Urban heat boosts some pest populations 200-fold, killing red maples

July 23 2014

This image depicts a scale insect infestation on a red maple. Credit: Adam Dale

New research from North Carolina State University shows that urban

"heat islands" are slowly killing red maples in the southeastern United States. One factor is that researchers have found warmer temperatures increase the number of young produced by the gloomy scale insect – a significant tree pest – by 300 percent, which in turn leads to 200 times more adult gloomy scales on urban trees.

"We'd been seeing higher numbers of plant-eating insects like the gloomy scale in cities, and now we know why," says Adam Dale, a Ph.D. student at NC State and lead author of two papers describing the work. "These findings also raise concerns about potential pest outbreaks as temperatures increase due to global climate change."

Gloomy scales suck sap from trees, removing nutrients and energy. This reduces tree growth and can eventually kill trees.

The researchers focused specifically on the abundance of gloomy scales on red maple (Acer rubrum) trees at 26 sites in Raleigh, North Carolina. "We wanted to look at the most important pest species of the most common tree species in urban areas of the southeastern United States," says Dr. Steve Frank, an assistant professor of entomology at NC State and senior author of the papers.

Urbanization reduces the amount of vegetation in a habitat and increases impervious surfaces such as roads and rooftops. This can diminish predator and parasitoid communities and their ability to control pests. However, it also makes cities hotter than rural areas. The researchers collected data on a wide variety of ecological variables that could affect gloomy scale populations, including habitat characteristics, the temperature at each tree site, and the abundance of predators and parasitoids.

"Temperature was the most important predictor of gloomy scale abundance – the warmer it was, the more scale insects we found," Dale

says. "The other variables we looked at had no significant effect on gloomy scale abundance." The researchers also found that temperatures were related to the amount of impervious surfaces in the area, including streets, sidewalks, and parking lots. In short, the higher the percentage of impervious surfaces, the warmer the area.

This image highlights the impact that a scale insect infestation can have on red maples. The tree on the left is infested with scales, while the tree on the right is not. Credit: Adam Dale

Gloomy scales reproduce only once per year, giving birth to live young. So Dale collected gloomy scales at each site he was monitoring and dissected them to see how many young they were about to produce.

"At the coolest sites – 18.26 degrees Celsius (64.87 Fahrenheit) – the females were producing approximately 20 young," Dale says. "At the

warmest sites – 20.12 degrees Celsius (68.22 Fahrenheit) – the females were producing around 60 young. That supports the differences we saw in scale insect abundance on the trees. Populations at the warmest sites were over 200 times more abundant than those at the coolest sites."

"We don't know all of the variables that contribute to the higher abundance, but higher reproduction rates are clearly part of the picture," Frank says. "When we look at abundance, we're looking at an accumulation of generations of scales."

The researchers also found a second factor in urban heat's adverse impact on red maples. Specifically, the researchers found that higher temperatures increase stress on red maples by making it harder for them get water from their roots to their leaves.

To get a sense of the overall impact of heat on red maples, the researchers evaluated the condition of 2,780 trees in Raleigh, North Carolina, and compared the condition against a heat map of the city.

"This work tells us that urban planners and foresters may need to change the way they decide which trees to plant, and select trees that are better suited to hotter conditions," Dale says.

"This also tells us that we need to plant more trees and vegetation in cities, increasing shade on impervious surfaces and limiting the 'heat island' effect," Frank says. "It would also make sense to choose trees that are less susceptible to scales and other pest species."

The research on scale insect abundance is published in "Urban warming trumps natural enemy regulation of herbivorous pests," which is forthcoming from the journal Ecological Applications. The research on the overall impact of urban heat on red maples is in "The effects of urban warming on herbivore abundance and street tree condition," which

was published in *PLOS ONE* on July 23.

The Ecological Applications study's findings are also consistent with an earlier study from Frank's lab that found another scale insect species is more abundant at warmer temperatures due to increased survival rates.

"This work makes us think that increasing urbanization and rising temperatures associated with global climate change could lead to increases in scale insect populations, which could have correspondingly negative effects on trees like the red maple," Dale says.

Provided by North Carolina State University