New study explains puzzling Lyme disease patterns

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(Medical Xpress)—In the U.S., most human cases of tick-borne Lyme disease occur in the Northeast—with a smaller cluster in the Midwest—even though the bacteria that cause it are equally common in ticks in both regions. A new study by researchers in the University of Georgia Odum School of Ecology, published in the August issue of the journal *Epidemics*, combines ecology and immunology to offer an explanation for this puzzling disparity.

The researchers, led by James Haven, a postdoctoral associate in the Odum School, used information about how Lyme disease behaves and ecological data about ticks to create a model that sheds light on this well-documented but poorly understood pattern.

They found the timing of the tick lifecycle—which appears to be driven by the local seasonal variability in temperature—plays an important role in determining which of the two types of Lyme disease thrive in a given area and how severe the disease outbreaks tend to be.

"In the Northeast, the difference between summer and winter temperatures is not as extreme as it is in the Midwest," Haven said.

In the Midwest, tick larvae and nymphs tend to emerge at roughly the same time, while in the Northeast larvae emerge after nymphs-in some cases more than a month later.

"Where the variability is big, there's a lot of overlap between when the

tick stages are active," he said, citing work done by the Yale School of Public Health's Anne Gatewood and her colleagues.

The other aspect at play is the differences in the two types of Lyme disease strains, said study co-author Andrew Park, assistant professor in the Odum School and College of Veterinary Medicine's department of infectious diseases.

One group of Lyme disease strains is considered persistent and is most commonly found in ticks in the Northeast. When it's first contracted, it is relatively less infectious. It gains its advantage by remaining in the host's system for a long time and, as a consequence, has a greater opportunity to spread within the body, leading to classic Lyme disease symptoms.

The other type, more prevalent in Midwestern ticks, is just the opposite. It is highly infectious at first, so much so that it alerts the host's immune system, which attacks and rapidly clears it from the host. This type is less likely to cause severe Lyme disease.

Park said the team undertook the study because they wanted to understand how rapidly cleared types of Lyme disease survive and thrive in different areas across North America. By combining information about disease dynamics and ecological data, they were able to do just that.

"If we hadn't taken the time to combine the tick ecology with laboratory-based disease duration data, we wouldn't have understood what, to many people, is strictly a medical problem," he said.

To understand why the two regions favor different strains of the disease, the researchers delved into the ecology of ticks.

The tick lifecycle consists of three stages—larva, nymph and adult. Tick larvae hatch in the late spring and feed once, usually on a small mammal such as a mouse or bird. They then remain dormant for about a year until they emerge as nymphs, at which point they seek their next single blood meal. They become adults several months later, in the fall.

If a larval tick's host happens to be infected with Lyme disease, the tick often becomes infected too. Then the nymph transmits the bacteria to its second host, often a mammal such as a rodent, dog or—increasingly—human.

The researchers incorporated data about climate, the timing of tick lifecycles and disease behavior—how its infectivity changes over time—into one model to attempt to explain patterns of Lyme disease across regions. The result, Park said, was an explanation of the mechanism behind some of the patterns observed in nature.

When the larvae and nymphs appear together, as in the Midwest, the rapidly cleared type of Lyme does well. It starts out highly infectious, so if a larval tick feeds on an animal that's just been infected, before the host's immune system has cleared the disease, it will become infected too.

When the nymphs emerge earlier than the larvae, the rapidly cleared type of Lyme disease is at a disadvantage. If a nymph transmits the rapidly cleared bacteria to an animal host, it will have been flushed out of the host's system by the time a larval tick appears on the scene to feed. On the other hand, if a nymph infects an animal with the persistent type, a larval tick that feeds on that host will become infected weeks—or even months—later.

More information: For more on the study, see www.sciencedirect.com/science/ … ii/S1755436512000333

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