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Double jeopardy: Weak weapons and hard targets in pest management

Publication of *Silent Spring* by Rachael Carson played a major role in focusing the world's attention on the ill-effects of pesticides. However, the book failed to silence its critics who averred that the use of pesticides was a necessary evil so *That we may live* (Jamiel Whitten) and the unabated use of pesticides continued all over the world. Paradoxically, the climbing graph of pesticide consumption was slowed down by the very organisms it was targeted at. Several insects had developed resistance to pesticides by mid-70s and by the end of 90s more than 500 species of insects had become highly resistant to insecticides, causing a rethink on the role of insecticides in agriculture and public health.

Fortunately, the sharp divide in the scientific community created by *Silent Spring* proved to be a boon. Alternative pest control approaches had been sufficiently well researched by late seventies. One of the major alternatives to synthetic inorganic chemicals was the use of *Bacillus thuringiensis* both as spores and bacterial toxin (*Bt*-endotoxin). Many proprietary products comprising various endotoxins came to be widely used in pest control, specifically against lepidopteran caterpillars. However, the use of *Bt* endotoxins appeared to be headed for the same fate as insecticides. What was sordid in this entire episode was the manner in which the basic axioms of population genetics were ignored. The successful use of *Bt*-endotoxin in pest control for almost two decades without reports of resistance gave room to complacency.

The bitter lessons learnt from an over-reliance on insecticides were forgotten too soon and no efforts were made to document the variation in susceptibility to *Bt* toxins in the targeted pest population. All this changed in 1989 with the reporting of resistance to *Bt* toxin in the cabbage diamondback moth. More research thereafter revealed that the diamondback moth has the potential to show up to 1000-fold resistance (based on the lethal concentrations required to kill 50 per cent of the population) in just four generations under laboratory selection. In the same insect 30 to 200-fold resistance has been reported since then from all over the world. Against this backdrop it is refreshing to see papers by Gujar *et al.* (**page 995**) and Kranthi *et al.* (**page 1001**) addressing the issue of resistance to *Bt* toxins in the cotton bollworm, the most serious pest of several crops in India.

Gujar *et al.* have shown that there is considerable variation in the susceptibility of the cotton bollworm to toxins derived from two strains of *Bacillus thuringiensis*, viz. HD-1 and HD-73. In fact their data seem to suggest a fairly high level of tolerance (resistance) to *Bt*-toxins in some populations even in the absence of any history of selection. That the threat of evolution of resistance to these toxins is indeed real is demonstrated by Kranthi *et al.* They show that the cotton bollworms can develop a 76-fold increase in resistance under laboratory selection in just ten generations. Further, these findings coming at a time when transgenic insecticidal cultivars (TICs) are on the horizon in India assume great significance. This, however, is only the beginning. Detailed insights into population genetics of resistance are urgently required, which in turn will benefit the development of improved TICs. More importantly, it will enable development of resistance management strategies against pests.

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Mapping of ophiolites

Use of data provided by spectral bands of the IRS-1C/1D LISS-III sensor with the high resolution panchromatic data of the PAN sensor by G. Philip *et al.* (**page 1014**) to reinvestigate the extremely rugged, inaccessible belt devoid of vegetation in Ladakh in north-western Himalaya has yielded very satisfying results. The new map vividly shows in all detail and precision the lithology and structure of the zone of collision of India with mainland Asia. The map is a considerable refinement of the earlier mapping done by field workers. It shows that the satellite-based mapping can be applied to map the entire inaccessible northern border of the Himalaya with a considerable degree of confidence.

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