# Editorial

The News Section of *BNI* has developed an international reputation as a source of the latest information, comment and analysis on key issues in biological control, ranging from biotechnology to biological control safety to the role of farmers in biological control research. Many regional newsletters of biological control and plant protection organizations quote items from *BNI* News in their own information to readers, and this helps to fulfil our purpose. For this reason we are delighted to announce that the News Section of the journal *Biocontrol News and Information* will be available free of charge on the Internet, via PEST CABWeb, from the March 1999 issue. We hope you will tell your colleagues of this, and make use of this easy access yourself. Subscribers to *BNI*, or individuals in institutions with a subscription have, of course, free access to the entire journal, including the review articles and abstracts. *BNI* can be found on the 'Web' at http://pest.cabweb.org/.

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# General News

## Brighter Future for Conifer Forests

There are signs of progress in classical biological control programmes against two major conifer sap-sucking pests in the New and Old Worlds.

***Pauesia* in East Africa...**

Since its invasion of East Africa in the early 1990s, the cypress aphid (*Cinara* sp. nov.) has become a major pest of cypresses and pencil cedar, which are among the most important tree species of economic value in Kenya. This has led to large losses. KEFRI (the Kenya Forestry Research Institute) report that some 10% of trees attacked by the aphids have died, and it is estimated that surviving trees have suffered a 20% annual loss in growth increment.

As a consequence, there has been a loss of interest in the planting and management of cypress trees for hedging and farm forestry and in the development of large-scale plantations.

Following the outbreak of the cypress aphid in Kenya in 1991, KEFRI and the IIBC Kenya Station (now CABI Africa Regional Centre) began a research programme, with financial support from CIDA (the Canadian International Development Agency), FAO (the Food and Agriculture Organization of the UN) and the Overseas Development Agency (ODA – now the UK Department for International Development) to find an effective classical biological control solution for the pest. After extensive exploration in the Americas, Europe and North Africa, and laboratory studies on natural enemies recovered from these surveys, an aphidiine parasitoid, *Pauesia juniperorum*, from western Europe was identified to be the most promising candidate.

The wasp was first released in 1994 and 1995 at Kamae and Keriita forests in Kiambu District, in the Central Highlands of Kenya. But initial post-release surveys suggested that the parasitoid showed very poor signs of establishment and it seemed then as thought the attempted introductions had been a failure.

This seemed to differ from the story emerging in Malawi. *Pauesia juniperorum* was also released there by FRIM (Forest Research Institute of Malawi) in 1994 and 1995, where it established successfully [see *BNI* **18(2)**, 23N]. The parasitoid has now dispersed over much of the central and southern part of the country, and studies by FRIM at Dedza in central Malawi indicate that the parasitoid is controlling the population growth of the aphid.

But in mid January 1999, KEFRI scientists found parasitized aphids at Londiani on the other side of the Rift Valley in Kenya, some 250 km away from the release sites. The parasitoid responsible has since been confirmed as *P. juniperorum*, and it has now been found to be established over an extensive area, from North Molo forest, through Londiani, Timboroa and Nabkoi forests and towards Eldoret. The puzzle is how the wasp got there. At the moment, the best explanation is that it was blown by the wind across the Rift, and was able to become established in this cooler part of the country. KEFRI scientists are very encouraged by this spread, and will carry out surveys to determine its distribution in other cypress-growing areas. They are also planning to carry out mass rearing of the parasitoid for releases around Mount Kenya and other major cypress growing areas where the parasitoid may not yet have established. The discovery of the widespread establishment of the parasitoid in the west of the country has raised hopes that populations of the aphid and hence damage to trees could soon be significantly reduced, so cypress may once again become a popular amenity and commercial tree.

There may be yet more good news, this time from Uganda, where *P. juniperorum* was also released in the mid 1990s. FORI (the Ugandan Forest Research Institute) has recently reported that an aphidiine has been found attacking the cypress aphid close to the release sites, but the identity of the species needs to be confirmed.

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**…And *Pseudoscymnus* in the USA**

The hemlock woolly adelgid (*Adelges tsugae*) is native to Japan, and was first recorded in the USA from Virginia in 1951. Since then, it has become a serious pest of eastern hemlock and Carolina hemlock in the eastern USA. Hemlock stands are among the only old growth forests in this part of the USA, and are of enormous environmental importance. However, although hemlocks in nurseries and most ornamental plantings can be protected by cultural and chemical control practices, these are inappropriate for forests and heavily wooded ornamental landscapes, and native natural enemies are ineffective against the introduced pest.

