaeology that has provided evidence and a theoretical base for estimating how early the Americas were populated by humans.

According to linguist Johanna Nichols of the University of California at Berkeley, both the Clovis chronology, with its estimated first arrival at 12,000 years ago, and an earlier chronology, with an estimated first arrival at 20,000 years ago, can be shown to be "in the wrong ballpark" if one analyzes the linguistic diversity of native American languages.

"The unmistakable testimony of the linguistic evidence is that the New World has been inhabited nearly as long as Australia or New Guinea, perhaps some 35,000 years," says Nichols.

Linguistic diversity, defined simply, is the variety among languages. Linguists view the different languages of the world as having developed in a pattern similar to that of genetic development. Over time a language naturally branches out into related languages, or lineages, which may or may not survive. Surviving languages continue to divide into other dialects, which over time develop into separate languages and so on. By comparing typological (structural) features, it is sometimes possible to trace which language families and stocks are "genetically" related.

Compared with the Old World continents of Africa and Eurasia, the Americas have a strikingly larger number of different language families, as shown on the map below.

"For decades people have been saying 'How could

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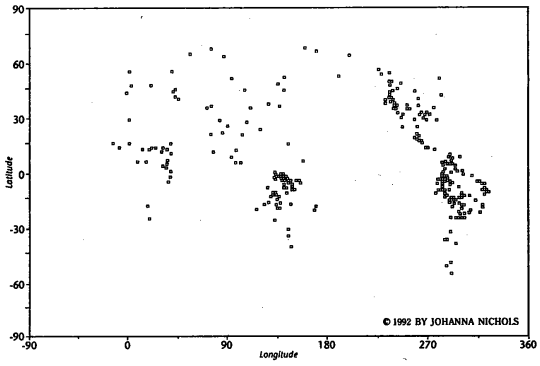

Plotted geographically, the world's language families create a map of the world.

Forensic Methods Focus on Paleoindian

Physical anthropologist Todd Fenton of the University of Arizona had only two and a half days to gather data from Paleoindian skeletal remains accidentally discovered in 1989 in a gravel pit near Buhl, Idaho (**Mammoth Trumpet** 7:2 "Idaho Burial"). What he found provided information about a young woman's life history that brought a human context to one of the few Paleoindians ever studied by anthropologists.

The skeleton clearly exhibited American Indian features.

Knowing that the remains were to be reburied, and therefore unavailable for study at a later date, Fenton took exhaustive anthropometric measurements and fully photographed and X-rayed the skeletal material during his brief stay in Pocatello, Idaho. The skeleton was examined at the Idaho State Museum there; work included taking casts of the teeth, and getting periapical (high-angle) dental X-rays.

By analyzing his carefully collected data, Fenton was able to determine that the individual was a robust, well-muscled female, approximately five feet, two inches tall, and between 18 and 20 years old at death. He was able to estimate her age by examining the epiphyses of individual bones. These bone ends unite with the shafts after growth ceases. In the Buhl woman all epiphyses were fused except those of the scapulas (shoulder blades), and clavicles (collar bones).

The completeness and state of preservation of the remains were remarkable, Fenton said during a recent interview in Tucson. "The head was just about pristine." The material was so well preserved that one of the delicate bones of the inner ear, the right malleus (approximately 5–10 mm long), was found while cleaning the cranium. The cranium was

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Why haven't we found more Paleoindian skeletons?

*Physical anthropologists could tell us much about Clovis or pre-Clovis people if they had even a modest sampling of skeletal material to study. Unfortunately, as D. Gentry Steele noted in a jocular introduction to his presentation to a session of the American Association of Physical Anthropologists in April, "as we all know, the Paleoindian sample of the Americas can only be described as the pits in terms of the sample size and the condition of the material." He reported on a statistical analysis of a mere 10 skeletons confidently dated to the 8,500- to 10,000-year-old range ("Paleoindian Skeletal Data Re-examined," **Mammoth Trumpet 7:2**).*

*While the bones of a young Idaho woman buried about 10,600 years ago ("Forensic Methods, Page 1; also see "Idaho Burial," **Mammoth Trumpet 7:2**) were in an almost perfect state of preservation, sites often preserve nothing but stone.*

Why haven't human skeletons of Clovis age or older been discovered? Here a veteran anthropologist and archaeologist, George A. Agogino, Distinguished Research Professor Emeritus at Eastern New Mexico University, offers his perspective.

By George A. Agogino

The reason for the lack of Paleoindian skeletons is basic. The size of archaeological excavations is based on available research funds, and Paleoindian sites, while small, are frequently limited in artifacts. Rarely are wooden artifacts and basketry found, and no pottery has ever been uncovered. The artifacts generally consist of lithic points, plus a few bone tools. Only in a few spots have eyed needles been found. Eyed needles were necessary if the first Americans came over the Diomede Islands some 12,000 years ago. Without tailored clothing, the cold would have proven an impossible barrier.

Most Paleoindian kill sites are small in scope, usually smaller in size than a baseball diamond. Should disease or injury have taken a member of a Paleoindian hunting party, burial would not have been within the kill-site area, but some distance away. How Paleoindians buried their dead is still largely unknown. It is suspected that earthen graves, crevice and cave burials, or even scaffold burials may have been used. It is possible that they simply left the remains for animals to devour and spread the bones about. Certainly, the final resting place of remains was not the camp or kill site since no graves have been found in prime excavated areas. It seems reasonable that when a member of the group died, his remains were quickly removed to a burial location. Archaeologists only work in the prime activity areas, which are almost surely outside the burial location. If one wants to find a skeleton, the excavation area of a Paleoindian site must be extended in size and scope. Presently, funding problems make such activity impossible.

Red Herrings

When I was teaching at the University of Wyoming more than three decades ago, a colleague telephoned and asked me to investigate three burials containing Agate Basin points. Our crew's excitement was so great that we drove all night and were at the site at sunrise. The report was correct; each of three Indian burials had a single Agate Basin point with the remains. But disappointment quickly set in as we noticed there were also archaic-style milling stones and pottery consistent with much later burials. It became clear that these Agate Basin points had been picked up by later people and treasured so greatly they became part of the burial package for the three deceased individuals.

Another factor to be considered is whether the skeleton was buried into an earlier level that might suggest to the inexperienced investigator that the remains were the same age as the strata in which they were found. If the bones were surface discoveries uncovered by erosion, all evidence of the burial pit might have been destroyed by weathering. In the 1960s, an excellent amateur archaeologist found what might well have been a Plainview skeleton. Unfortunately, it was removed without allowing professional observation of the remains in situ either by archaeologists or geologists. In addition, the discovery was kept secret for roughly a dozen years. As a result, while good techniques were used in the excavation, the failure to allow professional review in situ placed those remains in the category of "possible Paleoindian." A Paleoindian skeleton must be above academic criticism if it is to be widely and fully recognized as valid. Stratigraphy is a valuable tool in achieving initial acceptance, but it should be supported by artifacts that agree with the age of the strata and, if possible, by radiocarbon dating. Above all, the most experienced Paleoindian professional available should be brought into the project prior to the removal of skeletal remains.

