Invasive plants increase the risk of tick-borne disease in suburbs

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Wall of bush honeysuckle in a park in St. Louis. Half the time that unidentifiable shrubby green thing is the invasive plant Amur honeysuckle, Lonicera maackii. (BRIAN ALLAN)

(PhysOrg.com) -- “You don't have to go out into the woods anymore,” says tick expert Brian F. Allan, PhD, who just completed a postdoctoral appointment at Washington University in St. Louis. “The deer are bringing tick-borne disease to us.” So, it stands to reason that anything deer like, might increase the risk of tick-borne disease for people.

The invasive plant bush honeysuckle, for example.

Yes, that leafy shrub with the lovely egg-shaped leaves on arching branches, fragrant white or yellow flowers and the dark red berries so attractive to birds.

Called bush or Amur honeysuckle, Lonicera maackii derives from the borders of the Amur River, which divides the Russian Far East from Manchuria. Its Latin name honors Richard Maack, a 19th-century Russian naturalist.

“I’ve spent a lot of time in honeysuckle,” Allan says, “and I can tell you there are deer tunnels through it. So if you get down low, you can actually move through honeysuckle pretty efficiently. And you pick up a lot of ticks while you’re back in there.”

An interdisciplinary team made up of ecologists, molecular biologists and physicians from Washington University in St. Louis and the University of Missouri-St. Louis tested Allan’s suspicions by experiment in a conservation area near St. Louis.

In this part of the country, the tick of concern is Amblyomma americanum, called the lone star tick because the adult female has a white splotch on her back. The tick-borne diseases are the ehrlichioses, caused by bacteria in the genus Ehrlichia, named for the German microbiologist Paul Ehrlich.

As Allan and his colleagues report this week in the *Proceedings of the National Academy of Sciences*, the density of white-tailed deer in honeysuckle-invaded areas was roughly five times that in areas without honeysuckle and the density of nymph life-stage ticks infected with bacteria that cause human disease was roughly 10 times higher.

Hard as it may be to believe, given the long chain of interactions needed to get there, the presence of bush honeysuckle substantially increases the risk of human disease.

"But that's exactly what is happening," says Jonathan M. Chase, professor of biology in Arts & Sciences and a collaborator on the

project. The big question now, says Chase, who is also director of Washington University's Tyson Research Center, is whether what holds for honeysuckle holds for other invasive plants as well. “This may be something that’s occurring quite broadly, but we’re really just starting to look at the connection between invasive plants and tick-borne disease risk.”

The honeysuckle experiment

By fortunate chance, Allan and Chase were able to piggyback their honeysuckle research on a similar experiment organized by Humberto P. Dutra of the University of Missouri-St. Louis for his dissertation research.

At the August A. Busch Memorial Conservation Area in St. Charles, Mo., just west of St. Louis, Dutra set up four types of plots. In one type, the honeysuckle and its berries were left alone; in the second, both the plants and berries were removed; in the third, the plant was there but the berries had been picked and in the fourth, berry clusters were placed on the ground but the plants were uprooted.

“It was very labor intensive so Dutra organized large teams of volunteers — dozens at a time — to go out there and pick fruits,” Allan says.

“The deer used the open areas less than the honeysuckle patches and we don’t think it's because they’re eating the honeysuckle; we think they’re using it for physical structure,” says Allan. “They like to bed in it because it’s the densest thing out there, the best structure in town. No native species comes close to achieving the same density.”

Allan and Dutra measured vegetation density by counting how many leaves touched a string between two poles. By this criterion, honeysuckle patches were 18 times denser than patches of native vegetation.

Moreover, Allan says, bush honeysuckle retains its leaves longer than most native species do. It's the first thing to leaf out in the spring and it's the last thing in the understory to drop its leaves in the fall, so it creates structure for a large portion of the year.

"This includes really important times of the year from the perspective of tick biology," Allan adds. "Larval ticks, the first lifestage ticks, are out from August until October. Come late October, honeysuckle is the only thing providing green cover, so deer probably bed in honeysuckle throughout the larval tick season.

"The larval ticks become infected when they take their blood meal from an infected host, usually a deer, and the next life-stage, the nymphs, may spread disease to people if they grab onto them for the next blood meal.

Poop surveys

Allan figures out deer density by counting scat. "I can spot one pellet, just one little popcorn-sized pellet from a couple of meters away," he says. "And that's indicative of a really ridiculous amount of time spent in my life counting deer feces."

Poop surveys, he calls them.

"Deer scat is pretty distinctive," he says. "The only thing you could mix it up with is scat from an eastern cottontail rabbit, which is similar in size and shape but much smaller. But it would be hard to distinguish the scat from an adult rabbit and a baby deer; those are probably the only ones it would be possible to mix up."