Exploration in the Far East by Mark McClure of the Connecticut Agricultural Experiment Station led in 1992 to the discovery in Japan of a ladybird the size of a poppy seed, subsequently named *Pseudoscymnus tsugae*, which has shown great potential as a biological control agent. Following host specificity studies, which demonstrated that it was a specific adelgid predator, the ladybird was permitted to be imported into the USA in 1994. Since then, a mass rearing method has been developed that has resulted in more than 200,000 beetles being reared for laboratory and field experiments (from a starting colony of 50), and by this summer most of them will have been released in hemlock forests throughout the eastern United States. New Jersey Department of Agriculture is also now rearing large numbers of the beetle in cooperation with McClure.

The results of the studies by McClure and Carole Cheah have shown that *P. tsugae* feeds on all life stages of the adelgid, and its life cycle is well-synchronized with that of its prey. Using yellow sticky traps and direct sampling, it was demonstrated that adult *P. tsugae* actively explore branches for adelgids and move off release trees into the surrounding forest to find prey. Surveys in the springs of the following years showed that the introduced predator was able to survive, both through the extremely cold and snowy winter of 1995-96 and the relatively mild and snowless winters of the subsequent three years. The ability of *P. tsugae* to survive a variety of winter conditions confirmed its establishment. Studies since have demonstrated that it is successfully developing, reproducing and sustaining its population level; laboratory studies have indicated that the ladybirds adjust how many eggs they lay on a branch to the number prey available.

Recent results suggest that *P. tsugae* may be significantly reducing adelgid numbers in the field. Cage experiments in the field demonstrated that adelgids were 88% less numerous when *P. tsugae* was excluded. Further experiments without cages showed that pest numbers were reduced 87% on branches onto which the ladybird had been released, and 27% on branches on which they had not been released. McClure and Cheah suggest that this smaller reduction may reflect dispersal of the ladybirds from the release branches. A comparison made between areas of forest where *P. tsugae* had and had not been released revealed that the adelgid populations had been reduced by 47-100% in five months following the introduction of only 2400-3600 adult ladybirds. Based on these promising results, beetles will be released in ten other infested states in the eastern United States in 1999 according to the protocol developed by McClure and Cheah.

Source: McClure, M.S.; Cheah, C.A.S.-J. (1998) *Frontiers of Plant Science*, Spring 1998, pp. 6-8.

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## *Parkinsonia Problem Receding?*

*In the last issue we dealt with biological control programmes against mesquite and mimosa in Australia* [BNI **20(1)**, *5N-7N]. Here we deal with initiatives against a third leguminous shrubby weed.*

*Parkinsonia aculeata* (parkinsonia) is a woody, thorny shrub or small tree. It can form dense thickets, making areas inaccessible for man or animals, preventing access to water, hindering mustering, and shading out valuable pastures[1]. It is native to hot and dry regions between southwestern USA and Argentina. Parkinsonia has been introduced into and now grows in California, Florida, Hawaii, the Galapagos Islands, South Africa, the drier parts of tropical Africa, most of India, Pakistan, the Middle East, Italy, and Cyprus[1].

It was introduced into Australia in the late 1800s or early 1900s[2] as a shade tree for planting around bores, dams and homesteads. It is now well established in the catchments of the Fitzroy, Burdekin, Lake Eyre and Gulf river systems in Queensland, as well as the Kimberley region of Western Australia and northern New South Wales. In the Northern Territory parkinsonia infests some 230,000 ha of the Barkly Tablelands, Gulf and Victoria River districts. Parkinsonia tolerates a wide range of temperature and rainfall conditions, so has the potential to become troublesome over considerably larger areas than are already affected[3].

Control programmes, relying primarily on chemical and mechanical methods, have been conducted in various regions of Australia. Parkinsonia is susceptible to a range of soil or basally applied herbicides and blade ploughing. However its long-lived seeds, which are readily distributed by water and stock, mean such programmes are costly and long term. In addition infestations occur in remote and commercially low-value regions.