Clovis Probably the Oldest

Eventually, we will find an unquestioned "first American" skeleton. I feel certain the oldest such skeleton will be Clovis, for I strongly believe they were our first Americans—individuals who discovered a New World more than 11,000 years before Columbus. Currently we have no strong supportive proof either in Alaska or Northwest Canada to show that the Clovis hunters came down river valleys that were periodically clogged with glacial ice, or worse, flushed with the runoff from melting glaciers. Most projectile dates in the far north tend to be later than those in the lower 48 states. That no boat older than 5,000 years has been uncovered means nothing, since the coastline of any ocean is one of the most corrosive areas possible; wooden objects erode away in a few generations. Simple watercraft may well have existed 12,000 years ago. Since the concept of a floating log being made into a dugout is so simple, people 20,000 years ago or more may have had watercraft. It is possible that our first Americans made the trip by water helped by the Japan Current that swings about Northeast Asia and down the West Coast of North America. I envision a boat not unlike those that Northwest Coast Indians used in the last century when a dozen or more individuals could row a huge watercraft to explore and hunt whales, often out of sight of land. In a boat it would have taken only a matter of weeks, not years, to move from the Old World to the New.

No matter how the first Paleoindian came to the New World, or whether it was Clovis or an unknown older group, my hope is to live long enough to be involved with the first valid, unquestioned skeleton. As a seasoned forensic osteologist under contract with the U.S. Bureau of the Interior, I would be delighted to be allowed to make the initial report on any early human remains. Such a skeleton may be found in a long-established site like Blackwater Draw or it may be accidentally found in an unknown location. Wherever it is found, its value to science will be a priceless treasure of American heritage.

Forensic

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slightly more yellow than ivory with little, if any, mineralization.

The only parts of the body not represented in the recovered skeletal material were the left leg, the right leg below the knee, left upper arm, and the pelvis. Almost all the teeth were present.

Missing parts had been lost in the gravel-removal operations. Further, half of one humerus (upper arm bone) and a rib were destroyed in the dating process, which utilized bone collagen. The material was carbon-14 dated to 10,675±95 years B.P. (Beta 43055 and ETH 7729), indicating that the discovery was among the oldest North American human remains ever analyzed.

Analysis of the site indicated that she had been buried along with associated artifacts including a stem knife and a bone needle with a drilled eye. The site is a dry, well-drained terrace containing very old Bonneville flood gravel from the Snake River.

Consistent with Idaho law, the Shoshone-Bannock Tribes reburied the remains last December on the Fort Hall Indian Reservation. As it happened, the burial took place somewhat later than scientists had expected, so in theory Fenton could have taken more time for his laboratory examination, but in less than three days he had gathered all

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The eighth annual edition of *Current Research in the Pleistocene* has been published and is available through the **Center for the Study of the First Americans** for $20. The 132-page journal contains 63 articles grouped under five general subject areas: Archaeology, Physical Anthropology, Lithic Studies, Methods, and Paleoenvironments. The latter category is broken into three sub-groupings for articles on plants, vertebrates, and geosciences.

Jim I. Mead, editor, and David J. Meltzer, associate editor, processed a large volume of information in producing the timely collection of research notes. Besides containing dozens of reports on continuing research, *Current Research in the Pleistocene* provides a general subject index and an authors' index.

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that he needed to tell a great deal about this Paleoindian woman.

While Fenton found no pathologies nor any sign of the cause of death, he did find evidence that suggests the young woman probably had been subjected to nutritional stress during growth. The X-ray of the right femur (thigh bone) yielded the best radiographic information, revealing at least 12 Harris lines. Harris lines are indications of arrested growth due to stress on the body, and they appear in a fairly regular pattern along the bone from the middle to the distal end. Although the individual Harris lines cannot be linked to a specific period in the woman's life, their regularity suggests to Fenton that they may have been due to annual nutritional stress in the late winter and early spring when food stores may have been depleted.

Additionally, the left upper canine tooth exhibited a hypoplastic line. Hypoplasias are irregularities in the way tooth enamel is formed. When apparent on many of an individual's teeth, hypoplasia is an indication of systemic stress. When apparent on only one tooth, however, hypoplasia may be an indication of a traumatic event such as a blow that may have injured the tooth prior to its eruption.

A further item of interest was the young woman's dentition. "The amount of wear is tremendous for an 18- to 20-year-old individual," Fenton said. The teeth were so worn that few or no cusps remained on their chewing surfaces. Only the third molars, the so-called wisdom teeth that erupt in the late teens, had visible cusps. The teeth exhibited a helicoidal pattern of wear, not uncommon in populations that experience significant degrees of wear due to heavy chewing stresses. The premolars and first and second molars on both sides of the lower jaw were worn in a plane at an angle, with the highest point at the inner edge of the teeth and the lowest point at the outer edge. Fenton speculates that the degree and pattern of wear may have been the result of processing hides by chewing on them.

Fenton firmly discounted a rumor that the Buhl woman displayed non-Indian or perhaps even Caucasoid features. "This skeleton clearly exhibits morphological features consistent with its being Mongoloid," Fenton said, adding that the Mongoloid morphology follows the pattern of later American Indian groups. The 30-year-old doctoral student at the University of Arizona specializes in skeletal biology, forensic as well as prehistoric. He said the U of A forensic anthropology laboratory is often involved in answering questions of race or ethnicity in police cases. "It was not even a question," he said of the morphology of the Buhl woman.

Fenton was called in on the Paleoindian project by Tom Green, Idaho State Archaeologist. Fenton had previously worked with Green on the analysis of 58 individuals from the 6,000-year-old DeMoss site in Idaho. Fenton also was involved in the Alfred Packer Victims Exhumation Project at Lake City, Colorado, during the summer of 1989, and will be analyzing the human skeletal material from the excavation of an "infant cemetery" at a Roman villa in Lugnano, Italy, this summer. Working with Paleoindian remains is a fairly recent development in Fenton's career and has allowed him to take a forensic framework and "transport it back in time."

—Sylvia Lindsay

Lab Offers Service

Since 1986, a thermoluminescence dating laboratory has been operating at Western Washington University. Director Glenn Berger says the state-of-the-art laboratory specializes in dating eolian and waterlaid, fine-grained sediments, as well as volcanic ash and baked sediments. Interested professionals may inquire about collaborative or contractual services by contacting Dr. Berger, Department of Geology, Western Washington University, Bellingham, WA 98225; phone (206) 676-3584; fax (206) 647-7295.

Pampas Paleoindians Valued and Reused Precious Quartzite

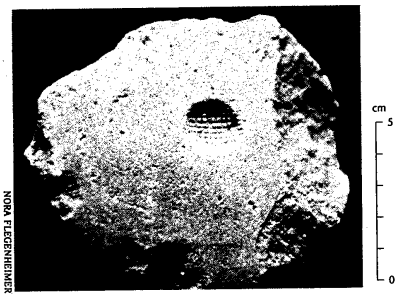
In the Tandilia hills of Argentina's Buenos Aires province Paleoindians crafted a variety of lithic tools that are now the subject of study by archaeologist Nora Flegenheimer, a researcher with the Argentine agency CONICET.

Flegenheimer, who is based at the National University at Mar del Plata, Argentina, recently showed samples of the artifacts, including handsome fluted fishtail points made from a fine amber-colored quartzite, to North American lithic experts. She was in the United States to attend the annual meeting of the Society for American Archaeology in Pittsburgh.

