Harnessing Chemical Signals from Microbes for Insect Control

Insect behavior is guided by their chemosensory systems, which have evolved over millions of years to help them avoid threats and find food and mates. Insect antennae are often loaded with specialized receptors that sense individual compounds. For example, mosquito antennae can detect carbon dioxide from human breath over a hundred feet away, guiding their attraction.

Given their crucial role in guiding insect behavior, scientists have long sought ways to manipulate chemical signals for pest control. Semiochemicals, derived from the Greek word semeion, meaning “signal” or “sign,” are chemical signals that facilitate communication between organisms and influence their behavior. These compounds include pheromones that regulate insect mating and allelochemicals that mediate plant-insect interactions.

Significant innovation in semiochemical discovery and product development from the 1970s to the early 2000s is exemplified by the identification of the sex pheromone “hexalure” for the pink bollworm (*Pectinophora gossypiella*). This led to the first commercial formulation, “Gossyplure,” in 1978 that effectively controlled this pest through mating disruption. Since then, many semiochemical-based commercial products have been developed.

▲ **Figure 1.** Bacteria from the southern green stink bug, *Nezara viridula*, were tested for their ability to attract or repel this agricultural pest. The efficacy of this microbial volatile organic compound (mVOC) shows that semiochemicals can be effective pest controls.

While the discovery of microbial volatile organic compound (mVOC)-based semiochemicals opened exciting possibilities for insect management, the agriculture industry’s continued reliance on synthetic chemistry raises concerns about sustainability and long-term environmental impacts. Therefore, there is growing interest in the discovery and implementation of mVOCs as pest management tools, driven by an increased awareness of the influence of mVOCs on insect behavior. Advances in genomics have revealed many novel biosynthetic clusters in microbial genomes, indicating that microbiomes are prolific producers of mVOCs. Yet, less than 10% of known mVOCs have been studied or assigned functions. Given there are an estimated 10^{18} microbial species on Earth, many mVOCs remain undiscovered. Furthermore, microbes could be genetically engineered to enhance their mVOC production or create novel compounds to target specific pests.

Aligning with the growing interest in harnessing microbial semiochemicals for behavior-based pest control, Univ. of Florida scientists affiliated with the Center for Arthropod Management Technologies (CAMTech), an Industry-University Cooperative Research Center funded by the U.S. National Science Foundation (NSF), uncovered microbes with semiochemical potential to repel or attract the southern green stink bug, *Nezara viridula*. *N. viridula* is widely dispersed in the U.S. and causes millions of dollars in crop losses, including in soybean and cotton, and can transmit pathogens that cause plant diseases.

The research team, led by Adam C.N. Wong and Arinder K. Arora, isolated microbes from stink bugs, various other insects, plants, and soil, creating a library of diverse taxa. These isolates were identified using colony polymerase chain reaction (PCR) testing and Sanger sequencing. Using a Y-maze olfactometer assay, the scientists screened for attractant or repellent effects of 41 individual bacterial species and strains on the stink bugs and identified two attractant and two repellent bacteria that function significantly better than known agents.

By discovering microbes with semiochemical potential for controlling a significant agricultural pest, this project “represents a key improvement in the development of crop protection technologies,” according to a CAMTech industry member. The identified microbes and compounds will serve as essential resources for formulation development, facilitating the optimization of chemical blends, structural modifications, and release methods to enhance potency and longevity in the field. Additionally, this research lays the foundation for identifying the insect receptors that detect these cues, uncovering new molecular targets for behavioral manipulation. This proof-of-concept research demonstrates that microbe-derived semiochemicals could be used to manage other insect species. Moving forward, CAMTech is interested in applying this technology toward managing urban pests and researching ways to increase formulation potency and effectiveness. Ultimately, these insights will advance the development of semiochemical-based products for sustainable agricultural pest management. CEP

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