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the Ecology of an Illness

—Patti Smith

Acorn eaters are having a good fall, for our region is experiencing one of those sporadic years when all of the oaks pump out a bumper crop of nuts. Acorns are so important to some species that their numbers rise and fall with the productivity of oaks. During typical years, oaks produce enough acorns to support a moderate population of nut dispersers, but by producing a BIG crop some years, they ensure that not every acorn will be eaten, and that a new generation of oaks will rise.

White-footed mice are among the species linked to oaks. During a big acorn year, white- footed mice will often continue reproducing right through the winter. The following spring, this enlarged population of acorn-fattened mice will enter the bountiful seasons prepared to breed some more. Mice enjoy omelets with their acorns, and are known to eat the eggs of ground-nesting songbirds. Ecologist Richard Osterfeld at the Cary Institute for Ecosystem Studies in Millbrook, New York, has been studying mice for many years. Osterfeld predicted that ground-nesting bird populations would also fluctuate with the pulses of acorn production.

While bird populations did decline as anticipated following a big acorn year, they did not rebound later when the mouse population dropped. Instead, the research found the birds had the highest reproductive success during years when there were moderate numbers of mice. It turned out that the hawks that fed on mice (and increased their own population) during rodent boom years, fed on birds when the mouse supply dried up. So, you see, mice also *save* songbirds by feeding hawks.

The mouse research also uncovered another unanticipated link—mice are extremely effective at finding and consuming the pupae of gypsy moths. They are so effective, in fact, that researchers suspected that gypsy moths would be eliminated if mouse populations remained at their acorn-high level.

Acorns, mice, songbirds, and hawks—these species have survived and succeeded through the ages despite the swings of fortune, for each of these elements is linked to countless others in the dense, living matrix of a New England forest.

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Do you remember the first time you heard about Lyme disease? Although it is not a new disease, it was such a rare disease that it was not identified until the mid-1970s when a group of children came down with arthritic symptoms in Lyme Connecticut. When the first cases appeared in Vermont, we all assumed that the ticks had been picked up on travels south. Over the past ten years, the incidence of Lyme in Vermont has increased markedly. There were just a handful of cases in 2005, 105 cases in 2006, and 893 cases in 2013. In 2014 the number dipped to 599, but it looks like it will go up again in 2015.

Mice are not the only species to appreciate the bonanza of an acorn mast year. White-tailed deer have been shown to spend much of their time in the vicinity of oak trees during the fall and winter when acorns are plentiful. White tailed deer are the primary host of adult black-legged ticks (aka deer ticks). Male and female ticks often meet up to mate while on a deer (both need a blood meal, the male just a small one, the female needs to become engorged, a two-to-three day process). When the female drops off, she will spend the winter under the leaf litter and emerge in the spring to lay eggs. A deer can carry 100 ticks or more. Each female tick lays around 2,000 eggs. Imagine the hordes of larval ticks that must emerge beneath oaks after a good acorn crop!

Larval ticks are really tiny, about ·-sized, so small that they cannot climb or move far. They attach themselves to hosts that are likewise low to the ground—mice, shrews, chipmunks, birds … Larval ticks do not carry *Borrelia burgdorferi*, the Lyme bacteria, when they hatch. They acquire it from a host. Some tick hosts are much more likely to pass the bacteria to a tick, for they carry it with no ill-effects. Other species eliminate the bacteria with a vigorous immune response. Richard Osterfeld's mouse research has become the study of Lyme ecology. His research team studied a wide variety of tick host species to determine which are the most "competent Lyme reservoirs," the most likely to infect ticks with *B burgdorferi*. Four species accounted for 90% of the bacteria carriers—chipmunks, masked shrews, short-tailed shrews, and white-footed mice. Of these, white-footed mice were by far the most likely to be carriers. White-tailed deer do not carry Lyme, but because they are the host for many of the adult ticks, they help to support a large tick population. With both deer and mice congregating near oaks, the year after a big acorn crop there will likely be many larval ticks and many mice in woods with oaks.

