Seminars in Biotechnology BTEC 591 & BTEC 691

"Chemical biomarkers that can accurately predict honey bee health factors"

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13:30
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Christopher (Chris) Mayack is a faculty member in the Molecular Biology, Genetics, and Bioengineering program at Sabancı University. He first learned about honey bees when conducting a summer undergraduate research internship that focused on understanding the cognition and navigation abilities of foraging honey bees at the University of Kansas in 2005. During this time, he worked with Dr. Rudolf Jander, a former graduate student of Karl von Frisch (Nobel Laureate). He graduated with honors in biology and a minor in chemistry from State University of New York at Geneseo in 2007 and then earned a Ph.D. in Zoology at Colorado State University in 2012. During his Ph.D. he studied the physiological and behavioral effects of the now world-wide distributed honey bee microsporidian gut pathogen that is implicated to play a role in the most recent bee declines, called *Nosema ceranae*. He was then awarded a two-year Alexander von Humboldt Post-Doctoral Fellowship, which was conducted in Germany, at Martin Luther University Halle-Wittenberg, to pursue studies investigating the role highly conserved metabolic pathways in the evolution of social behavior in bees. As a two-year Visiting Assistant Professor at Swarthmore College, he has mentored a number of undergraduate research students interested in the dynamics of collective decision making, improving bee health, and the regulation of appetite in highly social bees. Currently, he would now like to take a multi-omic systems biology approach to understand how stressed bee colonies collapse. In particular, he is interested in the metabolic pathways that are affected from multiple stressors which lead to synergistic declines in bee health. In addition, he is developing CRISPR-cas9 tools to conduct knockdowns in the bee brain to understand the role of synaptic pruning in learning and memory as the bee ages, as well as appetite regulatory mechanisms and how they vary with the level of social behavior across bee species.

Abstract

Recent years have witnessed a noticeable decrease in honey bee populations worldwide. Researchers have attributed this decline to several factors, both natural and unnatural (caused by human activity). At the same time, beekeepers regularly face challenges with determining the best management practices of their bee hives because they lack the rapid diagnostic tools required for determining the cause of decline in bee health before the colony collapses. To address this, we use a systems biology approach with machine learning validation to search for chemical biomarkers and the underlying mechanisms that might be responsible for the multifactorial synergistic bee health declines by integrating hive exposome data, with the prevalence and abundance of pesticides and bee diseases, sampled from urban and suburban environments. We determined top biomarker hits for all of the 20 most common bee diseases and pesticide exposures that were found across the hives sampled. Moreover, for 9 of the 20 diseases we were able to develop a chemical biomarker library that has around 90% accuracy for predicting if a hive is infected with this disease or not. These chemical biomarkers and libraries could therefore be used in the future for rapid diagnoses of bee hives using one standardized protocol for high throughput analysis that would give the beekeeper enough warning to improve bee health and prevent honey bee colonies from collapsing.