The points were discovered by Flegenheimer at sites on the Pampas about 250 miles south of Argentina's capital city, Buenos Aires. She has been working for 10 years at the sites, two of which have produced charcoal dated by the University of Arizona at 10,600 and 10,800 years B.P. Those sites were at Cerro La China; a third nearby site and others 15 km away on Cerro El Sombrero have not been dated, but they contain assemblages of the same period. Most remarkable is the site atop El Sombrero, a tabular hill 429 m in elevation that overlooks vast stretches of the grassy, treeless plains. There Flegenheimer discovered a large workshop where Paleoindians made fishtail points and reworked broken tools.

Among the most common artifacts found on the hill were stems that had broken from the fishtail points. "I think they were retooling," Flegenheimer explained during a recent visit to **The Center for the Study of the First Americans** at Oregon State University. "They brought their shafts with the stems still on them, threw away the old stems and put new points on them. Many of the points have been recycled." The points, she says, have all been worked and reworked.

She explains the pattern of reuse and recycling by noting that the few outcrops that contained tool-quality quartzite are very localized. The area is



NORA FLEGENHEIMER

Discoidal stone with graving.

mostly a flat, grassy plain with few places where the underlying rock of Paleozoic or Precambrian age outcrops. Local quartzite is coarse grained and not suitable for tool making, although some local quartz was utilized. Sources of the fine-grained quartzite are 30 to 60 km to the west.

Flegenheimer's sites provide her with many puzzles. One mystery is the large number of miniature fishtail points. Miniature forms are relatively common in North American Paleoindian sites, and investigators can only theorize about their function. Some of Flegenheimer's are barely one centimeter long, and many are quite carefully crafted. Ritualistic goods? Toys for children? She can only shrug. "I have no idea about many things which I find," she said with a quick smile.

Perhaps the most intriguing discovery is a discoidal stone, approximately four inches in diameter and an inch and a half thick, ground flat on top and bottom. At the center of the top is semicircular graving etched with fine intersecting lines. That rounded depression gives the impression that the stone was once soft clay into which screen wire was pressed with a thumb. But, Flegenheimer notes, the discoidal stone is made of a very hard sandstone. The graving obviously required much careful labor.

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Fishtail point of quartzite.

Bola stones, also created by grinding, are part of her discoveries. Such stones are not at all common for Paleoindians, she notes.

All her Tandilia sites are multi-component ones. Besides the Paleoindian levels with their fishtail points, there is an intermediate level that has yet to be dated. An upper level contains records of historical contact, with glass beads and ceramics.

Working with her to analyze the sites are Marcelo Zárate, a geologist, and Aldo Prieto, a palynologist. Both are on the faculty of the University of Mar del Plata. Soils that overlay the ancient rocks are loess that can be traced to deposits carried in by prevailing winds from the Colorado River a few hundred kilometers southwest. The Pampas were not glaciated during the Pleistocene, although montane glaciers in the Andes extended to lower elevations than they do now. Data indicate a region that has been grassland since the Pleistocene, although it is drier now than in Paleoindian times.

What did the early people do for shelters and shafts for their weapons? "There must have been some wood resource," said Flegenheimer, but wood is one of the puzzles that remain for her to solve. A shrub that grows on the hills makes good fuel, but its branches are crooked and would not make shafts—especially not long spear shafts. Willows possibly occurred along streams, but the pollen record shows scarcely any more woody plants in the past than in the present. Archaeology doesn't offer any clues because organic preservation at the site is very poor. Perhaps wood for spear shafts was as highly valued as the tool-grade quartzite.

Sources of food, too, are open to speculation. The only faunal material found at lower levels has been a section of the shell of a large, extinct armadillo, *Eutatus seguini*. Flegenheimer can only extrapolate food sources from discoveries made at other sites. Guanaco, the South American camel, usually makes up much of the faunal assemblage at sites in the region.

What intrigues Flegenheimer the most now is the differences between her individual Paleoindian sites on Cerro El Sombrero and Cerro La China. They clearly indicate different patterns of utilization. To improve her understanding of sites, she plans to continue her investigation. "There are many places to look still," she says, adding that she has yet to determine the extent of occupation of the hilltop site, so further sampling there is high on her priority list. She prefers to use small teams, which is fortunate because she says financial support is difficult to receive. "We work without money in Argentina," she said with a smile. A technician from the museum in the nearby city of Lobería and a few students from the university at Mar del Plata usually constitute the crew. Currently, she is pleased to have financial assistance from the Wenner-Gren Foundation. The ideal time for field work is November, but the students who make up her crews usually are busy then with their studies. The weather in January and February is very hot.

-DAH

Siberian Site

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told a plenary session of the Simon Fraser conference. They were pebble tools; the team promptly enlarged its excavation to find the source.

"We thought it was a mistake—impossible," Mochanov said through an interpreter. The tools they found resembled materials found at Olduvai Gorge in East Africa. Initial discoveries were near the surface, yet geological indicators pointed to unbelievably early dates—1.8 to 3.4 million years. The excavation proceeded following the mysterious cultural layer back into an abrupt slope that rises more than 100 m above the Lena River.

Many of Mochanov's Soviet colleagues chose to disbelieve and some continue to reject his theories about the site and its perplexing evidence. In spite of Mochanov's background as a graduate of the prestigious University of Leningrad—a distinction roughly parallel to an American's having a doctorate from Harvard or Yale—he has received much criticism.

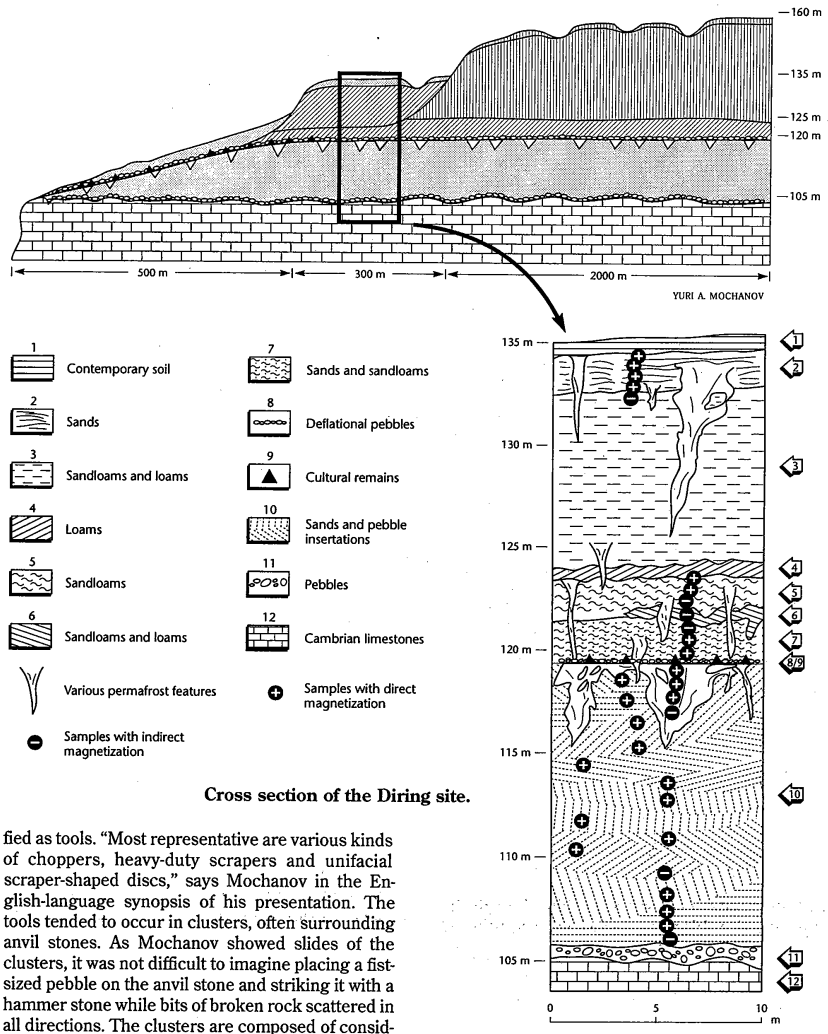
Americans and Canadians attending Mochanov's presentation undoubtedly had questions, too, about what they heard, saw in his slides, and read in the synopsis distributed to the audience. As one veteran archaeologist commented to a colleague shortly after the presentation: "It's the kind of a site that you'd be tempted to cover up and ignore, because you'd know you'd have to spend the rest of your life defending it." Mochanov has plenty of experience defending the Diring and related sites.

