LETTER

Reply to Beachy *et al.* and Parrott: Study indicates Bt corn may affect caddisflies

Beachy *et al.* (1) and Parrott (2) have questioned some findings reported in our recent paper (3); here, we respond to issues raised by these authors. All tissues identified as "Bt" in our paper (3) were verified to contain Cry1Ab protein by using Bt Cry1Ab protein ImmunoStrips (Agdia); materials identified as "non-Bt" were similarly confirmed to lack Cry1Ab protein.

The quantity of Cry1Ab protein actually consumed (in pollen or leaf tissue) by an individual insect could not be determined because of variation in feeding rates among individuals in any particular experiment. Our goals for the research did not include developing a traditional dose–response relationship because (*i*) the dose depended on individual feeding rates, and (*ii*) a dose–response relationship would have little relevance in assessing the effect of Cry1Ab containing materials on actual stream ecosystems in which organisms select among multiple food resources, not all of which would contain Cry1Ab protein. The goal of our feeding experiments was to determine whether trichopterans were at all susceptible to the effects of Cry1Ab protein, not to determine a safe level of exposure in a toxicological context.

Growth of trichopterans can be affected by many factors, including nutritional quality of food resources. As we stated (3), we paired "Bt" and "non-Bt" materials on the basis of nutritional quality (carbon:nitrogen ratios and lignin content). The use of isogenic hybrids would have resulted in food resources of different nutritional quality (4) and Cry1Ab content, and this would have confounded the experiments. We cannot fully disregard the unlikely possibility that some other leaf constituent was responsible for observed differences between the "Bt" and "non-Bt" treatments. However, we argue that the presence or absence of Cry1Ab protein is the most likely explanation for observed differences in trichopteran growth and mortality. We encourage others to pursue further research to develop a broader body of knowledge on the effects of Cry1Ab protein on aquatic insects.

We agree that extrapolation from laboratory experiments to ecosystems is unjustified without supporting evidence from field measurements. We (3) presented several lines of evidence suggesting that Cry1Ab-containing materials could potentially affect headwater stream ecosystems: (*i*) inputs of corn pollen and detritus to streams were documented and quantified, (*ii*) trichopterans collected from streams contained pollen in their guts or often were found associated with decaying corn detritus, and (*iii*) laboratory feeding trials indicated trichopterans are susceptible to the effects of Cry1Ab. Further study may reveal that the potential for detrimental effects is not realized *in situ* in streams or that effects are limited spatially or temporally and thus may not outweigh the benefits associated with the planting of Bt corn—only further study will reveal whether this is the case.

Regarding the concern of Beachy *et al.* (1) and Parrott (2) that the final sentence of our abstract overstated the conclusions of the paper, we agree that the sentence should have articulated the potential for ecosystem-scale consequences within streams, rather than suggesting that such consequences were observed *in situ*.

Lastly, Beachy *et al.* imply that our publication (3) and statements therein could "cause significant damage." We are unsure what Beachy *et al.* believe to have been significantly damaged. We argue that the wise use of any new technology requires a full understanding of both the benefits and the potential costs. In the case of corn genetically modified to express the Bt δ-endotoxin, the environmental costs appeared not to have been fully assessed, and we believe the studies we reported (3) contribute to a better understanding of potential effects on aquatic ecosystems.

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1. Beachy RN, Fedoroff NV, Goldberg RB, McHughen A (2008) The burden of proof: A response to Rosi-Marshall *et al.* 105:E9.
2. Parrott W (2008) Study of Bt impact on caddisflies overstates its conclusions: Response to Rosi-Marshall *et al.* 105:E10.
3. Rosi-Marshall EJ, *et al.* (2007) Toxins in transgenic crop byproducts may affect headwater stream ecosystems. *Proc Natl Acad Sci USA* 104:16204–16208.
4. Saxena D, Stotzky G (2001) Bt corn has a higher lignin content than non-Bt corn. *Am J Bot* 88:1704–1706.

The authors declare no conflict of interest.

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