**Biological Control**

Following investigations in southern USA, Mexico, and Central America between 1983 and 1986, three insect species were imported for host specificity testing. These are the mirid *Rhinacloa callicrates* and the bruchids *Mimosestes ulkei* and *Penthobruchus germaini.*

*Rhinacloa callicrates,* which stunts or kills developing leaf and flower buds, was approved for release in 1989. It has become established in Queensland but does no useful damage to the weed. Despite a number of releases it failed to establish in either the Kimberley or the Northern Territory. *Mimosestes ulkei,* a seed feeding bruchid, has been released in Queensland, the Northern Territory and Western Australia. It has established in Queensland and the Northern Territory but seed infestation rates are low. *Penthobruchus germaini*, another seed feeding bruchid, has been released in all states and has established readily and spread rapidly. In the Territory it is established throughout the Barkly Tablelands, Gulf and Victoria River districts. It has spread up to 200 km from release sites and destroys up to 74% of seeds. It is established through southwest, central and northern Queensland where it destroys up to 99.7% of seed.

Official release programmes have ceased in all states and landowners now distribute *P. germaini* by collecting infested pods from the field. Long term field monitoring is being conducted in Queensland. This species should be particularly effective in reducing parkinsonia seed production and eventually its seed bank.

Acknowledgments are due to Graham Donnelly who provided the information on parkinsonia in Queensland and to Noel Wilson and Brian Thistleton who provided the information on parkinsonia in Western Australia.

Sources:

[1]Wilson, C.G.; Miller, I.L. (1987) Parkinsonia in the Northern Territory. Northern Territory Department of Primary Industry and Fisheries Technical Bulletin, No. 106, 10 pp.

[2]Woods, W. (1986) Biological control of parkinsonia. *Western Australian Journal of Agriculture,* **27,** 80-83.

[3]Parsons, W.T.; Cuthbertson, E.G. (1992) Noxious weeds of Australia. Melbourne, Australia; Inkata Press.

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## Broom Beetle Gets Taste for Tagasaste

Researchers at Lincoln, New Zealand, have found *Bruchidius villosus*, a seed-feeding beetle introduced into New Zealand and Australia as a biological control agent for *Cytisus scoparius* (broom)[1], infesting seeds of *Chamaecytisus palmensis* (tree lucerne, or tagasaste). This was not predicted by host-specificity tests, or field records in Europe, which indicated that *B. villosus* was confined to *Cytisus scoparius* and a few very close relatives in the same genus.

*Chamaecytisus palmensis* is grown in parts of New Zealand for re-vegetation and for forage, but it is also reported as a weed of natural areas. Originating from the Canary Islands, it had not previously been exposed to *B. villosus*, so was tested with beetles prior to their release in New Zealand and Australia. In choice oviposition tests, no eggs were laid on pods of *C. palmensis*, while female beetles laid freely on *Cytisus scoparius*. John Hosking (New South Wales Agriculture) reared *B. villosus* from *Cytisus scoparius* and *Cytisus cantabricus* (a Spanish endemic difficult to distinguish from *C. scoparius*) in the field in Europe, but not from *Cytisus purgans* or *Chamaecytisus hirsutus* (in the same genus as *C. palmensis*).

One theory as to why host-range tests failed to predict that *C. palmensis* is an acceptable host for *B. villosus*, is that only choice tests were carried out, but the beetle encountered a no-choice situation in the field in New Zealand. The beetles do not have an obligatory diapause, and probably triggered, at least in part, by feeding on broom pollen to become reproductive, have found *C. palmensis* pollen a suitable alternative. Because *C. palmensis* flowers much earlier than broom, reproductive beetles had either to lay eggs on this plant, or wait several months, with full ovaries, for broom pods to appear.

Not all pods on affected *C. palmensis* plants, nor all seeds within infected pods, contained beetles. Very preliminary data indicates that fewer seeds of *C. palmensis* are infested by beetles than seeds of *Cytisus scoparius* growing in the same area. No beetles were found infesting seeds of the native legume *Sophora microphylla* growing at the same site. Infestation levels of *Chamaecytisus palmensis* seeds will be monitored next season, at Lincoln, and in other areas where the beetle is established on *Cytisus scoparius*. Seeds of native legumes will also be checked for the presence of beetles.

So how will this affect the biological control of broom programme, and other biological control of weeds projects? No-choice oviposition and development tests with *Chamaecytisus palmensis* and other close relatives of broom will be essential for other broom-feeding agents before we seek permission to release them as biological control agents. We would also like to do more realistic tests in the native range. However, this will involve finding an area in Europe where *Chamaecytisus palmensis* will grow alongside *Cytisus scoparius*, produce flowers and pods out-of-doors, and where we are permitted to plant it. This finding also emphasizes the importance of considering the biology and phenology of both non-target plants, and biological control agents, when designing and interpreting the results of host-range tests.