Host of the Northwest conference, Simon Fraser archaeologist Roy Carlson, has visited the Diring site and is convinced that Mochanov's material is both typologically and geologically old. "They are genuinely artifacts," Carlson said of the Diring pebble tools.

As Mochanov showed slides of the site, viewers gasped at the vast extent of the excavation. To an archaeologist accustomed to excavating units a meter or two wide, the sheer scope was staggering. Aerial photographs seemed to depict an open-pit mine, yet that overall view of a huge gash in a forested hillside wasn't merely a scene-setter, the entirety was the Diring site! To follow what he had identified as the cultural layer back into an ancient riverside terrace, Mochanov had the help of the Soviet Army and heavy earth-moving equipment. The excavation cuts as deep as 40 m into the hillside.

The Diring site is on a terrace above the confluence of Diring Yurekh (Deep Creek) with the Lena River, 140 km upstream from the city of Yakutsk. The site is due north of the Korean peninsula at 61 degrees latitude—approximately 2,500 miles straight west of Anchorage, Alaska.

The cultural layer that Mochanov identifies as Earliest Paleolithic (Oldowan) has produced more than 4,000 artifacts, 500 of which have been identified as tools. "Most representative are various kinds of choppers, heavy-duty scrapers and unifacial scraper-shaped discs," says Mochanov in the English-language synopsis of his presentation. The tools tended to occur in clusters, often surrounding anvil stones. As Mochanov showed slides of the clusters, it was not difficult to imagine placing a fist-sized pebble on the anvil stone and striking it with a hammer stone while bits of broken rock scattered in all directions. The clusters are composed of considerable lithic debris. Mochanov says the clusters vary in extent from 10 to 30 square meters.

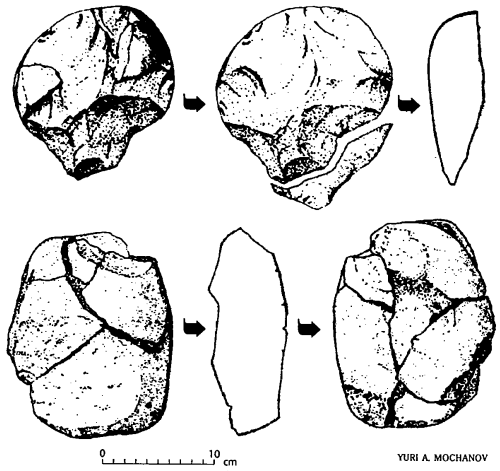


Cross section of the Diring site.

In an interview after the conference, Carlson described his first look at the artifacts in Mochanov's lab in Yakutsk. "We looked at some of the anvil stones, which do show battering marks on them, and some of the broken cobbles that could be refitted together." He has no doubt that they are artifacts. After traveling to the Diring site, Carlson observed bulldozers at work moving the sandy overburden, and saw in situ clusters of broken cobbles, anvil stones and tools.

Mochanov says that according to technical and typological indicators, the Diring complex is unlike any in Siberia and unlike any in all of Eurasia, adding that "it has the greatest similarity only with the stone assemblages of different Oldowan sites of the Earliest Paleolithic in Africa dating from approximately 1.7 to 2.7 million years B.P."

Surfaces of the pebbles in the clusters, including the apparent manmade scars, were all abraded by sand, indicating that they had been on top of the ground for a long time. Mochanov says that corrasion serves as an important stratigraphic indicator of the cultural layer of the Diring site, which tends to be about 3–5 cm thick, but is 10–15 cm thick in places. It lies on river-bed alluvium, the most ancient terrace of the Lena River, and is overlain by layers of alluvium. The deposits are dated geologically between 1.8 and 3.4 million years. Magneto-chronological dating produced an even older date, and radio-thermoluminescence dating also indicated dates of well over a million years. It was a cold period in Siberia—even colder than the present.



Discoidal chopper showing fragments (top) and fragments fitted to form complete pebble (bottom) from the Diring site.

"Now," says Mochanov, throwing down a challenge to his own unbelievable conclusions, "it is up to the scientists—the experts—to see how right or wrong we are."

"If these dates are valid, then Diring is the most ancient Paleolithic monument of Eurasia, and one of the most ancient in the world for the time being."

Mochanov devoted the final part of his presentation to speculation on human origins. He dedicated his paper to German naturalist Moritz Wagner, a contemporary of Charles Darwin who in the 1870s argued that humans evolved in cold climates.

"How could I possibly think that humans could come from Africa without any clothes and live in permafrost area?" Mochanov quipped. He went on to argue that human predecessors required the stresses of living at the edge of existence to be stimulated to evolve the intelligence to command fire, create tools and survive.

The possibility of hominids living relatively close to North America as long as 3 million years ago has staggering implications for questions about the peopling of the Americas. It also would require complete rethinking of anthropological theory. Recent debates have centered not on *where* humans came from but merely *when*.

Anthropologists have long agreed that the genus *Homo* evolved in Africa. Some members of the *Homo erectus* species are believed to have migrated out of Africa more than a million years ago, but there is little agreement about hominid evolution in the few million years previous that led to the development of the *Homo* lineage. Many fossils, as well as the East

African footprints Mary Leakey found at Laetoli, demonstrate that hominids were walking upright 3.7 million years ago, about a million years before any stone tools are known to have existed. Did a few generations of adventuresome walkers span continents so long ago?

Tools are considered important markers of the origins of *Homo*. The ability to look at a rock and visualize a completed tool that could, for example, shear meat more handily than the teeth of lions and hyenas or the beaks of vultures is taken as an important dimension of humanity. Most anthropologists accept *Australopithecus* and *Homo habilis* as predecessors of *Homo erectus*, but there are two distinct views of how modern *Homo sapiens* evolved.

