

Biological control of agricultural pests

Biological control involves the action of beneficial organisms to keep pests in check. Pests include animal as well as plant species. The latter are more often known as weeds.

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Classical biological control refers to the deliberate introduction of foreign organisms to control pests. The classic first example was the biological control of the cottony cushion scale, *Icerya purchasi* Maskell (Hemiptera: Monophlebidae) (fig. 1), that ravaged the orange industry in California some 150 years ago. Biological control was achieved by the introduction of effective beneficial insects from Australia, chiefly the vedalia ladybird beetle, *Rodolia cardinalis* (Mulsant) [Coleoptera: Coccinellidae]).



Fig. 1. The cottony cushion scale, *Icerya purchasi*, target of the classical example of biological control.

The importation of foreign control organisms was necessary because the cottony cushion scale was itself a foreign species. It arrived in California without its natural enemies and was able to spread unchecked. The solution

was to import its natural enemies. However the importation and release of any foreign organism carries a risk that the imported organism could itself become a pest. Hence this strategy required careful evaluation of possible risks before it could be implemented. Malaysia and other countries have benefitted from the publicity of this successful example of biological control.

Biological control of the diamondback moth

When I joined the Department of Agriculture 40 years ago, the cabbage industry was seriously affected by the diamondback moth, *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae) (fig. 2) and I was informed that the only way to control it was to use insecticides. At that time,



Fig. 2. The diamond-back moth, *Plutella xylostella*, an insect native to Europe, is destructive to cabbages in Malaysia because it arrived without its complement of natural enemies.

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Fig. 3. A larval parasitoid, *Diadegma semiclausum*, introduced to control *Plutella* in Cameron Highlands.



Fig. 4. A pupal parasitoid, *Diadromus collaris*, introduced to control *Plutella* in Cameron Highlands.

this moth was already resistant to a wide range of insecticides and the rejection of Malaysian cabbages by Singapore due to excessive insecticide residues in cabbages confirmed that reliance on insecticides would not contribute to sustainable production of these vegetables. At that time, biological control was unknown in Malaysia and hence every step taken was new. The introduction of parasitoids (beneficial insects that complete part of their life cycle feeding on their hosts) from New Zealand was a brave but necessary step. The two species introduced were *Diadegma semiclausum* Hellen (Hymenoptera, Ichneumonidae) and

Diadromus collaris Gravenhorst (Hymenoptera, Ichneumonidae) (fig. 3 & 4). This led to the first successful biological control in Malaysia and this success encouraged the biological control of the diamondback moth in Vietnam, Thailand and even in Tanzania.

Biological control of the weed *Cordia curassavica*

Like the diamondback moth, most of the weed species in Malaysia are introduced organisms, hence very suitable for classical biological control. *Cordia curassavica* (fig. 5) is an introduced species that grows to about 3m tall. A native of tropical America, it may have been brought into Malaysia as a garden plant. Because of its dense foliage and rapid growth even on poor soils, it was often used in to establish hedges, but it soon began to spread by itself. In the early 1960s it had become a rampant invasive weed. Two insects were introduced from Mauritius as they had successfully controlled *Cordia* there. One was the leaf feeder *Metrogaleruca obscura* Degeer (Coleoptera: Chrysomelidae) (fig. 6 & 7) and the other, a seed-feeding wasp, *Eurytoma attiva* Burks. (Hymenoptera: Eurytomidae) (fig. 8).



Fig. 5. *Cordia curassavica*, an exotic weed that was common in waste land.



Fig. 6. *Metrogaleruca obscura* adult was effective in defoliating *Cordia* bushes.



Fig. 7. *Metrogaleruca obscura* larva also aided the process of defoliating *Cordia* bushes.



Fig. 8. The small wasp *Eurytoma attiva* developed in fruits of *Cordia* rendering it useless in propagation.

