

ScienceWatch - Biotechnology and the Butterfly

Biotechnology can be defined as any product or process that uses a living thing or its components. Older examples of biotechnology are bread, which needs yeast to rise, or cheese making, which depends on an enzyme collected from calves (and more recently, molds) to curdle milk. Newer examples are detergents that use bacterial enzymes to remove stains, human insulin made by a genetically modified bacterium, and genetically modified plants that make toxins to kill insects.

The toxin genes come from an insect bacterial pathogen, *Bacillus thuringiensis*, which makes a variety of toxins, each specific for a particular family of insects. For example, one toxin is specific for caterpillars (Lepidoptera); another kills beetle larvae (Coleoptera), while still another attacks larvae of flies and mosquitoes (Diptera). Organic farmers as a natural way to protect their crops from caterpillars have used spores of the bacterium as a spray for decades. During the past two decades biotechnology companies have spent millions of dollars to develop seeds with bacterial toxin genes inserted into their DNA. The inserted genes cause the plant tissue to produce toxin, making the plants insect-resistant. Currently, there are three major commercial "Bt" crops: Bt-potatoes are resistant to the Colorado potato beetle, Bt-cotton kills the cotton bollworm and Bt-corn is resistant to the corn borer.

Much controversy has surrounded these "transgenic" plants. Proponents say they are beneficial because they specifically target the insect pests that eat the plants and do not release harmful chemicals into the environment. Moreover, in contrast to many chemical pesticides, Bt-toxin is readily degraded in the environment and is completely harmless to vertebrates. Opponents say huge commercial growers will overuse Bt-crops, rendering the insecticidal toxins useless by producing resistant insects. Even worse, they say the release of genetically modified plants into the environment could cause unknown consequences by hybridizing with related plants in the field.

In fact, resistant insects do develop, and a debate has ensued among the biotech seed producers, the EPA, and farmers over the need to plant unmodified seeds so as to avoid killing off all the sensitive insects and being left with only resistant pests. Many farmers want to plant 100% Bt seeds to maximize crop yield, the EPA contends 40% of the seeds planted should be unmodified as a "refuge" where sensitive insects can continue to breed. The biotech companies say only 20% are needed to generate enough sensitive insects to keep them from becoming entirely resistant.

Adding to the controversy over the use of genetically modified plants is a letter appearing in the May 20th issue of the prestigious British journal *Nature*. The letter by three Cornell University entomologists presents evidence that Bt-corn could threaten the monarch butterfly (*Danaus plexippus*), dubbed the "Bambi of the insect world" by one scientist. The study found that pollen from Bt-corn, which contains the toxin active against Lepidoptera, kills monarch caterpillars. The researchers collected corn pollen from bioengineered plants, tapped it onto milkweed (*Asclepias curassavica*) leaves, and let young monarch larvae feed on the dusted leaves. After four days almost half (44%) of the caterpillars feeding on leaves dusted with Bt-pollen were dead. All the larvae eating

leaves dusted with unmodified pollen survived. These laboratory results are difficult to translate to field conditions, but they could represent a real effect. Monarch larvae feed almost exclusively on milkweed and much of it in the Midwest grows near corn fields. Furthermore, entomologists at Iowa State University say they are publishing a study showing that monarch caterpillars were killed after eating the leaves of potted milkweed plants kept at the edge of *Bt*-corn fields. They grew the potted plants one meter (three feet) from the edge of a *Bt*-corn field, brought the plants into the laboratory, and allowed monarch caterpillars to feed for 48 hours on the *Bt*-pollen contaminated leaves. During that time 20% of the larvae died, whereas no deaths occurred among those eating washed leaves.

Critics say that heavy corn pollen only disperses up to 60 meters (197 feet) so it won't blow far enough away from fields to cause any danger to monarchs. In addition, they say monarchs are typically not found in the areas where corn fields are prevalent. Other entomologists contend that as much as 30% of the milkweed growing in states like Iowa and Illinois is within 20-30 meters (65-98 feet) of corn fields, threatening a large fraction, perhaps 30-40%, of the monarch population.

These studies have sent a shock wave through the biotechnology industry because they give opponents a powerful issue to rally the general public against transgenic crops. Certainly biotechnology companies like Monsanto, Novartis, AgrEvo, and Pioneer Hi-Bred, who have a lot invested in the technology, will be conducting field studies.

Saul Scheinbach