In one view, now called the "regional continuity" theory, the *Homo erectus* populations in Africa, Asia and Europe slowly evolved into *Homo sapiens* between one million and 100,000 years ago, with genetic continuity maintaining the connected-ness of the species' changes. This view has been challenged in the past decade by genetic analyses that suggest that the level of differences among modern humans is so small that the species must have been generated in one specific region within the last 200,000 years. In this second model, it is expected that one group of *Homo erectus* developed some new attributes or anatomical, ecological or behavioral advantage and subsequently spread to the rest of the world, replacing all earlier humans. This view has become known as the "replacement" or "out of Africa" theory, because Africa is considered the most likely site of modern *Homo sapiens*.

Existing theory offers no means to explain the presence of a population of hominids living and making Oldowan-style pebble tools in the far north as

"They are genuinely artifacts."

long as 3 million years ago. Mochanov goes back to the 19th-century theory of Moritz Wagner to suggest an explanation. Wagner, says Mochanov, believed that the cooling of the environment in the Late Pliocene was crucial to human evolution. "As man had to search to rescue himself from cold and darkness," Mochanov says in his written paper, "it stimulated him to manufacture tools and to use fire." Extreme environmental stresses, he suggests, are what gave a pre-human species the fateful (and, no doubt to most individuals, fatal) genetic nudge to develop the large brain that defines *Homo*. "Stress influences mutation," Mochanov told his audience, and such stresses occur not in the center of a habitat but on the edge. On the blackboard of the Simon Fraser University lecture hall he drew a large circle as he spoke. "In remote places, on the edge," he said, indicating the upper extremity of his circle, "a very interesting phenomenon occurs." At the edge of existence—Siberia, for example—"adaptive peaks" may occur. There, on the edge, he suggested, is the likely cradle of humanity.

Carlson says he believes in keeping an open mind. "While we still think that Africa is the most reasonable homeland, nevertheless there are some things that need to be explained. So far they haven't been." David Huntley, a Simon Fraser University physicist, expects to help seek an explanation later this year by going to the Diring site to do thermoluminescent dating of some newly uncovered artifacts. Carlson explains that the technique, which dates the last time artifacts were exposed to light, requires unearthing artifacts in the dark of night, difficult at such a northerly site when summer days are so long.

After Mochanov noted that dignitaries who have visited the Diring site included a Cosmonaut who declared that investigating Earth with a shovel is as interesting as investigating it from space, he invited his North American colleagues to join in his search for answers.

The puzzle of human origins can be approached, he says, "only by joining the efforts of scientists of different disciplines and countries. I trust that the joint work in this direction is as important as the joint flight of Soyuz-Apollo."

-DAH

Yuri Mochanov argues a point about Diuktai culture with Fumiko Ikawa-Smith of McGill University, right. Between them are archaeologist Richard Shutler of Simon Fraser University and interpreter Mila Bonnichsen.

A Diversity of Relevant Research

Research in many disciplines pertains to the peopling of the Americas. In recent weeks the **Mammoth Trumpet** attended several presentations at the 39th Annual Northwest Anthropological Conference in Burnaby, British Columbia, and at the 96th Annual Conference of the American Association of Physical Anthropologists in Las Vegas, Nev.

Amid the diversity of the research reported on were some investigations that relate directly to human habitation of North America. Many other reports were of less-obvious but no-less-important relevance to the quest for the first Americans.

"Always the arrows *start* in Siberia," said Russian archaeologist Yuri Mochanov, as he began a presentation at the Northwest conference, which was at Simon Fraser University. Mochanov was referring to a map depicting popular theories for the peopling of North America. He says that 30 years ago he chose to investigate a region near the Lena and Aldan rivers in eastern Siberia to be as close as possible to the peopling of the Americas. Mochanov leaves no doubt in the minds of his listeners that strong evidence exists for humans living for extended periods in a very cold climate.

If participants in these meetings were representative of North American anthropologists, there remains outspoken skepticism, based on archaeological evidence, about human occupation of the Americans before Clovis time some 12,000 years ago. C. Loring Brace, a prominent human evolution authority at the University of Michigan's Museum of Anthropology, summarized this skepticism: "The more you look at the evidence, the more you find there is nothing there." Brace presented a paper in Las Vegas on human biological diversity in the Late Pleistocene and the peopling of the Americas. The great diversity of micro-environments at the end of the Pleistocene, coupled with cultural variation in technologies and exploitation of resources, he said, probably are responsible for great regional diversity in populations, including those who migrated to the Americas.

In the same session, Ryk H. Ward, a human geneticist at the University of Utah, presented a paper written with three of his colleagues on molecular evolution and linguistic differentiation in the Americas. The team studied samples of mitochondrial DNA in individuals from three adjacent tribes in the Pacific Northwest. Two of the tribes—Nuu-Chah-Nulth and Bella Coola—are considered part of the Amerind language group, and the other—Haida—possibly is part of (or close to) the Na-Dene language group. The investigators actually found less genetic divergence between the Haida and each of the other two groups than between the Nuu-Chah-Nulth and Bella Coola. Further, the team found less genetic difference between Haida and Inuit people in faraway Greenland than they found between Haida and a sampling of five Northwest groups of Amerind speakers. "The results are consistent with a greater antiquity of the Amerind stock than previously supposed," Ward said. "Our data do not say *when* divergence occurred." The team's abstract says: "Molecular data suggest that Na-Dene and Inuit share a more-recent ancestry than do Amerind tribal groups."

Amid scores of presentations, hints and outright clues to questions of the peopling of the Americas appeared. It may well remain for other investigators to seize on pertinent clues and processes that will lead to new discoveries and new theories. The physical anthropology conference included many presentations on highly specialized techniques and procedures that eventually may answer questions about the peopling of the Americas. J. R. and K. K. Kidd, Yale University geneticists, reported on their continuing work with DNA markers, and several investigators described new techniques in analyzing bone materials. One researcher reported on blood studies that sampled an Arizona Indian tribe as an example of the "first wave" of migrants into the Americas from Siberia. Another reported on extracting molecular markers from bones of ancient humans.

Formal theoretical discussions relating indirectly to the peopling of the Americas occurred at both the physical and the Northwest anthropological meetings. A symposium at Las Vegas examined the growing argument about where and how modern humans evolved. At Simon Fraser University a group of archaeologists discussed Paleolithic cultures of east Asia, specifically the Diuktai, presumably the forebears of some, if not all, first Americans. Yuri Mochanov of the Academy of Science in Yakutsk, Siberia, described Diuktai as a very widespread and long-lived culture that spanned the Late Paleolithic from about 35,000 to 11,000 B.P.

The archaeologists focused much of their discussion of the Siberian Paleolithic on tool types, specifically the microblade tradition. Alan Bryan of the University of Alberta said the distribution of microblade cores is the only typological tradition that can be traced from northeast Asia 25,000 to 35,000 years ago into North America. "The microblade tradition persists through northern Canada and Alaska until quite recent times," Bryan said, "but does not come south except in post-glacial times. You never have microblades farther south at an earlier time. I think this is a very significant thing. What Diuktai *is* is the peopling of northwest North America."