Once the larvae have fed, they are able to grow and transform into nymphs. Nymphs are bigger than larvae, but still pretty darned small. They overwinter and are ready to begin looking for a blood meal of their own in late spring/early summer of their second year. They are now big enough to climb up into taller vegetation and wait for the chemical and heat messages that alert them to the presence of a host. Because they are so small, they often go undetected, and an undetected tick is the one most likely to transmit Lyme.

By the end of summer, the nymphs have become adults, and with two meals behind them, they are the most likely to carry *B. burgdorferi*, but are also the most likely to be discovered before they have a chance to transmit the disease.

Black-legged ticks need a humidity of more than 80% to be active and questing for blood. Humidity is highest in the shade. The regrowth of New England forests has expanded tick habitat and has also allowed deer populations to grow.

Lyme may also be on the rise because more and more people have settled in the woods where ticks live. This pattern of sprawling housing development also chops forest into smaller and smaller pieces, and the smaller the fragments, the lower the wildlife diversity. There are, however, a few species that do really well in these simplified habitats. Among them are white-tailed deer and white-footed mice. Many of the species that regulate mouse populations—raptors, coyotes, foxes, and weasels—are found far less frequently in fragmented forests. What's more, it is not simply the number of mice that influences the number of infected ticks, it is the abundance of alternate tick hosts. Because other hosts are unlikely to pass the bacteria to ticks, they dilute the Lyme pool. Lower host diversity equals more infected ticks. Another Cary Institute study found that forest patches smaller than three acres had an average of three times as many ticks as larger forest patches. What's more, because most of the larval ticks were feeding primarily on mice, eighty percent of the adult ticks in the smallest patches were infected with Lyme.

Last September, Jeff Ward of the Connecticut Agricultural Experiment Station, spoke to a local audience about his Lyme-related research. He targeted another factor in the ascent of Lyme—the very invasive Japanese barberry. Widely planted as a low maintenance, shade-loving ornamental. Barberry can take over the understory of a forest, forming impenetrable prickly thickets. Like Br'er Rabbit in his brier patch, mice find secure shelter in barberry. Further, because it forms a lush umbrella of tiny leaves, it also creates and maintains a high humidity environment. Ward found that the humidity beneath barberry often remained above 80% for 23 hours a day, offering ticks a much longer feeding period than in areas that lacked barberry. His team sampled ticks in three different zones: barberry infested areas, areas where barberry had been removed, and forested plots that had never had barberry. In the first zone, they found 120 infected ticks per acre, in the second the average was forty

infected ticks per acre, and in places with no barberry they found just ten infected ticks per acre.

Global warming is allowing the black-legged tick to expand its range northward and is increasing the length of tick season. As a resident of Marlboro, I have joined other denizens of higher altitude towns in Windham County in commiserating the loss of our tick-free status over the past couple of years. All of these factors—warming climate, forest fragmentation, invasive barberry, and large populations of tick hosts — lead to a proliferation of the virus.

The Center for Disease Control lists the following among recommendations to reduce the risk of Lyme disease :

- Avoid areas with forest and brush where deer, rodents, and ticks are common
- Clear tall grasses and brush around homes and at the edge of lawns
- Mow the lawn frequently and keep leaves raked
- A single springtime application of an acaricide (tick pesticide), such as bifenthin, can greatly reduce the number of ticks in your yard.

The CDC landscaping preventatives advise making the areas around our homes inhospitable to all of nature to reduce the incidence of Lime disease. The last item on this list may raise the most alarms. Acaricides are labeled to kill ticks and mites. We might take a perverse pleasure in slaying ticks and mites, for parasites offend our moral sensibilities, but did you know that the soil and leaf litter are also home to a legion of mites that never bite? They spend their lives breaking down organic material and enriching the soil. Furthermore, ticks and mites aren't the only organisms that are killed by acaricides. These chemicals also kill insects (like pollinators) and are highly toxic to aquatic organisms.

