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Manipulation of predatory insects for enhanced biological control of insect pests

Principal Investigator:
John J. Obrycki

Co-investigators:
Thomas Baker

Jun-wei Zhu
Entomology
Iowa State University

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Abstract: *Findings from this project provided the basis for novel forms of biologically intensive pest suppression, and encouraged the development of attractant-lures. Preliminary studies demonstrated the efficient use of the lures with a previously developed dispenser system.*

Background

Several species of predatory insects, including lacewings and lady beetles, have been mass-produced and released for biological control for a few decades with variable results. Since the early 1970s it has been known that adults of the predatory lacewing species, *Chrysoperla carnea*, are attracted to honeydew—the excretory material of aphids. Pioneering studies done in California provided an understanding of the chemical cues used by this predator to locate its prey. It appears that *Chrysoperla carnea* adults must receive a blend of chemical cues to locate prey: first, a volatile plant chemical, followed by volatile breakdown products derived from honeydew. Little experimental work had been done since these early findings. To successfully manipulate predatory species for sustainable pest management, scientists need to know more about the chemical bases used by these predators to locate their prey.

Three species of predatory insects were used in this study: two lacewing species (*Chrysoperla carnea* and *Chrysopa oculata)* and a coccinellid, *Coleomegilla maculata. C. carnea,* a very common predatory species in Iowa agricultural systems, has been extensively studied and is commercially available. *C. carnea* adults can be attracted to artificial honeydews. It is now known how adults of the coccinellid species use chemical cues to locate prey. However, the specific chemicals that function as attractants for lacewing adults have not been identified using modern analytical techniques.

Approach and methods

Coleomegilla maculata adults were collected from an overwintering site at Roland, Iowa. Larvae of *C. carnea* were purchased from California and reared in an ISU laboratory. Adults of *Chrysopa oculata* were collected from the field, brought back to the laboratory, and reared under similar experimental conditions.

Potential sex pheromone-like substances were extracted from *C. maculata* and defensive compound extracts also were collected. Volatile compounds were collected from host plants as well. These were used in field tests and laboratory experiments to determine behavioral responses of the insects. To examine the possible correlation between the external morphology of the antennae *C. carnea* and their possible function, the antennae were scanned and examined under electron microscopy.

Results and discussion

Several pheromonal compounds from host plants and their prey were identified as being able to elicit significant electrophysiological responses (EAG) from sensory organs of the insects' antennae. The attraction of these

newly identified compounds toward target beneficial insects has been demonstrated in both laboratory and field tests.

One of the odors (2-phenylethanol) emitted from several host plants is highly attractive to lacewings, in particular to the female *Chrysoperla carnea*. Indications are that this compound may act as an oviposition stimulant.

The 2-phenylethanol scent also attracts the lady beetle species, *Coleomegilla maculata*. Traps baited with a terpineol compound also caught significant numbers of adult *C. maculata*.

The researchers considered the attractiveness of aphid sex pheromones for a second predatory lacewing species, *Chrysopa oculata*, in Iowa. The aphid sex pheromone component, nepetalactol, appears to be attractive to *C. oculata*, but not to *C. carnea*. In addition, the project identified a compound, (Z)-4-tridecene, from the defensive secretion of *C. carnea*, which could possibly be used for a push-and-pull strategy in manipulating *C. carnea*.

Conclusions

From this three-year study, an effective attractant for the adults of two species of predaceous insects—a lady beetle and a lacewing—has been identified from alfalfa plants. Alfalfa is one of the many host plants used by aphids, which are prey for lacewings and lady beetles. Several other volatile compounds attractive to other species of beneficial insects also have been identified and were tested during the course of this study. These include aphid sex pheromone components that were shown to attract the adults of a second lacewing species, and indole, which was shown to be appeal to syrphid flies (flower flies), whose larvae feed on aphids. A compound identified from the reflex bleeding secretion of lacewings (for whom the bleeding serves a defensive function) has also been shown to be a repellant of both lacewings and other insects such as ants. This compound also may prove useful for manipulating the movement of lacewing predators.

Impact of results

The primary outcome of this study has been the development of a better understanding of the chemical, physiological, and behavioral basis for prey location by three insect predators. From this research, new tools for manipulating the behavior of predatory insects are being developed and plans are being made to make these tools available to growers and the home gardening public.

Education and outreach

Two papers about aspects of this project were published in the *Journal of Chemical Ecology*. In the technology transfer mode, an ISU Research Park-based company, MSTRS® Technologies, Inc., has signed an exclusive licensing agreement with ISU for the rights to the patented attractant blend for these predaceous insects (patent pending). This company has developed a long-lasting lure formulated with the attractant and has shown that this lure is attractive to lacewings over a period of several weeks. This lacewing/ladybeetle lure will be marketed by Gardens Alive under an exclusive distribution agreement signed with MSTRS® Technologies, Inc.

For more information contact John Obrycki, Entomology, Iowa State University, Ames, Iowa 50011; (515) 294-8622, e-mail obrycki@iastate.edu