Mochanov and the discussants also dwelt on the likely origins of the Diuktai, and in a sense their dialogue represented a continuation of parallel discussions among physical anthropologists at Las Vegas. While one focused on artifactual assemblages, the other focused on the human skeletal record. Neither discipline, of course, has data free of vast gaps, and much extrapolation and speculation is possible. Available data seem to show cultures and morphologies appearing over wide areas at approximately the same time. Dates ascribed to early sites often span a range of 5,000 or more years, making it difficult for theorists to make convincing arguments regarding cultural migrations from one place to another.

Because of his experience with early Paleolithic sites in Siberia, Mochanov brought a different perspective to the Northwest discussion. To most anthropologists, the only question is *when* humans or their predecessors came out of Africa and spread across the other continents. Mochanov challenged his North American colleagues to consider *whether* humanity originated in Africa's nurturing warmth rather than in the frigid north. "We should somehow change our imagination and not think that only from Africa early humans came," Mochanov told his colleagues.

While he insists that the Diuktai culture dates to more than 30,000 years ago, the Siberian archaeologist does not insist on a particular point of origin for it. Stabbing at a map of northern Asia with a small pointer, Mochanov said: "To put exact origin of Diuktai here, here, or here—personally I am indifferent."

-Don Alan Hall

Linguist

continued from page 1

that many different language families have developed in the New World in only *X* number of years?' or, 'How could you possibly have moved enough languages into the New World in so short a time that would account for this many daughter languages?' " Nichols said in a recent telephone interview.

She approached these questions by developing new methods of assessing diversity. Her methods, such as measuring the amount of branching in a language stock, enable her to estimate approximate ages for linguistic populations. Considering the New World, Nichols is confident that her technique can indicate whether a proposed time for colonization is adequate; that is, whether it provides enough time for the existing diversity in the language stocks of North America to have developed.

"What's interesting is that these methods give a way of estimating the minimum length of inhabitation on purely linguistic evidence, independent of archaeology," Nichols says.

The world map of language families illustrates one of Nichols' gauges of linguistic diversity: linguistic density. To calculate linguistic density, the number of different families in any broad uniform region are counted; that number, divided by the millions of square miles in the region, provides a means of comparing the amount of linguistic diversity among regions.

As the map indicates, linguistic density is not uniform. It is much higher along coastal areas than in interiors, it is higher in mid-latitudes and tropics than at latitudes greater than 55 degrees, and it is higher in the Americas and the Pacific region than in Europe and Asia. Mountainous areas are associated with high density; low rainfall with low density. New World and other recently colonized areas are associated with higher densities than Old World areas.

Nichols has proposed a thorough explanation of the many factors at work in the survival of language families that would lead to so much variation in intensity. In addition to geographic influences, she has identified the scale of an area's economy as being instrumental because a spreading economy and culture will favor its own language, either by pushing other language groups aside into other areas or by absorbing their speakers and hence bringing about their extinction. The result is decreased language diversity.

Certain cultural or economic advances documented in the archaeological record can therefore be expected to have led to decreased diversity. For example, lineage density is low in Africa, where agriculture and stockbreeding have been practiced for a long time. Nichols says that geographic and seasonal factors are intertwined with economic ones, since they can prevent or help the spread of a population. For example, an inhospitably dry area would be economically unable to support enough autonomous populations to allow linguistic diversity. Further, an arid land that has high linguistic diversity along its coasts might be unable to support such diversity inland.

Citing archaeological evidence, Nichols notes: "We know Australia has been inhabited for at least 40,000 years, and maybe 50,000 years. But if you apply to the languages of Australia the methods I used to calculate approximate age—based on rates of branching—you come up with a time depth that is less than the actual inhabited age of Australia. The reason is that most of Australia is dry and interior and just cannot contain as many languages as would have developed in more habitable areas. So the characteristics of an area, which either favor high density or low density, affect the number of branches that survive in a [language] family, as well as the number of different families found in the area."

Nichols adds that "the distribution of lineage density and typological diversity is not an accident of history but reflects factors that are broadly geographic and economic." By typological diversity, she refers to another way to measure the degree of diversity among languages—through analysis of structural differences. It was a study of typological diversity that led Nichols to her approach to measuring the age of New World inhabitation. She has been cataloging structural differences of the world's languages since the early 1980s.

Structural Differences

"In the mid-80s I began to notice that there were systematic differences in the frequencies of certain structures in languages between different parts of the world," she says. "A structural feature might be common in the New World but infrequent in the Old World. I also became aware that the typological things I was looking at were fairly stable in language families."

She identified a new way to classify languages, based on a difference in their structures that she calls "head/dependent marking." She discovered that all languages can be classified as either "head-marking," in which the grammatical function of a word in a sentence is indicated by marking the head (such as the predicate noun) of a phrase, or "dependent-marking," in which the word that is marked is the dependent (such as a modifier) in a phrase.

For example, in the English phrase "the man's house," "man's" modifies "house." This relationship is indicated by attaching the apostrophe and "s" to the modifier "man"; this pattern holds true often enough to classify English as a dependent-marking language. By contrast, in the same phrase in Hungarian, *az ember háza*, the head noun "house" is marked (*a* of *háza* means "his, her"; thus *háza* is "his house"), and this Hungarian phrase is classified as head-marking.

This relatively simple but clear-cut difference enabled Nichols to do statistical analysis of this difference in all the world's languages to compare how frequently it occurs among the languages in any particular area. She found that each continent has a different frequency of head and dependent types, giving it a characteristic statistical profile.

Nichols' work counting the frequencies of typological features turned into a worldwide database. "By the late '80s I was trying to collect the largest number of relatively stable structural features, and work out a worldwide sample that would give me at least one language from each language family known on earth."

After studying diversity in the Caucasus, a mountainous region with very high linguistic density bordered by a steppe area that is more linguistically uniform, Nichols went to Australia in 1989 to apply the same type of analysis to languages in northern and southern Australia.

"By the end of that summer, I realized that one could use diversity in itself as a way of measuring the approximate age of a group of languages, whether or not they were thought to be related. What I saw was that it was pretty clearly going to be the case that the New World would have to have been inhabited much longer than the 12,000 years that archaeologists have posited."

There are several keys to Nichols' methods. In general she treated diversity as developing in two possible ways: either internally, the result of natural branching, or externally, the result of populations moving into an area. High diversity in an area requires either many migrations or sufficient length of time for natural branching to occur, or a combination of both.

Another important element is Nichols' finding that when branching occurs, the resulting number of surviving families for most languages is roughly constant worldwide: 1.6 surviving branches per stock, every 5,000–8,000 years. At the time that Nichols pointed this out, it had been assumed that high rates of branching in ancient languages were common. "I showed that high numbers of branches are unusual, and can be associated with particular kinds of archaeological or climatic events," Nichols says.

Geography is a Key

The influence of geography is also integral to Nichols' methods. "If you're going to use diversity as a clue to the age of a set of languages, then that set of languages has to be in an area where the geography and so forth will not have greatly limited their ability to proliferate.

