CONFERENCE REPORT

BIOLOGICAL CONTROLS SQUASH INSECT PESTS

ITHACA, N.Y.—Plant physiologists and entomologists are stocking the biological pest control toolbox with powerful and precise equipment. Researchers meeting at a conference held at the Boyce Thompson Institute for Plant Research on the Cornell University campus discussed progress in understanding the mode of action, production, and use of the much-studied *Bacillus thuringiensis* (Bt) and baculovirus insect toxins. They also unveiled blueprints for new crop protection vehicles, ranging from transgenic plants, to synthetic analogs of insect "alarm" pheromones, to using invertebrate neurohormones to fatally disrupt an insect's homeostatic balance.

As the biological control toolbox grows, so does the economic and ecological impetus for using it. Unlike chemical pesticides, biological controls target specific pests and tend not to persist in the environment. And registering a non-living biological control agent with the EPA costs only a few thousand dollars, versus the $15-20 million it now costs to register a new inorganic pesticide, according to Bruce Carlton, vice president of research and development at Ecogen (Langhorne, PA). While some conference-goers hailed the end of the chemical era, Ralph W. F. Hardy, president of the Institute, suggested that biocontrols will strike a balance with, rather than replace, conventional approaches.

Bt Receptor Identified

Mark Vaeck of Plant Genetic Systems (Gent, Belgium) announced a putative Bt receptor in the midgut of susceptible insects. He and his colleagues correlated the ability of recombinant Bt2 delta-endotoxin to kill two insects—the tobacco hornworm (*Manduca sexta*) and the cabbage butterfly (*Pieris brassica*)—with the presence of binding sites in the brush border membrane of the midgut. The non-recombinant Bt delta-endotoxin Bt4412, on the other hand, binds only to *P. brassica* midgut receptors and kills only *P. brassica*. A Scatchard plot (see figure) of the binding of radiolabeled Bt2 toxin to *M. sexta* midgut vesicles indicates that these insects have a single high-affinity binding site for Bt2, but none for Bt4412.

These correlations provide a rationale for the differential toxicity of various Bt strains. The Bt binding site has not yet been characterized, but as research continues, it may lead to new ways to screen for and manipulate Bt toxicity.

Harnessing Neurohormones

Research has identified about 20 different invertebrate neuropeptides and neurohormones that regulate growth and homeostasis. Frank Keeley of Texas A&M University's Entomology Dept. (College Station, TX) outlined the prospects for using genetic engineering techniques to alter these regulators, noting that their diversity promises a host of agonist/antagonist interactions that could serve as tools for biological pest control.

For example, one could disrupt the enzymatic processing of prohormones to their active forms, disrupt hormone secretion, or genetically engineer insects to produce inactive hormone analogs. Keeley also suggested that the gene for diuretic hormone could be spliced into baculoviruses, then sprayed onto crops. Insects feeding on the plant would express the gene, desiccate, and die.

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Binding of ^{125}I-Bt2-toxin (○) to *M. sexta* vesicles was saturable. The Scatchard plot (inset) indicates a single high-affinity binding site with an equilibrium dissociation constant K_d = 0.43 nM and a binding site concentration of 4.3 pmoles/mg vesicle protein. Bt4412 toxin (□), to which this species is immune, does not compete for binding to the Bt2 site.

Warding Off Tolerance

Slide after slide attested to the effectiveness of transgenic pest control schemes, showing barely nibbled experimental plants alongside untreated controls thoroughly chewed up by hungry bugs. But this success could lead to a familiar problem—the development of toxin-resistant insects. In fact, George Georghiou, a University of California (Riverside) entomologist, described the development of partial Bt resistance in the stored grain pest *Plodia interpunctella* (Indian-meal moth).

With this problem in mind, a member of the audience questioned whether engineering plants to express Bt endotoxin systemically (*Bio/Technology* **5**:807–813, August '87) might ultimately be less effective than current practice (periodic application of Bt toxin in microbial vectors). Mathematical models of selection pressure predict that if engineered anti-pest plants become a permanent part of their environment, insect resistance would develop rapidly. Many attendees called for the biological control community to draw on experience with resistance to chemical pesticides to devise an overall strategy against tolerance to biocontrols.

Strategies proposed for delaying resistance include rotating among various Bt strains or between biological and chemical agents. Selection pressure for tolerant insects could be relaxed by switching, at a critical time for the onset of resistance, from biological to chemical pesticides. Using a mixture of biocontrol agents having different modes of action could also head off tolerance.

—Pamela Knight