

Biological control programmes — time to retrospect

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Biological control is a tool free from the ill effects associated with chemical control. However, while the lack of documentation of the attempts that have failed has overestimated its potentiality, the euphoria of the success stories seems to have masked the repeated warnings about its other tangential disasters.

BIOLOGICAL control, where biological agents are used to control pests, began as an environmentally safe alternative to the chemical means of control. The Chinese are believed to be the pioneers in using this technique to control the stored grain pests by introducing the nests of the Pharaoh's ants into their barns and bins¹. Around 1200 AD, nests of *Oecophylla* ants were being sold in the markets of China to the farmers to release them in their citrus and litchi orchards to control the insect pests². Some of the recorded instances in the most recent history are the introduction of mynah birds from India to control red locusts in Mauritius during 1762 (ref. 3) and mongooses from Calcutta to Trinidad to control rats during 1872 (ref. 1).

Perhaps the most celebrated example of biological control is the introduction of the Australian vedalia lady beetle to California to control the cottony-cushion scale insects of citrus orchards. The entire citrus industry of California threatened by the scale insect during the late 1880s was rescued following the introduction of the lady beetle during 1889 by Albert Koebele⁴. The success of this introduction triggered the interest world-over in the potentiality of biological control and initiates an extensive application of this technique to control the pests. In India, some of the well-known examples of biological control are the introduction of *Dactylopius opuntiae* from USA (via Australia) to control the prickly pear⁵, *Opuntia elatior* and that of *Aphelinus mali* from Uruguay to control the woolly apple aphid in the apple orchards of Shillong⁵.

Concern over the mass scale introduction of alien biological agents was expressed as early as 1899 by David Sharp when Albert Koebele introduced the vedalia beetle to America⁶. Referring to this as a 'huge biological experiment', Sharp warned about the possible

disturbances to the native flora and fauna and called for a long-term monitoring and for meticulous recording of the consequences. Unfortunately, his warning went unheeded.

For most instances of biological control, there has been a lack of documentation and long-term monitoring of the native biota before and after the introduction of the alien species. Infact lack of such data *per se* has been used as an argument in favour of the safety of the biological control programme. But it should be realized that 'absence of evidence of negative environmental impact is not evidence of the absence of their impact'⁶.

In a few situations where monitoring does exist, there is evidence to suggest the adverse environmental impacts caused by biological control programmes. *Bessa remota*, a tachinid fly was introduced to control the coconut moth, *Levuana iridescens* in Fiji Islands. But the fly has made the country poor by the targeted⁷ and an other unrelated moth species⁶. Perhaps the most disastrous effect recorded was that due to the release of the predatory snail, *Euglandina rosea* to control the alien African Giant snail, *Achatina fulica*, in the Hawaiian islands⁸. *E. rosea* invaded the native forests and is believed to have annihilated several species of endemic tree snails⁹; today most of the 41 native species of snails are believed to be extinct while the African Giant snail still continues to be a pest⁶. Despite its failure in the Hawaiian islands, the predatory snail was introduced to the French Polynesian island, Moorea, during 1977 where it caused similar havoc to the endemic snails. Clarke *et al.*¹⁰ reported that consequent to its introduction, seven endemic species of *Partula* became extinct. As they expressed, 'their loss is not merely a tragedy for students of genetics, it is also a warning about the potentially devastating effects of some programs in "biological control"'.

The effect of introduction on the native flora and fauna would often be complex, indirect and hence not immediately recognizable. For example, the introduction of *Myxoma* virus in Britain to control rabbits has been traced to have led to the extinction of the large

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blue butterfly, *Maculina arion* due to loss of its original habitats¹¹. While these are clear demonstrations of the ill-effects of the introduction of biological agents on the native biota, we could never be aware of the scores of species that are being slowly pushed to the verge of extinction.

The irony however is that even the experts accept these losses as inevitable; perhaps as a small cost to be paid for the manifold benefits to human betterment. There could also be other unintended but direct cost of biological control where the introduced species targeted to control a pest might itself turn out to be a pest. Such danger is especially high when the biological agent introduced to control a weed might end up as a pest on an economically important crop. For example the bug *Teleonemia scrupulosa* introduced to Uganda to control the weed *Lantana* was observed to switch over to the sesame crop¹²; fortunately, the problem was not serious since the bug could not reproduce on sesame¹³.

Amusing though it may seem, there are instances where the introduced biological agents have necessitated the introduction of yet another biological agent to control them after they have turned out to be pests themselves. The monitor lizard, for instance, introduced by Japanese to Micronesian islands to control rats became pest, and toads were introduced to poison them. However, nature thought otherwise and today both lizard and toad live there happily as pests with unknown consequences to the native biota¹⁴.

In the background of these examples it is probably time to critically re-evaluate the pros and cons believed to be associated with biological control. It is true that biological control as a programme has been frequently successful and instances of failure might not be all that important in the face of the huge benefits that could be accrued by a successful programme. It is also true that the ill-effects of the biological control programme have been at least partly foreseen and accordingly, regulatory policies have been formulated. But it is also likely that these policies have become obsolete since they were formulated at a time when our understanding of the functioning of the ecosystem was poor.

It has been shown theoretically that introducing a species in a stable ecosystem can have chaotic consequences before it can regain stability¹⁵. For this reason, any biological control programme involving the introduction of a species alien to the habitat needs to be *a priori* analysed as comprehensively as possible with respect to the disturbances it might cause to the local habitat. Further the regulations overseeing the introduction are restricted only to the political borders; but the borders for the organisms which are habitats and not political have not been considered in analysing the possible ill-effects of introduction. Such regulations based on the habitat boundaries are especially

important in tropical countries such as India which have an intricately linked mosaic of diverse habitats vulnerable for such chaotic perturbations. Sadly enough, it is these countries that are lacking in such regulations.

Consider, for instance, the recent programmes to control *Parthenium* in India. *Parthenium* itself being an introduced weed, two programmes were initiated by independent groups to control it. While one group introduced a beetle¹⁶ (see box page 729, this issue) from Mexico, the other^{17,18} resorted to the use of a plant *Cassia uniflora*, Mill., a leguminous weed that entered India from South America. Our regulatory norms with respect to the environmental safety being still at their infancy, it is difficult to ensure if these methods have been rigorously and comprehensively evaluated for sufficient period of time for being environmentally safe before they were executed. Further assuming that both groups had generated evidence in support of their method to control *Parthenium*, an important question would be—was there a necessity to use both the biological agents in view of the potential disasters of introducing them? The alarm about the possible ill-effects of the beetle has already been raised (see page 729, and accompanying box, this issue). We have no assurance that the intentionally accelerated spread of *Cassia* will have no ill-effects on the native flora and fauna especially because its allelopathic effect observed against *Parthenium* has not been comprehensively studied on other native flora. This is particularly appalling considering that 'interference (allelopathy and/or competition) is found to influence succession and vegetation patterning in many plant communities'^{19,20}.

To conclude, our purpose here has not been to witch-hunt biological control programmes, rather it has been an attempt to introspect the effects of what may be termed as mass-scale biological experiments. It would be grossly unjustified not to acknowledge the benefits of these experiments and at the same time to fail to recognize that these experiments could be disastrous interventions into the long process of biological evolution if executed without seriously analysing the consequences.

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