Resistance to Bt Toxins

Although we share the general concerns about pest resistance to transgenic crops discussed by F. Huang *et al.* [Reports, "Inheritance of resistance to *Bacillus thuringiensis* toxin (Dipel ES) in the European corn borer," 7 May 1999, p. 965], reconsideration of several aspects of their report is warranted. They examined resistance to Dipel ES, a commercial formulation of *B. thuringiensis* (Bt) toxin, in a laboratory-selected strain of the European corn borer, a major lepidopteran pest. Bt genes encoding insecticidal proteins have been introduced into the genome of maize to provide protection from larvae of the European corn borer. The transgenic hybrids are called Bt maize.

The results presented by Huang *et al.*, however, are not directly relevant to potential resistance of the European corn borer to Bt maize because Dipel ES differs substantially from the toxins produced by Bt maize. Dipel ES contains Bt spores and at least three Bt toxins (Cry1Aa, Cry2A, and Cry2B) that are not present in Bt maize. Thus, the European corn borer strain studied by Huang *et al.* could be resistant to these components of Dipel ES, rather than to the toxins in Bt maize.

Huang *et al.* mention in note 7 that neonates from their European corn borer strain with 65-fold resistance to Dipel ES caused more damage than susceptible insects when placed on certain Bt maize hybrids. However, damage by neonates is not a reliable indicator of survival on transgenic plants. Results with the Colorado potato beetle show that neonates with greater than 400-fold resistance to Bt toxin Cry3A do not survive on Bt potato plants that produce Cry3A (*1*). Therefore, in some cases, pests may need extremely high levels of resistance to overcome the high concentrations of toxin in Bt plants.

The critical point about the inheritance of resistance and its implications for resistance management is whether heterozygotes die on transgenic plants. Huang *et al.* provide no evidence that either larvae from their Dipel ES–resistant strain or heterozygous larvae can survive to maturity on Bt maize, which means that no conclusions can be drawn about inheritance of resistance to Bt maize.

In contrast to survival of resistant diamondback moth on Bt broccoli and Bt canola (*2*) and resistant pink bollworm on Bt cotton (*3*), as far as we know, no one has reported results showing survival of European corn borer on Bt maize. The failure to find such resistance in European corn borer despite extensive efforts (*4*) bodes well for managing resistance of this pest to Bt maize. Several examples of nonrecessive inheritance of resistance to Bt toxins are known (*5*), but in the few cases of resistance to Bt plants analyzed so far, inheritance of resistance to the Bt plants is recessive (*3, 6*).

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Response

We described European corn borer resistance to Dipel ES in an earlier manuscript (*1*). Our report in *Science* was written to describe the inheritance of Dipel ES resistance in the European corn borer. We did not expect that inheritance of resistance to Dipel ES was more dominant than recessive. We were careful to point out that there were limitations in applying this research to corn borer resistance on transgenic plants. As Tabashnik *et al.* indicate, if the insects do not survive to adulthood, they will not be able to pass along their genes for resistance. Further research is needed to determine if these Dipel ES–resistant corn borers can survive and reproduce on various Bt corn hybrids. However, we believe it is important to report this research as evidence that European corn borer resistance to some Bt toxins may be more dominant than recessive.

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CAMPFIRE Experiences in Zimbabwe

Wayne M. Getz *et al.* present an optimistic outlook for community-based natural resource management (CBNRM) in their Policy Forum "Sustaining natural and human capital: Villagers and scientists" (19 March 1999, p. 1855), and they suggest that the key is for scientists and villagers to develop partnerships. Communal Area Management Programme for Indigenous Resources (CAMPFIRE), a community-based approach to wildlife management in Zimbabwe, provides "concrete examples of CBNRM success in raising the income levels of poor rural communities," Getz *et al.* say. Emerging problems, however, could derail many of the initiatives. A small group of researchers in Zimbabwe have played a key role in the devolution of wildlife management from central to local government. However, in achieving this success, the line between scholarship and advocacy has become blurred.

The push for CAMPFIRE has resulted in a concentration of power in Rural District Councils (RDCs), the lowest level of government (*1*). RDCs generally view CAMPFIRE as a means to raise funds. Our fieldwork in three CAMPFIRE districts indicates that many villagers show little knowledge about CAMPFIRE or view the program as an extension of the RDC or "government." Even where counselors do represent their communities in the RDC, they may have little bargaining power over benefits derived from CAMPFIRE, because counselors from wards without wildlife schemes are often in the majority.

Villagers living with wildlife bear the costs of wildlife (impacts on agriculture), whereas benefits from safari hunting may be spread beyond the community that bears the costs or may be concentrated in the RDC. We found that 50 to 90% of revenues from hunting were retained by the RDC, whereas in one district, household dividends were $1 to $3 per household per year (*1*). If antelope were poached and sold for meat, they would bring $7 to $20 each.

Scholarship is needed to establish under what conditions CBNRM works. There are successful CAMPFIRE schemes, but each district is different, providing rich data for scholars. An emerging hypothesis is that devolution must go lower than the RDC if CBNRM is to be successful (*2*). The successes of CAMPFIRE must be built on by developing genuine local participation and ownership. Given that villagers are largely not benefiting from CBNRM, further work on institutional and anthropological themes (power, property rights, incentives) should perhaps be the

priority over building technological partnerships between villagers and scientists.

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Response

Campbell, Sithole, and Frost caution that "Scholarship is needed to establish under what conditions CBNRM works." They also make the point that "devolution must go lower than the RDC if CBNRM is to be successful." We agree with them on these points. We also agree that work on institutional and anthropological questions is a priority over technological partnerships because the latter will fail without the appropriate institutions and processes. Because we both presented well-documented data on the substantial growth of revenues in some CAMPFIRE villages and cautioned that CAMPFIRE is "not without problems," our differences with Campbell *et al.* are largely ones of emphasis. Clearly, without rigorous analysis of CBNRM, outcomes associated with differing social, economic, political, and environmental circumstances, CBNRM has the potential to become yet another means by which central governments extract economic benefits from local people, thereby undermining the fundamentals of the approach. Increased funding for such research is crucial for the success of CBNRM. This said, we still maintain that with the proper institutions and processes in place, technological support is certainly needed to help communities adaptively manage their natural resources in an efficient and far-sighted manner (*1*). To achieve this, all players, including scientists, must be involved in a constructive, community-focused way.

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CORRECTIONS AND CLARIFICATIONS

The affiliation listed for Kathleen Cranley Glass, co-author of the Policy Forum "Commercialization of genetic research and public policy" by B. M. Knoppers *et al.* (17 Dec., p. 2277), was incorrect. She is with the Biomedical Ethics Unit, Faculty of Medicine, McGill University, Montreal, H3A 1W9 Canada.

In addition to the affiliations listed for the authors of the report "First-principles determination of elastic anisotropy and wave velocities of MgO at lower mantle conditions" (26 Nov., p. 1705), authors R. M. Wentzcovitch, S. de Gironcoli, and S. Baroni are also at the Istituto Nazionale per la Fisica della Materia, I-34014 Trieste, Italy.