Too Hot Downtown? The Effect of Urban Warming on Bee Communities

Presented by: Elsa Youngsteadt

Related publication: Hamblin, A. L.[1], E. Youngsteadt[1], M. M. López-Uribe[2], and S. D. Frank[1]. 2017. Physiological thermal limits predict differential responses of bees to urban heat-island effects. *Biology Letters* 13: 20170125.

[1] Department of Entomology and Plant Pathology, North Carolina State University, Raleigh, NC, USA

[2]Department of Entomology, Center for Pollinator Research, The Pennsylvania State University, University Park, PA, USA

Background: In eastern North America, cities are typically 1 - 3°C warmer than the surrounding landscape. This is due to the urban heat island effect, in which pavement and other impervious surfaces absorb solar energy and reradiate it as heat.

Even within cities, temperatures vary on a fine spatial scale such that some areas average 1 – 2 °C warmer than others, just blocks away.

Insects, as ectotherms whose metabolism depends largely on environmental temperatures, are sensitive to thermal variation in cities. Insect species (and populations) vary in their heat tolerance, such that fitness begins to decline at lower temperatures for some species than for others.

We asked whether bees' species-specific thermal tolerance drives changes in their abundance across urban temperature gradients. That is, are bee species with low heat tolerance the ones that decline the most in urban hotspots?

Approach: We sampled the wild-bee community at 18 sites in Raleigh, NC, USA. Sites were parks and residential yards, selected to represent a range of urban warming intensities.

We sampled each site a total of 11 times during the summers of 2014 and 2015 using a combination of pan traps, vane traps, and netting.

We monitored air temperatures at each site using iButton temperature dataloggers.

To assess bee thermal tolerance in the lab, we measured critical thermal maxima (CT_{max}) for 15 common species (collected in Raleigh, but outside the 18 focal sites) using a heat-ramping assay.

Results and discussion: The entire community sample included 3,593 individual bees of 113 species. Across sites, total bee abundance declined by 41% per °C urban warming. Site temperature was among the best predictors of bee community composition—that is, the relative abundances of bee species differed between hotter and cooler urban sites.

Among the 15 common species for which we measured CT_{max}, those with the lowest thermal tolerance were those whose populations declined the most at hotter sites. No species was more abundant at hotter sites than cooler sites; rather, species with the highest CT_{max} had stable populations across sites.

Solitary species and cavity-nesting species (all of which were bumble bees) had the lowest CT_{max}, suggesting that these groups may be most sensitive to urban warming and, potentially, global warming.

CT_{max} has rarely been measured in bees, and expanding such a dataset will likely improve predictions of bee community response to urbanization and climate change.

To support bee abundance and diversity, urban pollinator conservation efforts may benefit from considering urban warming intensity when selecting sites for conservation plantings.