

Bedbugs

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The common bedbug, *Cimex lectularius*, is now widely recognized as a pest of public health importance. It is imperative researchers investigate short-term solutions (for example, optimizing heat treatments), and long-range studies that seek to understand the basic biology of bedbugs and identify critical vulnerabilities that can be exploited. The resurgence of bedbugs has challenged and depleted local resources; meaning innovative and transformative approaches for their eradication will require a coordinated, collaborative research efforts across institutional boundaries.

Genetics & insecticide resistance

Resurgent bedbug populations could come from local sources that have recently expanded, or a few source populations that have been spread globally through human transport.

North Carolina State University's (NCSU's) entomology department is addressing these questions through a collaborative population-genetics project supported by a grant from the United States Department of Agriculture (USDA). Two complementary classes of molecular genetic markers — microsatellite markers and mitochondrial DNA markers — are used to investigate the genetic structure of bedbug infestations at various geographical scales; from local aggregations within a room, to populations around the world.

Recent advances in DNA technology have created the opportunity to use the Genome Sequencer system at NCSU to mine the bedbug genome for microsatellite markers. An analysis of the genetic diversity of eastern U.S. bedbug populations by Ph.D. student Vima Saenz has revealed high genetic diversity across the continental U.S.,

as well as within cities. This reveals a differentiation of populations, suggesting current infestations originated from multiple populations, rather than a single introduction, either from within the U.S. or, more likely, from abroad.

At a finer geographical scale, Saenz and NCSU researcher, Warren Booth, find aggregations within a room are genetically depauperate, often representing offspring from a single mated female with incredibly high levels of relatedness among individuals, resulting in highly inbred populations. NCSU is further investigating how bedbug populations are adapting to avoid the inbreeding depression that devastates natural populations of other species.

It appears that relatively young/recent infestations in apartment buildings represent a single introduction event followed by population expansion. Older infestations appear to represent multiple introductions of genetically differentiated bedbugs. The genetic analysis allows NCSU researchers to scrutinize dispersal pathways within the building. These complicated routes, suggest that human-mediated transport is an important component of bedbug dispersal.

An important component of population genetics research is an investigation of the geographic variation in *kdr* insecticide resistance genotypes. Researchers have screened populations across the U.S. (collected between 2005 and 2009) for two mutations that confer high levels of resistance to pyrethroids (and DDT). With partial support from the National Pest Management Association's Pest Management Foundation, NCSU researchers have found a high frequency of *kdr* mutations, and a grim pattern regarding the prevalence of insecticide resistance within bedbug populations.



Chemical ecology: A search for attractants, feeding stimulants

Blood-sucking insects apply most of their sensory systems to the detection and pursuit of their hosts. Funded by a post-doctoral fellowship from the National Science Foundation, Alvaro Romero, an NCSU researcher, has been investigating the physical and chemical cues that guide bedbugs toward finding and accepting a host using an integrated approach, screening various vertebrates for the most attractive host, then screening the odorants that mediate the host-seeking process. Concurrently Alvaro has been exploring approaches to optimize the artificial rearing system by investigating bedbug performance on blood from various animals, the "shelf life" of blood, and the stimulatory effects of various blood components on engorgement of bedbugs.

Rick Santangelo, a lab manager with NCSU's entomology department, has developed a rearing system that uses isolated host blood and a feeding apparatus in place of a host. NCSU maintains 40 colonies providing bedbugs for studies, educational programs and research throughout the U.S. **pmp**

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