[1]Syrett, P; Fowler, S.V.; Coombs, E.M.; Hosking, J.R.; Markin, G.P.; Paynter, Q.E.; Sheppard, A.W. (1999) The potential for biological control of Scotch broom (*Cytisus scoparius*) (Fabaceae) and related weedy species. *Biocontrol News and Information* **20(1)**, 17N-34N.

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## Biogeographic Fine-tuning Helps Weed Biocontrol

A common problem in introduction biocontrol projects for alien invasive weeds is knowing where to look for natural enemies. Frequently, it is critical for the researcher to have determined the native range of the alien weed in question, as this information provides a scientific basis for the surveys and decisions on what natural enemy species should be selected for further study as biocontrol agents. During the last decade, several molecular techniques have been developed which have helped biocontrol practitioners resolve the taxonomic status and distribution of alien weeds in relation to non-pest species that are closely related.

DNA molecules are extremely large. The genomic DNA of an organism can consist of many millions of nucleotide bases pairs, the basic building blocks of the molecule. It is the order of these base pairs that determines the genetic code, which makes an organism what it is. Closely related organisms will share much of their genetic code but differences can occur between isolates/species over time due to mutations. The entire genome is too large to examine in total so molecular methods home in on smaller, more manageable, sections (a molecular version of sorting the wheat from the chaff).

The simplest way to do this is to look for RFLPs (restriction fragment length polymorphisms) between the isolates of interest. This is achieved by cutting the large DNA molecules with restriction enzymes. These are small proteins that recognize specific sequences of base pairs (normally four or six base pairs in length) within a DNA molecule and then cut the molecule at these sites. The smaller pieces of DNA so-formed are known as restriction fragments. Mutations within the DNA can cause the formation or loss of restriction enzyme recognition sites resulting in smaller or larger fragments, respectively, being formed. The resulting restriction fragments from different isolates are then separated by loading them onto an agarose gel through which an electric current is passed (gel electrophoresis). Under these conditions different sized fragments migrate to different positions on the gel, thus creating a ladder of bands. Many of the bands from different isolates will migrate to the same positions on the gel (indicating that there has been no change between the isolates at these points) but some bands will differ in size due to the loss or gain of a restriction enzyme cut site in one of the isolates. It is these differences that are known as restriction fragment length polymorphisms. In general RFLPs are most useful for differentiating morphologically similar species. However, some RFLPs can be found between isolates of the same species, especially within chloroplast and mitochondrial DNAs which tend to mutate at a faster rate than chromosomal DNA.

The practical application of this technique is illustrated by a study on the origins of a *Ligustrum* species that has become highly invasive in La Réunion and Mauritius. Researchers at the University of St Andrews in Scotland took dried leaf samples obtained during initial surveys for biocontrol agents in the purported area of origin of the plant, and subjected them to DNA RFLP analysis. The results enabled them to confirm beyond any reasonable doubt that the species (*Ligustrum robustum* subsp. *walkeri*) has its origins in Sri Lanka, and not other localities in the Indian subcontinent.

However, for many notorious alien invasive weeds, although the region of origin is known, the native range can be extensive, covering a wide geographical area and several climatic zones. Examples include

*Chromolaena odorata*, *Parthenium hysterophorus* and *Mikania micrantha*, all of which are highly invasive in the Old World and have extensive native ranges in Central and South America. Here it becomes important to identify the origins and number of the invasive populations as this facilitates the matching of geographical types (e.g. genetic or physiologically adapted forms) of natural enemies to these particular weed populations. On the basis of this, meaningful comparisons of 'biotypes' of particular natural enemy species can then be made. Several groups of workers are making exciting advances using a process referred to as random amplification of polymorphic DNA (RAPD).