"You also need to have areas that have been colonized, for which we know a precise date of first colonization, and that rules out places like Asia and Europe. It is only for colonized areas that we can say, 'here's a first date of inhabitation and the languages in the area cannot go back to any earlier than that.' "

New Guinea, known to have been inhabited for at least 40,000 years, was a logical choice for study. It now has a high-lineage density, which Nichols attributes to three factors: favorable geography, probable multiple colonizations from Malaysia and/or the Philippines, and long passage of time. Until about 12,000 years ago, humans could also move overland from New Guinea to Australia. Therefore Nichols assumes that there were also numerous migrations from New Guinea into Australia, which would have led to similar linguistic lineages and density until the two were separated by rising sea level.

Since the post–Ice Age sea-level rise, the languages of the two land masses can be assumed to have developed separately. Nichols' 1989 study provided supporting evidence, for while there was some typological continuity, she found the head/dependent marking was different enough to indicate a long period of separate development.

She saw that several parallels could be drawn between New Guinea/Australia and Siberia/North America. In both cases colonization took place across barriers such as water or bottlenecks of land.

SUGGESTED READINGS

ON Linguist Finds Evidence for Early Peopling of the Americas

Nichols, Johanna 1990 Linguistic Diversity and the First Settlement of the New World. *Language* 66:475-521.

Greenberg, Joseph H. 1987 *Language in the Americas.* Stanford University Press, Stanford.

Peopling

Ackerman, R. E. and Roy L. Carlson 1991 Diring Yuriak: An Early Paleolithic Site in Yakutia. *Current Research in the Pleistocene* 8:1.

Wilson, Allan C. and Rebecca L. Cann 1992 The Recent African Genesis of Humans. *Scientific American* 266.4:68-73.

Thorne, Alan G. and Milford H. Wolpoff 1992 The Multiregional Evolution of Humans. *Scientific American* 266/4:76-83.

Site preservation campaign nearing goal

The Thunderbird Research Corp. and the Archaeological Society of Virginia are continuing their program to assure protection for the Thunderbird Paleoindian site in Warren County, Virginia. Land clearing on two of the privately owned lots in 1988 damaged the site, and a preservation project was launched to protect the site from further construction activity.

The project has received grants totaling $99,000 from the Virginia Department of Historic Resources and has raised an additional $40,000 from other sources including contributions from hundreds of individuals in 44 states and Canada. The money has been used to buy four of the five lots that encompass the core of the site. Fund raising continues to purchase the fifth lot.

The Thunderbird site exhibits a continuous stratigraphic record ranging from the Paleoindian period to the end of the Early Archaic. Preserved in largely undisturbed, superimposed living floors, the record includes documented evidence of one of the earliest human structures in the Western Hemisphere.

Readers interested in more information or in helping assure protection for the site may write or send donations to Thunderbird Research Corp., 126 East High Street, Woodstock, Va. 22664.

It is expected that at least initially the lineage density of a colonized area will be similar to that of the source. This is still true for Siberia and Alaska-Canada, which have a similarly sparse density (probably kept sparse by the hostile climate). But farther south in North America, along the Pacific Coast and in the mid-latitudes and tropics, the linguistic density was as high as in Australia and New Guinea.

Nichols concluded that the higher linguistic density found at mid-latitudes and low latitudes in the New World must mean that a period of internal development took place after migration. Therefore the diversity at mid and low latitudes must be related to the age of the population.

"Since the metric was amount of diversity and both New Guinea and the New World had about the same amount of diversity, then the ages of the two populations are not distinguishable," she says. Her studies indicate that this high a density is found "only in areas inhabited—and almost certainly colonized—for at least 40,000 years."

Typological Differences

Using a second, different method of analysis, Nichols looked more closely at typological differences. Because of her finding that head/dependent frequency is different for each continent, she was able to ask how long a period of independent development would be required to form these different frequencies. Again she was able to find an answer in Australia and New Guinea that suggested a parallel to the New World.

Rising sea level separated Australia from New Guinea between 8,000 and 16,000 years ago, probably closer to 16,000. Nichols' typological analysis of northern Australia and New Guinea shows that although the languages were once related, their head/dependent frequency is now quite different. She found that the head/dependent typological distance between North America and northern Eurasia is greater than that between Australia and New Guinea, indicating that the time separation between the two would have had to have been of the same order, a minimum of 8,000–16,000 years. Her method is precise enough to show an even greater typological difference for the interior and southern parts of the New World—evidence that in general the time separation has been longer than proposed by the Clovis chronology and perhaps longer than an earlier chronology, based on the Meadowcroft site in Pennsylvania, that Nichols refers to as the "received chronology."

In a third approach, Nichols set out to determine how long it would have taken a language group to move through a high-latitude area such as Siberia. To do so she used estimates of the minimum population size needed for a tribal group to survive in Siberia. "Population size gives you a toehold on the question of how many colonizations you can have in a length of time," she explains. If there were multiple colonizations, one could multiply the estimated time required for one linguistic succession by a plausible number of colonizations to determine how long ago such colonizations began.

Looking at several studies done on northern people commonly referred to as Eskimo, Nichols found that the minimum size needed for a group to enter and survive in the Arctic was probably at least 900 individuals. Such a number requirement, together with the probable low-lineage density of the high-latitude source, suggests to her that the "rate of linguistic colonization cannot have been rapid."

The archaeological record of cultural succession in the Arctic and northeastern Siberia is consistent with Nichols' conclusion: cultural succession occurred at the rate of one entry every 1,000 to 3,000 years throughout the Neolithic. So if multiple colonizations took place, this entry rate would require many thousands of years of migration.

In a fourth approach, Nichols examines the highly controversial view that language stocks entered North America in three successive waves, leading to a stratification of stocks in the northern part of the New World. As proposed by Joseph Greenberg of Stanford University, the most recent stock is the northernmost one, Eskimo-Aleut. It was preceded by Na-Dene, which was preceded by Amerind, which Greenberg and others believe entered 12,000 years ago. Speakers of Amerind, in this view, branched out in the New World to create about 140 descendent stocks that are scattered throughout North and South America.

	Years between Na-Dene entry and first settlement	*Colonization rate*	
		No. entries	*Rate*
Clovis chronology	3,000–5,000	6	1 stock per 800 yrs
		11	1 stock per 300 yrs
		73	1 stock per 41–68 yrs
Received chronology	10,000–13,000	6	1 stock per 2,200 yrs
		11	1 stock per 1,200 yrs
		73	1 stock per 180 yrs

Table 1 Derived colonization rates for Clovis and Received chronologies (based on Na-Dene age of 7,000–10,000 years)

If entrance of these language stocks was stratified in this way, then, Nichols points out, one can use the age of surviving stocks to calculate how frequently stocks moved into North America. She refers to this as the colonization rate.

Nichols uses this approximate colonization rate to examine whether the Clovis chronology and the Greenberg model of three colonizing stocks are realistic.

"Assuming a colonization rate for Alaska of 3,000–5,000 years," she says, "the Eskimo and Na-Dene entries then take us back to 6,000–10,000 years ago. On the Clovis chronology, whereby New World settlement goes back only some 12,000 years, at this colonization rate there remains time for only one or two more stocks, for a total of three or four within the entire span of New World settlement. Three colonizing stocks is exactly what Greenberg's method proposes: there is time for approximately one more colonizing stock before Na-Dene, and that stock is Amerind."

