**Infectious Disease**

**Plague Linked to Precipitation**

For the first time, researchers have confirmed a long-suspected link between precipitation and plague. After reviewing nearly half a century's worth of data, a team of scientists from New Mexico and Colorado have found a strong tie between above-average precipitation during New Mexico winters and an increase in human cases of the still-dreaded plague. Their research, funded by the National Science Foundation, was published in the November 1999 issue of the *American Journal of Tropical Medicine and Hygiene*.

A pattern of wet years followed by outbreaks of plague has been observed around the world for more than a century, but a direct link to precipitation, particularly in a specific season, has never been proven. "That's what makes this dramatic," says Paul Epstein, associate director of the Center for Health and the Global Environment at Harvard Medical School in Boston, Massachusetts.

Plague, caused by the bacterium *Yersinia pestis*, can kill within a matter of days if not treated with antibiotics. High rodent populations are one well-known factor governing the spread of the disease among humans (plague is transmitted by the fleas carried on rodents). Team leader Robert Parminter, a research associate professor in the biology department at the University of New Mexico at Albuquerque, says he and his colleagues knew that rodent numbers tend to increase when higher levels of precipitation lead to increased food availability.

But they also knew that human factors such as crowding, behavior, sanitation, and land use practices, along with the biology and behavior of both fleas and their rodent hosts, could influence the spread of plague. Some 1,000–3,000 cases of the disease are reported worldwide each year, according to the World Health Organization, including 10–15 cases in the United States. Fifty-five percent of U.S. cases have occurred in New Mexico.

To test whether precipitation alone might influence the spread of plague, Parminter's team examined data on precipitation and 211 plague cases that occurred from 1949 to 1996 in 38 New Mexico locations. They found that 60% of the cases occurred in years with above-average precipitation from October through May, as measured within about 20 kilometers of each plague case. They also saw a hint of increased plague cases with above-average local summer precipitation and with above-average precipitation when viewed statewide (during summer and winter) or on a global scale (during winter alone), but these numbers weren't statistically significant.

In some years, the team found a marked drop in plague cases when local precipitation fell to a range of 10–25% below mean annual levels, particularly when the condition persisted for years in a row. When such a dry spell occurred in the mid-1950s, no plague cases were recorded for seven years. But when the converse happened in the mid-1980s and precipitation was consistently above the yearly average, the number of cases per 100,000 residents peaked at more than four times its annual mean.

Parminter's team found many exceptions within these patterns, but that's somewhat predictable since the biology of plague is poorly understood, says Janine Bloomfield, a senior scientist with the Environmental Defense Fund. To help fill in the gaps revealed by those exceptions, Russell Ensore, an environmental health specialist at the Fort Collins, Colorado, office of the Centers for Disease Control and Prevention, is developing a mathematical model that builds on Parminter's study. His preliminary results suggest that summer temperatures may be a key factor, since a few weeks of temperatures above 95°F can negate an entire wet winter. "It just shuts the cycle off," says John Pape, an epidemiologist with the Colorado Department of Public Health and Environment who has been following the study. Ensore is shooting for publication in the *American Journal of Epidemiology* later this year.

Public health officials in New Mexico aren't waiting, because Parminter's study already offers a new tool: "It will help us craft and time our public health messages," says Gary Simpson, medical director for infectious diseases at the New Mexico Department of Health, who helped get the study under way. -Bob Weinhold

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**Radiation**

**Microwaves and Memory Loss**

New research published in the January 2000 issue of *Bioelectromagnetics* suggests that exposure to microwaves may affect long-term memory function in rats. Henry Lai, a research professor in the bioengineering department at the University of Washington in Seattle, and Booming Wang, a visiting professor from Tianjin Medical University in China, reported an alteration in long-term memory and learning in rats following exposure to microwaves.

In the study, one group of rats was exposed to pulsed microwaves for 1 hour at a frequency that Lai says is twice as high as cell phone emissions. A control group of rats was not exposed to microwaves. The researchers placed the rats in a tank of water clouded with powdered milk and trained them to swim to a submerged platform that they couldn't see. The rats were then reintroduced to the pool at different locations to see if they could remember how to find the obscured platform.

"The microwave-exposed rats were much slower in finding the platform during the training session. They tended to spend more time attempting to climb the wall of the pool or swimming along the wall," Lai says. The difference in the rats' ability to find the platform was attributed to a deficit in long-term memory and learning ability rather than motivation or motor skills since the different groups' swimming speeds were the same.

After repeating this process several times, the researchers removed the platform and observed that rats in the control group spent most of their time swimming in the area where the missing platform had been located. The irradiated rats didn't show a tendency to search for the missing platform, and instead behaved more randomly. "They seemed to have trouble making a map in their heads, like the normal rats did, so they could recall where the platform was," said Lai in a November 1999 press release from the university. "Their spatial reference mapping or 'place learning' strategies [using the relative position of various different cues as guides] seemed to be affected after their exposure."

Disturbance to the central nervous system may lessen the animals' learning capacity, Lai suggests, forcing them to resort to simpler learning strategies. However, critics of the study point out that there are other potential interpretations of the data. For example, effects such as those seen in both the training and testing phases of the experiment could be attributed to an emotional component in the rats.

Lai says that the frequency is similar to devices such as radar and other microwave equipment. The question remains whether or not this same type of long-term memory loss could affect humans exposed to similar microwaves. "It's difficult to extrapolate from these animal data whether or not the effect would be the same on humans." Lai says. -Lindsey A. Greene