exposure to herbicides has been difficult to document. The panel acknowledged that limitation but said its review suggests that people (including Vietnam veterans) who come in contact with these chemicals run a risk of developing the three cancers and two other diseases.

"How big that risk is quantitatively, we just don't know," says IOM panel member David Kriebel, an occupational epidemiologist at the University of Massachusetts at Lowell.

The IOM panel also found hints of a weaker association between exposure to herbicides and lung and throat cancers, prostate cancer, and multiple myeloma, a cancer of the bone marrow. However, the group says the observed link could result from chance or bias.

A raft of disorders fell into a gray zone in which the panel concluded that available studies were not of sufficient quality or did not have the statistical power to warrant any conclusions. These health problems include immune disorders, renal cancer, leukemia, birth defects, and infertility.

Finally, the IOM committee sifted through the evidence and concluded that there appeared to be no connection between herbicide exposure and skin cancer, bladder cancer, brain tumors, or gastrointestinal tumors such as stomach cancer. *– K.A. Fackelmann*

Pleistocene diet: Tough on the teeth

For a predator, dinner is always catch as catch can. But the saber-toothed cats and other large carnivores living in America at the end of the last ice age had a particularly difficult time finding enough food, according to a study of teeth preserved in the tar pits of Los Angeles' Rancho La Brea. The preponderance of jaws with broken teeth suggests that carnivores back then had to crunch on bones or pick them clean in order to get their fill.

Blaire Van Valkenburgh and Fritz Hertel of the University of California, Los Angeles, analyzed specimens dating from the late Pleistocene epoch, 36,000 to 10,000 years ago, when Earth was emerging from the latest ice age. The most plentiful fossilized teeth at Rancho La Brea belong to coyotes and three species of extinct animals: the American lion, the saber-toothed cat, and the dire wolf.

Compared with modern carnivores, the animals that died at Rancho La Brea had a far higher frequency of broken teeth. The tar pit animals fractured between 5 and 11 percent of their teeth, whereas existing predators break only 0.5 to 2.7 percent, the researchers report in the July 23 SCIENCE.

The researchers also found a high proportion of broken teeth among ice age remains of dire wolves in Mexico and Peru, suggesting that this pattern occurred elsewhere, not just at Rancho La Brea.

Among modern carnivores, those that eat bone, such as the hyena, run the greatest risk of fracturing their teeth. Van Valkenburgh and Hertel therefore propose that carnivores from Rancho La Brea broke many teeth because they ate or gnawed on bones more often than their modern counterparts do. These early carnivores may have been forced to consume as much of their kill as possible because prey was scarce or because predators faced stiff competition.

The teeth story from the tar pits could reflect how the ecosystem of North America was changing in response to a wave of extinctions that wiped out most of the larger mammals on the continent between 13,000 and 10,000 years ago. This was the time when mastodons and mammoths disappeared, as did camels, many species of horses, and super-size elk. With their prey vanishing, predators may have had to alter their feeding practices, the researchers suggest.

Paleontologist Russell Graham of the Illinois State Museum in Springfield praises the study, saying, "It's a novel way of trying to figure out what the feeding strategy of these animals was. A lot of previous studies have looked at this in a subjective way, but Van Valkenburgh has found a way to quantify this and test it."

The new findings could rekindle the debate concerning the causes of the late Pleistocene extinctions. Paleontologists have traditionally explained the die-offs as the result of climate change at the end of the ice age. But some argue that human hunters, arriving from Asia, sped across the virgin continent, wiping out the big herbivores (SN: 3/27/93, p.197).

If future teeth studies show that carnivores altered their habits long before humans came to North America, that would bolster the climate change hypothesis, Graham says. *– R. Monastersky*

Atomic rebound makes breaking up hard

When chemical reactions occur in solution, solvent molecules exert a strong influence on the making and breaking of bonds. A team of researchers has now obtained the first glimpse of what happens when a laser light pulse lasting only a few femtoseconds (quadrillionths of a second) excites and splits an iodine molecule surrounded by a layer of argon atoms.

"With femtosecond time resolution, we can obtain snapshots of chemical reactions in real time," says chemical physicist Ahmed H. Zewail of the California Institute of Technology in Pasadena. This capability permits researchers to monitor motions on an atomic scale and to investigate what role solvent molecules play in easing bond formation or bond breaking.

Zewail and his Caltech co-workers studied the behavior of iodine molecules enveloped in clusters of argon atoms traveling in a molecular beam. From previous studies of isolated iodine molecules in the gas phase, they already knew that extremely short light pulses at different wavelengths cause iodine molecules to break up in different ways.

At a wavelength of 614 nanometers, a light pulse lasting only a few femtoseconds causes such a rapid breakup of an iodine molecule into two iodine atoms that the two atoms shoot away from each other at high speed. At a wavelength of 510 nanometers, the dissociation of iodine molecules occurs much more slowly.

The presence of argon atoms changes the dynamics of this chemical reaction considerably. In the first case, the two iodine atoms speed apart until they hit the surrounding "wall" of argon atoms. The iodine atoms rebound along their original paths and recombine into a molecule. This "hot" iodine molecule then gradually cools down via repeated collisions with its shell of argon atoms.

"We see the recombination of the atoms, which you don't see in the gas phase," Zewail says.

In the second case, because the iodine molecule breaks up more slowly, the surrounding argon atoms have sufficient time to get between the two iodine atoms. "There is plenty of time for the solvent to rearrange, and as a result of that, we lose this [fast] recombination of the atoms," Zewail says.

The results demonstrate that the dynamics of the dissociation of iodine molecules depend critically on how swiftly bond breaking occurs relative to how quickly solvent atoms rearrange themselves. The researchers can also pinpoint the rebound of iodine atoms within their argon trap as the mechanism responsible for a process by which a solvent may enhance bond formation in solution by trapping reactive atoms or molecules in "solvent cages."

"Now we want to try to generalize this result," Zewail says. "There are a lot of other solvents we would like to do." By studying what effect solvent composition has on the dynamics of this and other chemical reactions, researchers may obtain important insights into the atomic forces that lead to various types of chemical behavior.

Zewail, Qianli Liu, and Juen-Kai Wang describe their findings in the July 29 NATURE. *– I. Peterson*