

NAME _____
Cause and Effect Guide

Environmental Science
Ticks, Moths & Acorns

Directions: Match the correct effect with the cause. Then answer the questions that follow.

Cause	Effect
_____ 1. Larvae become nymphs.	A. tree populations are severely impacted.
_____ 2. Mouse populations are at a peak	B. sharp decline in population of animals that consume acorns
_____ 3. High fat and protein content of acorns	C. deer carry adult ticks which drop off and lay eggs beneath oak trees
_____ 4. Deer move into forest when there is an abundance of acorns	D. gypsy moth population explodes
_____ 5. Low population of acorn consumers	E. number of acorns produced drops significantly
_____ 6. Gypsy moth population explodes	F. food preferred by mice and deer
_____ 7. Oak populations crash	G. nymphs molt to become adult ticks which attach themselves to deer
_____ 8. Mouse population crashes	H. large population of ticks feed on mouse blood and pick up Lyme spirochete
_____ 9. Low output of acorns	I. More chance that some acorns grow to become oak saplings
_____ 10. Gypsy moths feed on oak leaves then become pupae	J. mice feed on pupae, controlling the moth population

Questions

1. What happens to gypsy moth populations as a result of tree defoliation?

2. What happens to gypsy moth populations as a result of an increase in the population of mice?

3. Why would feeding the mice when acorns are scarce (to control gypsy moths) cause an increase in Lyme disease?

4. Explain two ways that gypsy moth populations impact mouse populations.

5. Describe two effects that an increase in deer population would have on the ecosystem.

Ticks and Moths, Not Just Oaks, Linked to Acorns

By LES LINE
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A TANGLED cycle of events in northeastern forests that gives a reason for both Lyme disease epidemics and outbreaks of gypsy moths has been unraveled by ecologists. They have traced both events to the bumper crops of acorns that are produced every three or four years and to the white-footed mice that feed on them.

The bumper acorn crops influence the life cycles of mice and deer as well as the gypsy moths and the spirochetes that cause Lyme disease. Based on their theory, the two ecologists, Dr. Richard S. Ostfeld and Dr. Clive G. Jones of the Institute of Ecosystem Studies in Millbrook, N.Y., predict that the gypsy moth population in the Northeast will undergo one of its periodic explosions beginning this year. They expect it to build to a major defoliation in 1999 that will rival the devastating caterpillar blight of 1979-81 unless one of the moth's natural enemies, like a fungus or parasite, intervenes.

The two ecologists also warn that there will be tremendous numbers of deer tick nymphs, the vectors of Lyme disease, in the oak-dominated woodlands of New York and New England this spring and summer.

What the two ecologists call "the acorn connection" is laid out in the May issue of the journal *Bioscience* in an article written by them and Dr. Jerry O. Wolff, a biologist at Oregon State University. The study's principal findings come from long-term studies of gypsy moths and white-footed mice at the Mary Flagler Cary Arboretum, site of the Institute of Ecosystem Studies, and a 14-year study by Dr. Wolff of mouse populations at the Mountain Lake Biological Station in southwestern Virginia.

The forests at both sites are dominated by oaks, which have evolved a cunning strategy for reproduction. Their acorns are rich in the proteins and fats that give them a head start over other tree seeds, but that also make them a favorite food of mice and deer. So instead of producing large crops each year, which would foster a steady population of acorn consumers, the oaks have evolved a feast-and-famine regimen: occasional bumper crops, separated by years in which the consumers starve.

"The evolutionary response of oak trees appears to have been to produce such large crops of acorns that the various forest consumers are simply unable to eat them all, and some survive to become seedlings," the scientists concluded.

"Trees aren't as stupid as they look," Dr. Ostfeld said.

In the Virginia study, 1980, 1985, 1988 and 1989 were years of peak acorn production, while bumper crops were produced at Cary Arboretum in 1991 and 1994. By regular trapping, the researchers found that white-footed mice became most numerous in the summer after a bumper acorn crop but that their numbers dropped sharply the following winter or spring. Except in bumper years, mice run out of stored acorns by January.

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The next actors in the drama are the white-tailed deer, which move into the oak-dominated areas of the forest during years of bumper acorn crops. The deer also import a cargo of adult ticks, which drop off and lay eggs in the leaf litter beneath the oak trees. The tick larvae, each the size of a pinhead, hatch the next summer, just as the woods are overrun with a peak population of their preferred host, the white-footed mouse.

It is from the mice, not the deer, that the tick larvae pick up the microorganism, called a spirochete, that causes Lyme disease. The tick larvae take a single blood meal from the mice, then molt a few months later into nymphs. The following spring, these Lyme disease-carrying nymphs attach themselves to mice and other mammals, including humans. They molt to become adults in late summer; the adult ticks wait in ambush for a deer to brush past, and the cycle begins anew.

"Without mice, the deer ticks would be a nuisance," Dr. Ostfeld said, "but they would not cause illness because they hatch from eggs free of the Lyme disease agent."

By measuring the number of ticks on the forest floor, the ecologists have shown that the larvae are most numerous in oak-dominated woods in the year following a bumper acorn crop; they peak in maple-dominated woods in years after poor acorn crops. That confirms the idea that deer are the ticks' principal transport system. "There is no evidence whatsoever that other factors, particularly weather patterns, influence tick abundance," Dr. Ostfeld said.

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