Counting ticks

Wherever you find white-tailed deer, you are likely to find ticks, Allan says. Lone star ticks need blood meals to power their metamorphoses from larva, to nymph, to adult and to fatten up for egg laying.

They sometimes bite coyotes, foxes and other animals, but their favorite hosts are wild turkey and white-tailed deer.

“I use a very straightforward way of trapping ticks, Allan says, "and that’s a cooler baited with a piece of dry ice. As the dry ice sublimates, it releases carbon dioxide gas that attracts the ticks. The ticks climb onto the trap and get stuck in doublesided carpet tape on the board, and that’s really all there is to it."

“The lone-star tick, the most commonly encountered tick in the St. Louis area, is very aggressive and will actually go after its host. It will run toward the host, faster than most people probably think a tick can run. It has its front legs out, and it’s trying to find you. It has sensory organs on its front two legs, so it’ll stand there and wave those legs around trying to detect your heat and your carbon dioxide signature. And when it gets closer, it kind of zig zags as it’s approaching you, because it’s homing in on your signal and when it gets really close, it grabs on.

“Sometimes I’ll just stand there and watch the ticks do this,” he says grinning. “It’s pretty amusing.

“My record trap, the one that blew the rest out of the water, had 5,000 nymph lifestage lone-star ticks on it. We’ve done capture studies that suggest the nymphs don’t travel much more than three meters, so that means there were 5,000 nymphal ticks within about a three-meter radius of where we put that trap down."

“It was remarkable. It took 10 man-hours to count all the ticks on that trap. We need to bring them into the lab to test them, so we pick them

off with a pair of forceps one at a time and put them in ethanol."

Getting blood from a tick

The ticks are brought into the lab where they are pulverized and the mash is run through a DNA assay developed by Robert E. Thach, PhD, professor of biology in Arts & Sciences and of biochemistry and molecular biophysics in the School of Medicine, and Lisa S. Goessling, staff research associate in the Department of Biology.

“The technology for identifying mosquito blood meals has existed for some time,” Allan explains, “because mosquitoes take many blood meals over a short period of time, so the blood is usually still fresh when you capture them.

“It’s much harder to get blood from a tick, which usually takes only one blood meal per life stage," Thach says. "By the time we capture the tick, eight months to a year may have elapsed. The tick has had a long time to digest that blood, so there may be only a tiny amount of DNA left — if there’s any."

The team did two assays on tick DNA: one to identify pathogenic bacteria and the other to identify the animal that provided the tick’s last blood meal.

The results showed that more blood meals were taken from deer in honeysuckle-intact plots.

The assay also looked for Ehrlichia chaffeensis and Ehrlichia ewingii, among other pathogens. Both bacteria were once thought to cause disease only in animals but have been found to infect people as well. (See “Emerging tick-borne diseases: a domestic ecological mystery”)

Ehrlichiosis is the general name used to describe several bacterial diseases that affect animals and humans. The first case of human ehrlichiosis was diagnosed in 1986.

A case of ehrlichiosis caused by another bacterium was identified in 1999 by Gregory A. Storch, MD, the Ruth L. Siteman Professor of Pediatrics at Washington University's School of Medicine. Worldwide, four ehrlichia species are currently known to cause disease in humans.

Ehrlichiosis begins with symptoms typical of bacterial infection, such as fever, headache, fatigue and muscle aches. More serious symptoms, such as joint pain and confusion, may occur and in rare instances the disease is fatal.

Thach says that when he goes into the woods he wears special anti-tick underwear called Bug Skinz and permethrin-saturated clothing over that. Thach's lab is currently investigating Ehrlichia bacteria in squirrels and local Ehrlichia hotspots, locations where the pathogen is found every single time the scientists sample.

Win-Win Ecology?

The irrepressible Allan is more encouraged than not by the new findings.

“We’re really simplifying our environment, he says. That’s what the diversity crisis is leading to — humans living in monocultures. That’s exactly what bush honeysuckle is, a human-caused monoculture."

“But as ecologists like to say, nature abhors a monoculture. Monocultures are unstable, and they often have negative consequences for human health."

“Many studies around the world are showing an increase in the risk of

infectious disease as a result of the loss of biological diversity."

“It’s hard to get people to focus on invasive plants. That’s why these invaders are so successful. They’re basically more persistent than we are."

“But people are more likely to pay attention when their health is at stake."

“So this may be a case of win-win ecology. Honeysuckle control would benefit native species but it would also benefit human health. I think that’s the really encouraging message to have come out of this study. ”

Provided by Washington University in St. Louis