Such a scenario depends on Greenberg's hypothesis that there was only one entry of the early parent stock, "Amerind." Nichols believes that the stocks said to descend from Amerind actually came in several colonizations. In Greenberg's model, she argues, Amerind is older than Na-Dene by 3,000–5,000 years. The breakup of Na-Dene is known to have left three to four typologically similar families. But the number of stocks supposedly emanating from the breakup of Amerind—140—is much larger, and the stocks are much more typologically diverse. Nichols says that it is not likely that such a degree of difference could have occurred in only 3,000 to 5,000 years.

If so-called Amerind did enter as several separate stocks, then Nichols' methods indicate that the Clovis chronology does not provide enough time for them to have arrived. A chronology with first entry at 20,000 years is possible but improbable.

To support her argument, Nichols calculated the number of years between the first entry and Na-Dene entry (for Clovis, 12,000 years minus the age of Na-Dene, 7,000–10,000 years; for Received chronology, 20,000 years minus the age of Na-Dene), and then divided the result by a hypothetical number of stocks that might have entered separately during that period. The result gives the colonization rate, or amount of time between separate stocks, that would have had to be operating if either the Clovis or the Received chronology is accurate.

For example, if there were six separate entries, Nichols finds that the colonization rate for the Clovis chronology would have to have been one stock moving through every 800 years, and for the Received

Skeletal Data

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chronology one stock moving through every 2,200 years.

The variable is the number of separate stocks that entered. Table 1 shows Nichols' calculations for several possible numbers of entries. The rates derived for the Clovis chronology are either impossibly short (43 years) or are inconsistent with the rates of a few thousand years, described above, that are implied by archaeological and other data. Similarly, for the Received chronology all derived rates are improbable except for perhaps 2,200 years.

Rate of branching	*Age of stocks in years*	*Time to Proto-Northern Amerind in years*	*Time to Proto-Amerind in years*
1.4	7,000	70,000	91,000
	5,000	50,000	65,000
	3,000	30,000	39,000
1.6	7,000	49,000	70,000
	5,000	35,000	50,000
	3,000	21,000	30,000
2.0	7,000	35,000	49,000
	5,000	25,000	35,000
	3,000	15,000	21,000 R
	2,000	10,000	14,000 C
3.0	7,000	21,000	28,000
	5,000	15,000	20,000 R
	3,000	9,000	12,000 C

Table 2 Calculated ages for Proto-Amerind. Proto-Amerind is assumed to consist of 140 stocks; Proto-Northern Amerind, 50 stocks. C indicates figures consistent with Clovis chronology; R, with Received or earlier chronology. Data are published in Nichols: "Linguistic Diversity and the First Settlement of the New World," *Language* 66:504. c1990 *Language*.

"Stratification was one of the different ways that I used to get an estimate of how frequently colonizations could have occurred," Nichols explained. She went on to say that stratification and the size of populations, plus trends in the recent archaeological record, indicate that entries of new languages to the New World took place at the rate of about one every two or three millennia. "But if we assume Greenberg's chronology of 12,000 years, and we ask how frequently stocks would have had to come in, the answer is much, much too frequently."

In yet another calculation, Nichols used the rate at which lineages branch out into new families to estimate how long it would have taken for the 140 stocks of Amerind to develop from a single lineage. She found that it would have taken much more time than either the Clovis or Received chronology allow.

Nichols did a calculation for approximating the branching rate of 2.0 surviving families every 7,000 years. Going backwards in time, every 7,000 years the number of stocks would be cut in half. "There are approximately 140 Amerind stocks now, so 7,000 years ago there were only half that number, or 70 stocks, 14,000 years ago only 35 stocks, 21,000 years ago only 17.5, and so on. At this rate it takes 49,000 years to reach a figure of under two stocks, and this can be taken as the amount of time it would have taken Proto-Amerind to split into its approximately 140 daughter stocks."

To see what values would work for the Clovis and Received chronologies, Nichols calculated a range of values. She used branching rates of 1.4, 1.6, 2.0, and 3.0 (although, she noted, only 1.4 and 1.6 are realistic), and stock ages of 3,000, 5,000, and 7,000 (although only 5,000 and 7,000 are realistic). Some of her results are shown in Table 2.

Nichols says her results show that using either the Clovis chronology of first entry at 12,000 years or the Received chronology of 20,000 years requires "unrealistic conditions such as an average age of 3,000 years for stocks (an age in such a range of time defines a family not a stock) or an average rate of branching of two or more (higher than the demonstrated survival rate). But assuming the more realistic ages (5,000 to 7,000 years) and rates (1.4 to 1.6) requires a minimum of about 50,000 years—a figure greater than the received ages of inhabitation of any part of the Pacific, hence unlikely to represent the real age of New World settlement."

"This," Nichols says, "indicates that either the Received and Clovis chronologies are too shallow or Amerind is not a single lineage, or both. So if you assume Greenberg's classification of languages, then his chronology can't be correct, and vice versa."

What happens when the calculations are made using what Nichols considers more reasonable assumptions, and without assuming that Amerind is a single lineage?

One of her hypothetical sets of variables—a colonization rate of one stock per 3,500 years, 10 entering lineages, a branching rate of 1.6, and an average stock age of 5,000 years—produces an age for New World settlement of 37,500 years ago. This age is consistent with the result from Nichols' third method, using the same values: if the colonization rate is 3,500 years, the time required for 10 lineages to move in is 35,000 years.

Instead, if Amerind was a single entry that could have occurred during a glacial retreat 50,000 years ago, such as Ruth Gruhn of the University of Alberta has proposed, Nichols suggests another scenario. Assuming a stock age of 5,000 and a branching rate of 1.6, with entry to the New World blocked by glaciation most of the time (making the colonization rate irrelevant), and one entering lineage during the glacial retreat (giving rise to 140 stocks), Nichols gets a settlement date of 50,000 years ago. The time is identical to Gruhn's suggestion, which was based on archaeological and paleoclimatological grounds.

Nichols is continuing to refine her methods of measurement. "Now I'm working not so much on the time depth but on the number of colonizations and where they probably came from. I'm also continuing to expand my data base for languages and typological features."

Recently she found evidence of multiple New World colonizations, which would weaken the case for a single entry at 50,000 years ago. Her claim is based on typological diversity. "I looked at frequencies of the same typological features in various parts of the New World, separated into western North America, eastern North America, Mesoamerica, and South America. Since then I've used a bigger sample and it still works out. I found that for a number of the features, there's a sort of line or scale of increase or decrease in frequency. Within the New World, for example, a certain feature is least frequent in western North America and most frequent in eastern North America. It looks as though the frequency distribution that you get within the New World echoes that which you get between Australia and New Guinea, and in general that which you get from continent to continent.

"I take this to be evidence that the New World was colonized a number of times by different languages," she says. The earlier the colonizer, she adds, the greater the chance that the language had certain features, and the later the entrance the less of a chance that it had those features.

"Ultimately," Nichols suggests, "the linguistic evidence may yield a more precise answer than paleoclimatology can give as to whether and when the New World was open to entry 50,000 years ago during the Ice Age."

"Prehistorians, linguists included, have traditionally looked to archaeology to establish dates of earliest inhabitation," says Nichols. But in the absence of well-accepted dates in the archaeological record for the earliest American populations, that reliance may be reversing direction.

–Susan Simpson