ScienceWatch

Of Moths, Mice, Masting - and Lyme?

Every 2-3 years oak trees (*Quercas* spp.) produce an abundance of acorns. The increase, known as "masting", draws white-tailed deer (*Odocoileus virginianus*) into the forest and is associated with increased population densities of the white-footed mouse (*Peromyscus leucopus*) during the following midsummer. The mice are an important predator of the gypsy moth (*Lymantria dispar*). The moth, an introduced pest, undergoes periodic outbreaks, defoliating millions of acres of oak forests, and decreasing tree growth, survival and masting. Both deer and mice are primary hosts of the black-legged tick (*Ixodes scapularis*), which is the vector of the spirochete bacterium (*Borellia burgdorferi*) that causes Lyme disease in humans.

In a 3-year study published in the February 13th issue of *Science* a team headed by Clive Jones and Richard Ostfeld traced the connections among these forest species to show that a bumper crop of acorns leads to a rise in mouse numbers. More mice harbor more ticks, but also protect the oaks by eating gypsy moth pupae. The team first wanted to learn if moth populations explode once mouse populations crash. In the summer of 1995 mouse densities were high because of a masting the previous autumn. During June and July when moth larvae are normally pupating, the team removed over half the mice from three unfenced 6.6-acre plots of upstate New York forest by live trapping and left three other control plots untouched. They found over 40 times more pupae and egg masses in the plots with fewer mice. A direct link between mice and moths was established by using freeze-dried pupae embedded in wax and noting that virtually all the pupae in the control plots contained teeth marks from mouse attacks, while about 30% of pupae in experimental plots where mice had been removed, remained free from attack.

In autumn of 1995 the team took advantage of a mast failure by artificially adding (with help from local Girl Scouts) 4 tons of acorns to their experimental plots to simulate a mast. As a result mouse densities were seven-fold higher by spring 1996 than in control grids without added acorns. Tick populations also soared in the experimental plots. That summer they found an eight-fold rise in tick larvae and 40% more ticks on mice in the acorn-rich plots. The results have important ramifications for determining the best ways to control both ticks and moths.

Jones *et al*. surmise that the simulated mast attracted more tick-bearing deer to these plots during the fall when adult ticks mate and take to ground cover to overwinter. In the spring the adults lay their eggs and the larvae hatch in midsummer. Newly-hatched larvae are virtually free of *B. burgdorferi* but can become infected after feeding on mice that serve as a reservoir for the spirochetes. Larvae then molt to nymphs, spending their first winter on the forest floor, and are ready to feed on (and likely infect) any vertebrate host, including humans, they encounter. The researchers did not monitor incidence of Lyme. Nonetheless, they conclude that high densities of infected nymphs should cause a high risk of Lyme disease two years after masting and recent evidence supports that conclusion. In the summer of 1996, two years after the '94 masting, 5,301 cases of Lyme disease occurred in New York State. Typically the number has been between 3,000 and 4,000 a year.

A better understanding of the interactions between host and parasite may lead to predicting the risk of contracting Lyme disease based on masting events, but what can be done to lower the incidence of the disease? This study highlights the difficulties in managing ecosystems for short-term benefit because trying to reduce Lyme disease by chemically preventing masting, for example, could yield large outbreaks of gypsy moths and a long-term decline in oak forests. Trying to reduce gypsy moth populations by spraying pesticides, for example, could yield more bumper acorn crops, possibly raising the incidence of disease. Take your pick!