The insects were amazingly effective in seeking out *Cordia* plants regardless of whether they

Conservation biological control of oil palm bagworms

Conservation biological control involves the use of local organisms instead of imported ones, to control pests and diseases. These organisms are already part of the natural environment but may have been diminished and rendered ineffective by the indiscriminate use of pesticides. Chemical insecticides do not distinguish between good and bad insects and would eliminate the good insects, making control totally dependent on the continuous use of such insecticides. As the pest insects develop resistance, the insecticides have to be made increasingly more potent and more harmful to the environment. Going back

In a short time, *Cordia* plants were dried up and dead everywhere.

were self-perpetuating weeds or carefully tended garden hedges. Gardeners were shocked but could do nothing to save their hedges. *Cordia curassavica* was effectively wiped out. The outstanding success in the biological control of *Cordia curassavica* is an example of what could be done to control introduced weeds.

to natural control involves taking action to restore, conserve, and promote natural control organisms.

Back in the 1950s, outbreaks of the oil palm bagworms threatened the survival of an emerging industry. It was demonstrated that

the use of persistent chemical insecticides led to the destruction of effective beneficial insects that had been naturally keeping the bagworms in check in local palms. With this discovery, the use of insecticides in oil palm was minimized and the beneficial insects were able to keep the pest insects (especially bagworms and nettle caterpillars) at levels that would not cause yield loss. The three common bagworms found in oil palm plantations are *Mahasena corbetti* Tams, *Metisa plana* Walker and *Pteroma pendula* (Joannis) (Lepidoptera: Psychidae) (fig. 9, 10 and 11). A common nettle caterpillar is *Setora nitens* Walker (Lepidoptera: Limacodidae). (fig. 12). The native insect pests are kept at



Fig. 9. *Mahasena corbetti* bagworm on oil palm.



Fig. 10. *Metisa plana* bagworm on oil palm.



Fig. 11. *Pteroma pendula* bagworm oil palm.



Fig. 12. *Setora nitens*: the caterpillar has stinging hairs that have earned the group the common name of nettle caterpillar.



Fig. 13. This ichneumonid wasp just emerged from a parasitized nettle caterpillar.

low levels most of the time by effective native natural enemies especially wasps (fig. 13). If insecticides are used, they would kill many of the parasitoids and predators that keep populations of these pests in check.

The saga of the rice brown planthopper (BPH)

Successful conservation biological control in Malaysia has been clearly revealed in the research on this rice insect. The records in the Department of Agriculture show that the rice brown planthopper, *Nilaparvata lugens* (Stål)



Fig. 14. A short winged BPH exits to lay more eggs in rice plants.

(Hemiptera: Delphacidae) (fig. 14) was first reported in Melaka in 1939. Normally it existed in very low populations until 1977 when large outbreaks were reported from the Tanjung Karang Irrigation Scheme. Later studies showed that this rice pest multiplied in large numbers when its natural enemies such as *Pardosa pseudoannulata* (Boesenberg and Strand) (Araneae: Lycosidae), *Cyrtorhinus lividipennis* Reuter (Hemiptera:

Miridae). *Casnoidea interstitialis* Schmidt-Gobel (Coleoptera: Carabidae); *Paederus fuscipes* Curt. (Coleoptera: Staphylinidae) and *Pseudogonatopus* sp. (Hymenoptera: Dryinidae) (fig. 15, 16, 17, 18 and 19) were killed by insecticides. This led to the phenomenon of hopperburn (fig. 20) as a result of dehydration of the rice plants caused by the sucking activity of large numbers of the BPH. Hence, minimizing the use of chemical insecticides will help maintain the rich agro-biodiversity existing in rice fields in Malaysia and result in better control of the planthopper.



Fig. 15. A wolf spider, *Pardosa pseudoannulata* feeding on a BPH.



Fig. 16 The mirid bug, *Cyrtorhinus lividipennis*, an important predator of BPH eggs.



Fig. 17. A carabid beetle, *Casnoidea*, is a common predator found in rice fields.



Fig. 19. The dryinid wasp, *Pseudogonatopus*, feeds and parasitizes BPH.



Fig. 18. The staphylinid beetle, *Paederus*, is a common predator in rice fields.



Fig. 20. A hopperburn field in Tanjung Karang.

Biological control requires continual vigilance and expertise with the tools of biological control.

New pests may arrive in the country unannounced, and may not have any natural enemies in the country. Once such a pest finds a suitable host plant to live on, it can spread rapidly. With global travel now affordable and easy, the transfer of plants and animals across

borders has been greatly facilitated. If harmful organisms manage to arrive and spread, the damage may already be serious before the alarm is raised. To organise a counter-attack, scientists, especially entomologists and pathologists, have to be vigilant at all times.

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