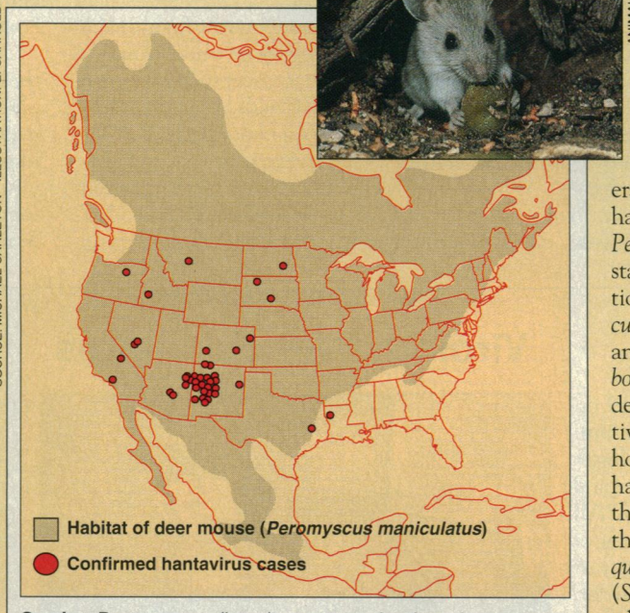
The Mouse-Piñon Nut Connection

Six months ago, a research team led by University of New Mexico mammalogist Robert Parmenter was pursuing what seemed like an obscure piece of research: collecting data on rodent populations at the Sevilleta Long Term Ecological Research site near Albuquerque, New Mexico, and at Pecos National Historical Park near Santa Fe. Heavy rains and snows the previous spring had disturbed the ecological balance in the deserts and mountains, producing an abundance of piñon nuts and insects. All of a sudden, deer mice—pale-gray to reddish-brown rodents about 6 inches long—were everywhere. Parmenter estimates the mouse population, feasting on piñon nuts and grasshoppers, grew 10-fold between May 1992 and May 1993.

This ecological cascade might have remained a curiosity if it weren't for the fact that deer mice (*Peromyscus maniculatus*) have been found to carry the deadly Four Corners hantavirus, which was responsible for a cluster of deaths in the Southwest in May and June. "It was a stroke of luck we were focusing on small mammals," recalls Parmenter, who adds that none of the 40 Sevilleta researchers who have studied the rodents in the past decade have tested positive for the Four Corners virus.



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Carrier. Deer mouse *(inset)* appears to be the primary reservoir of the newly discovered hantavirus.

Parmenter's data became a hot commodity at the Centers for Disease Control and Prevention (CDC), which has been investigating the outbreak of hantavirus respiratory syndrome that occurred in May and June in the Four Corners region of Arizona, Colorado, New Mexico, and Utah. By the first week of June, CDC scientists had found antibodies to hantavirus in tissue samples from infected people; knowing that rodents carry hantavirus in Asia and Europe, CDC officials contacted Parmenter, whose data provided an explanation for why the cases clustered in the Four Corners region.

Since May, however, Parmenter's team has tracked a sharp decline in the number of deer mice at the study sites, from about 30 per hectare in May, to fewer than 20 per hectare in July, to about four per hectare in August (levels were about two to three per hectare in May 1992). Parmenter says he's unsure why the mouse population has crashed—there's still plenty of food available—but he speculates that predators such as foxes, owls, and snakes, or some disease may be responsible. With the mouse reproductive season almost over, "it's questionable whether the mice can bounce back" to early 1993 levels, Parmenter says.

Nevertheless, the fact that deer mice appear to be the chief carrier of the virus is cause for concern. The reason: The deer mouse habitat stretches across most of the continental United States and Canada (see map) and the virus may well infect the animals throughout their range. Of 770 mice in Arizona, Colorado, and New Mexico that CDC has tested by the polymerase chain reaction (PCR) technique for hantavirus DNA, about 30% in each state were infected, a very high rate. This leads CDC epidemiologist James Childs and others to speculate that the virus infected the deer mouse population years ago and has achieved a steady state in the Southwest—and perhaps elsewhere. "We have no reason to believe the distribution of the virus is limited to states where cases of illness are occurring," Childs says; to test this theory, CDC is testing mouse tissue samples from other states.

Moreover, while deer mice seem to be the main carriers of the Four Corners serotype, several other rodent species may also harbor it. Two other members of the *Peromyscus* genus found in Western states have significant rates of infection—the piñon mouse (*Peromyscus truei*), 19.7% of 314 tested so far, and the brush mouse (*Peromyscus boylii*), 6.8% of 59 tested. Other rodent species that have tested positive for the virus so far include the house mouse (*Mus musculus*), the harvest mouse (*Reithrodontomys*), the cliff chipmunk (*Tamias dorsalis*), the Colorado chipmunk (*Tamias quadrivittatus*), the rock squirrel (*Spermophalus variegatus*), and the white-throated wood rat (*Neotoma albigula*).

Determining the extent of hantavirus infection in the animal kingdom may prove more than an academic exercise—it may shed light on three cases of pulmonary disease in Louisiana, Mississippi, and eastern Texas that developed outside the deer mouse range. The CDC has evidence that another rodent was involved in the Louisiana case, CDC epidemiologist Jay Butler told *Science*, but he declined to reveal the species. CDC is still investigating the Texas case.

The third case, involving the death of an 8-year-old girl in Mississippi, remains a mystery. CDC has decided not to classify it as due to a hantavirus, although virologists at the U.S. Army Medical Research Institute of Infectious Diseases have evidence—including an electron micrograph—of what appears to be a hantavirus in the girl's tissue. The vector remains unknown.

CDC is also investigating whether other animals, particularly those that prey on rodents, may carry the virus. The impetus for this research is a 1987 study suggesting that cats, which tested positive for two other hantaviruses—the Hantaan and Seoul types—may help transmit the virus to humans in China. Ted Tsai, a microbiologist at CDC's infectious disease lab in Fort Collins, Colorado, and collaborators at Shanghai Medical University found that cat owners were twice as likely to come down with hantaviral kidney disease. As for the Four Corners virus, so far CDC scientists have identified one infected nonrodent species (aside from humans): the desert cottontail (*Sylvilagus audubon*i). But virologists think most nonrodents are "dead-end" hosts that shed little virus and are unlikely to infect people. So public health officials, with the help of Parmenter and other mammalogists, intend to pay closest attention to the deer mouse.

–Richard Stone