Research on behavioral manipulation of insect natural enemies through olfactory, gustatory, and visual sensory reception

Takuya Uehara (Institute of Agrobiological Sciences, NARO)
tue@affrc.go.jp

Animals make various behavioral decisions, such as foraging, reproduction, egg-laying, and escape based on specific sensory stimuli from their environment. By identifying the stimuli that trigger particular behaviors, we may be able to manipulate these behaviors. Our research has focused on the structural identification of chemical substances that influence insect behavior, as well as on the wavelength characteristics of light. Specifically, we have concentrated on predatory stinkbugs (*Orius sauteri* and *Nesidiocoris tenuis*), which are natural enemies of thrips and whiteflies, significant pest of vegetable crops. Our work aims to develop technology to manipulate the behavior of these natural enemies through olfactory, gustatory and visual cues.

The dispersal ability of *Orius* bugs hinders their ability to establish themselves on crops, resulting in unstable pest control effectiveness. We identified the chemical structures of two components, (*E)* -2-octenal and (*E)* -2,7-otcadienal, present in the accessory glands of *Orius* bugs. Our findings revealed that a blend of these compounds has opposing physiological effects, acting both as a sex pheromone and an alarm pheromone. Using these pheromones as attractants and repellents allowed us to effectively control the movement and dispersal of the indigenous *Orius* bugs. Additionally, in our study on the photoresponse of predatory stink bugs, we discovered that they have a unique attraction to violet light at 405 nm , a wavelength that is relatively invisible to other pest insects. We installed a lighting system with LEDs peaking at this wavelength, which was turned on for three hours each evening. As a result, the population of indigenous *Orius* bugs increased approximately tenfold compared to conventional setups, while the number of eggplant pests, such as thrips, was reduced by about half. This research was a pioneering effort in demonstrating the concept of 'optical control of insects,' where natural enemies on crops are attracted and pests are managed solely through light irradiation.

We focus not only on sensory stimuli from the environment but also on the sensory receptors that perceive these stimuli. *N. tenuis,* a natural enemy insect, exhibits a unique feeding habit called zoophytophagy. This species has an advantage over other natural enemies as it can reproduce solely on plant-based food and can sustain its population even when pest densities are low. However, there is concern that at high densities, it may begin to damage the crops themselves. How can we reduce or eliminate this species' preference for plants? To explore the genetic basis of its feeding habit, we constructed a whole genome using next-generation sequencing techniques. Genomic analysis revealed that gustatory receptors, in particular, play an important role in adapting its feeding preferences. Next, we conducted gene expression analyses on closely related species with varying feeding habits and identified several gustatory receptors as candidate genes responsible for plant preference. We are now investigating how these genes influence foraging behavior for both plant and animal-based food sources.