The CDC's recommendations pose a particular conundrum for us at BEEC. Not only do we encourage people to engage in landscaping that provides wildlife habitat (including for insect pollinators), but part of our job is to get people out in nature. We know it to be good for the human soul and good for nurturing stewardship. This is especially true for kids. A growing body of research shows the tremendous benefit of free play in natural areas for the development of young minds. The CDC recommends that outdoor play be restricted to tick-free, sprayed and manicured areas.

That said, Lyme is now a very real and serious health issue, thus the conundrum. Here is what we have decided to do at BEEC: We have cleared our main loop trail, Dorothea's Trail, to an eight foot width. If walkers keep to the middle of the trail, they should not encounter ticks. That won't work for our camp programs. Walking in the middle of a trail does not confer the same benefits to developing minds as playing in the woods. For our camp programs, we will continue to be vigilant about tick checks, and remind parents about dressing to be outdoors in tick season. How *should* you dress? Here are suggestions:

- Long sleeves and long pants
- Pant legs tucked into socks or boots
- Tucked in shirt
- Light-colored clothing so ticks will be seen
- Fabrics with a fine weave (harder for ticks to latch onto)
- Careful tick check after being in the woods or anywhere brushy
- Take a shower when you come in
- Apply tick repellent to clothes, with special attention to shoes and pant legs since this is where ticks begin their trek.

Recommending repellents is a challenge since the information on safety and efficacy is often conflicting. What we know is that Lyme disease can be a serious and debilitating illness, especially if not detected right away. DEET is the repellent with the most proven track record for repelling ticks from skin, and 20-30% DEET provides protection for up to several hours. Permethrin treated clothing has become one of the most recommended ways to prevent Lyme. Ticks that come in contact with permethrin curl up and fall off, or are killed by contact lasting more than thirty seconds. There are a variety of options for acquiring treated clothing—you can treat it yourself, and it will remain active through five to six washings; you can send your clothes to a service that will treat your clothing for you; or you can purchase pre-treated clothes. The latter methods are purported to maintain their tick repellency through up to seventy washings.

I found no published data on the efficacy of herbal tick repellents, though I did find advertisements and anecdotes galore. I prefer to use herbal products myself, and suspect that they have a smaller ecological footprint than commercial chemical repellents, but I can not vouch for their ability to repel ticks.

Remember to be on the lookout for nymphs during June and July, and adults in October and November, with some becoming active again in April and May.

And, by all means, if you do have an outdoor area where activities are concentrated—playground equipment, a patio— some of the CDC recommendations can make these areas inhospitable to ticks.

While it is unclear how much blame humanity should take for the proliferation of Lyme disease, the answer is not "none." It seems wrong to respond to a crisis that is ecological in nature by spraying more pesticides and pushing nature into ever smaller or more remote places. This is wrong not just from an ethical perspective, but from a public health perspective as well.

How nice it would be if we could address the Lyme prob-

lem by reversing global warming, sending exotic species back where they belong, and restoring fragmented landscapes. Maybe someday. In the meantime, let us look to the work of disease ecologists.

While a vaccine for humans remains elusive, the Cary Institute has been testing a vaccine for mice. In a field study using oral vaccine baits, they produced a 75% reduction in the infection rate of ticks after four years of treating mice. Others have experimented with bait stations that treat deer and mice with topical tick killers, a strategy that must have a lower ecological impact than spraying large areas, and could prove more effective in reducing Lyme incidence over the long run.

One good thing we can each do is take care of ourselves and each other, which means adopting the habits of vigilance and appropriate attire and reminding our friends to do the same. Make tick checks a routine. Make them fun! Make tick-unfriendly attire a fashion statement. Not only will these efforts help keep us healthy, but if we can manage Lyme disease better through such measures, there will be less pressure to manage it by assaults on nature.

If only we could summon the Pied Piper and have him waltz all of the mice (or perhaps the ticks?) out of Hamelin and then live happily ever after… oh, wait. That wasn't how that story ended. The Pied Piper returned for payment and took the children. That may be the best moral for our ecological tale as well. As H.L. Mencken said, "There is always an easy solution to every human problem—neat, plausible, and wrong." We would do well to remember that the piper must be paid.