energy defined in relativity theory, the energy that accompanies the constant's antigravitational effect is equivalent to an increase in the apparent density of matter in the cosmos. Theory predicts that the cosmological constant could solve both the age and missing mass problems if it adds enough energy to produce the equivalent of an omega value of 0.8.

But gravitational lens expert Chris Kochanek of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, has now all but slammed the door on that possibility. When light from, say, a quasar passes by an intervening galaxy on its way to Earth, the galaxy's gravity bends the light like a lens, creating multiple images of the quasar. Astronomers have been scouring the sky for these strange objects and counting how many they see out to a specific distance. If the cosmological constant exists, its antigravitational influence has the effect of boosting the volume of space between two distant objects—and thus increasing the number of gravitational lenses caught by surveys that look out to a given distance. Unlike counting single objects, gravitational lens numbers reflect conditions at two locations—that of the quasar and of the galaxy—both affected by a cosmological constant.

For a cosmological constant equivalent to an omega of 0.8, Kochanek calculates that about 15 gravitational lenses should have been seen by current surveys. So far, only 6 have been found. With his current results, to be published later this year in the *Astrophysical Journal*, Kochanek can say with 90% certainty that the cosmological constant is less than 0.5 for current models of the universe. "A cosmological constant of 0.8 is more or less right out," he says.

Cosmologists have taken the news on the chin, but still cling to the hope that the result may be flawed. Princeton University cosmologist Jim Peebles, for instance, notes that the apparent dearth of lenses may be the result of their being obscured by dust. But Kochanek, unswayed, counters that dust does not explain other problems, such as the constant's failure to give the correct distance of individual gravitational lenses.

So what now? Once possibility is to introduce a cosmological constant that varies with time—an idea investigated by Peebles himself. With suitable tweaking, this might get around the current problems. But many cosmologists would find this disturbingly reminiscent of the attempts of medieval astronomers to patch up their Earth-centered view of the solar system by devising more complicated celestial machinery to propel the planets.

–Robert Matthews

Robert Matthews writes for the Sunday Telegraph *in London.*

ARCHAEOLOGY

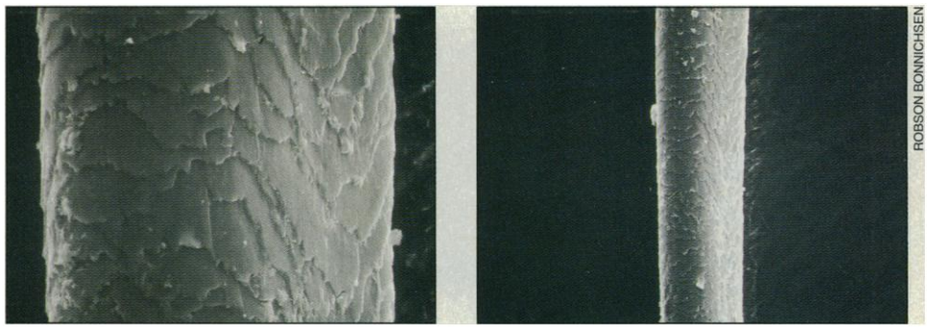
Pulling Hair From the Ground

Humans shed a lot of hair, hundreds of strands each day. And archaeologists are discovering that what was hair yesterday is here today as well: They are pulling it by the clump out of archaeological sites. "The hair has been there all the time, but we never saw it," explains Rob Bonnichsen, an archaeologist at Oregon State University (OSU), Corvallis, who has helped devise a technique for recovering ancient hair fragments. And researchers are finding hair and its immediate surroundings to be a hatful of information.

Bonnichsen and his colleagues have recently plucked hair from an archaeological site in western Montana dating from about 10,000 years ago, and last month they extracted DNA from some fragments—genetic information that could speak volumes about ancient populations should it turn out to be genuine and not a more modern contaminant. And other organic substances found in the soil around the hair, such as fish scales and bird feathers, could reveal important clues about the populations' diet and health.

By mixing the sediments with water and sodium hexametaphosphate, then running this slurry through a flotation tub and capturing the outflow in a mesh bag, Beatty was able to break down the clumps of earth, separating out any organic remains. A surprising amount turned up. "We've found a lot of little fragments of hair, both animal and human, plus bird feathers, a single fish scale, plant matter, beetles—things that we'd never found before because this [sediment] material is normally discarded," says Bonnichsen. The technique, he adds, is a little bit like "looking for a needle in a haystack—only there are a thousand needles to find."

If DNA is found in the hair, the molecule may provide clues about how many related groups occupied a given site. DNA may also help resolve disputes about the number of migrations into North America from Asia and from where in Asia these early peoples came. DNA linked to a specific archaeological site would also enable archaeologists to tie a particular culture to a particular people,



ROBSON BONNICHSEN

Hair-raising find. This hair from a 10,000-year-old site may reveal ancient population genetics.

George J. Armelagos, a physical anthropologist at Emory University in Atlanta, says that "any organic material that is recovered from an archaeological site is of immense interest. So finding a method to collect these hairs is a fantastic breakthrough."

Looking for hair seems obvious now, Bonnichsen says, but archaeologists usually go into a site with their eyes on bigger game, like bones or stone tools. In 1986, Bonnichsen got his first clue that hair could be found as well. While sieving the sediments at a 14,500-year-old cave in western Montana, his team noticed that hairs were often left behind on the water screens. Then, at the 10,000-year-old site, known for its Clovis artifacts, a team member found a single, long, black hair stuck in a clump of earth on the bottom of a stone. "That's when I realized there had to be more, but we were missing it," says Bonnichsen. He then turned to Marvin Beatty, a soil scientist from the University of Wisconsin, for aid.

something that is now nearly impossible to do. "We've often wondered who is Clovis," says Bonnichsen, referring to the earliest known culture in the Americas. "Some of us think of Clovis as a population group, others as a technology that spread across a group of populations." The DNA in hair samples associated with Clovis artifacts could conceivably lay this issue to rest.

But, says Walt Ream, the microbiologist at OSU who is pursuing the DNA in Bonnichsen's ancient hair, a lot of work must be done first. Ream's initial tests on 3- to 5-centimeter lengths of hair from Bonnichsen's 10,000-year-old site have given him a positive DNA signal, although he says a great deal of testing remains to be done before the DNA can be identified as coming from a past inhabitant. "It's premature to say we have viable old DNA," he says. Still, archaeology may yet become a field where splitting hairs is extremely significant.

–Virginia Morell