The RAPD technique is based on the use of the polymerase chain reaction (PCR) a method that enables the selective amplification of smaller sections of DNA within larger molecules. PCR was made possible by the discovery of a thermostable DNA polymerase (the enzyme used to synthesize new DNA strands prior to cell division) from a bacteria which lives in hot springs. The PCR method consists of three steps repeated many times. First, the double stranded DNA to be amplified is heated to cause the two strands to separate or melt. Second, the solution is cooled to below the melting temperature, and at this point short, single stranded pieces of DNA known as primers bind (anneal) to any regions of the original DNA sample that have a complementary sequence of nucleotide bases. The third and final step raises the temperature of the reaction to 72°C. At this temperature the thermostable DNA polymerase finds the regions of the original DNA which have primers bound to them and the enzyme then starts to make a new DNA strand using nucleotides present in the reaction. Each set of these three steps is known as a cycle. At the end of each cycle the amount of DNA flanked by primers has doubled and after 30 to 40 such cycles the reaction contains many millions more copies of these regions than at the beginning of the PCR process. The region amplified depends on the primers added at the beginning of the process; these may be specific to a particular region of the genome, such as a gene itself, or, as in the case of RAPD, of a random sequence. Indeed RAPD differs from the majority of PCR reactions in that it uses very short primers (ten bases in length compared to approximately 20 bases used in most other PCR reactions). As RAPD primers are so short they find many more binding sites than the longer primers used in other reactions; the chance of finding a match for a ten-base primer being much greater that that for a 20-base primer. The distribution of such short binding sites can be spread throughout the genome of an organism in a random manner. When the RAPD products are separated by gel electrophoresis a number of bands can be observed (occasionally up to 20) and some of these can vary between isolates of the same species. It is these different bands that can be used as markers for specific populations. However, problems can arise from using the RAPD technique because of the short length of the primers used, as missmatches can occur during the second step of the reaction. It has also been demonstrated that the same DNA sample can yield different RAPD patterns depending on the how fast the PCR machine used to perform the reactions heats up and cools down. This in turn can be influenced by daily temperature fluctuations within the laboratory where the reactions are performed. For these reasons great care must be exercised when carrying out RAPD analyses and extensive controls must be performed with every run.

However, when the RAPD technique works well it can yield excellent results. For example, from results obtained using this technique, the Cooperative Research Centre For Tropical Pest Management, Australia was able to indicate that *Parthenium* in Queensland is likely to have originated from two areas in the southern USA – northern and southern Texas.

At CABI Bioscience, UK, we have been using the technique of amplified fragment length polymorphism (AFLP). This is a relatively new technique[1], which is based on the selective amplification of subsets of restriction fragments by PCR (Figure 1). The technique is more reproducible than other fingerprinting methods, such as RAPD, because it utilizes the highly specific action of restriction enzymes to digest genomic DNA. These restriction fragments are then joined to adapters by a DNA ligase. Adapters are short (around 20 base pairs in length) double stranded pieces of DNA, at one end of which is a region complementary to the restriction enzyme which has been used to fragment the DNA, thus allowing the adapter to join to the ends of the digested genomic DNA. The sequence of the remainder of the adapter can be determined by the researcher. The adapter/ligated fragments are then amplified by PCR using one of the adapter strands as a primer to bulk up the total number of DNA molecules. The final step is to perform a second selective amplification using the same primer as before, but with two extra nucleotides added to one end. This step selectively amplifies only those restriction fragments that have an adapter ligated to each end and then the complimentary nucleotides to the two extra selective nucleotides on the primer. In effect, we are amplifying a subset of the total number of restriction fragments and typical results yield up to 20 bands per primer. As there are four nucleotides that make up DNA (A, C, G and T) this means there are 16 possible combinations of the two selective nucleotides (AA, AC, AG, AT, CA, CC, CG, CT, etc.) which can be added to the end of the selective primer. Using the full range of 16 selective primers gives AFLP the potential to generate large amounts of data in a relatively short space of time. The AFLP products are then separated by gel electrophoresis and the profiles from different strains/populations compared by analysis of their banding patterns. A measure of genetic relatedness is obtained by comparing the number of bands shared by two isolates in relation to the total number of bands each contains. Thus if two isolates have identical banding patterns the genetic distance between them would be zero.

The strength of the AFLP technique stems from the high specificity of the restriction enzyme used to digest the genomic DNA (Figure 1, step 1) and the high annealing temperatures possible during the amplification reactions (Figure 1, steps 3 and 4). This increased stringency (due to the longer primers and their subsequent higher annealing temperature) leads to much higher reproducibility for AFLP than is possible with RAPD. However, as with all techniques there are also drawbacks. With AFLP these include a need for high purity DNA samples in greater quantities than required by other methods. Other possible pitfalls with AFLP tend also to be true for other fingerprinting methods. When analyzing banding patterns it must be assumed that bands migrating to the same position in two samples are the same piece of DNA. For populations within a species this is probably true for the vast majority of bands. However, this may be far less likely when comparing species; in this instance, the method of choice would be to compare either the nucleotide sequence of one specific region of the genome, or RFLPs within a region as was done in the chloroplast study of *Ligustrum*.

The AFLP method has been used to assess genetic diversity for a wide range of economically important crops such as wheat, rice, maize, carrot, sunflowers and soybean. It has also been used for similar purposes for bacterial and fungal pathogens of such crops. To date we are aware of little in the way of published studies on the genetic diversity between populations of weeds.

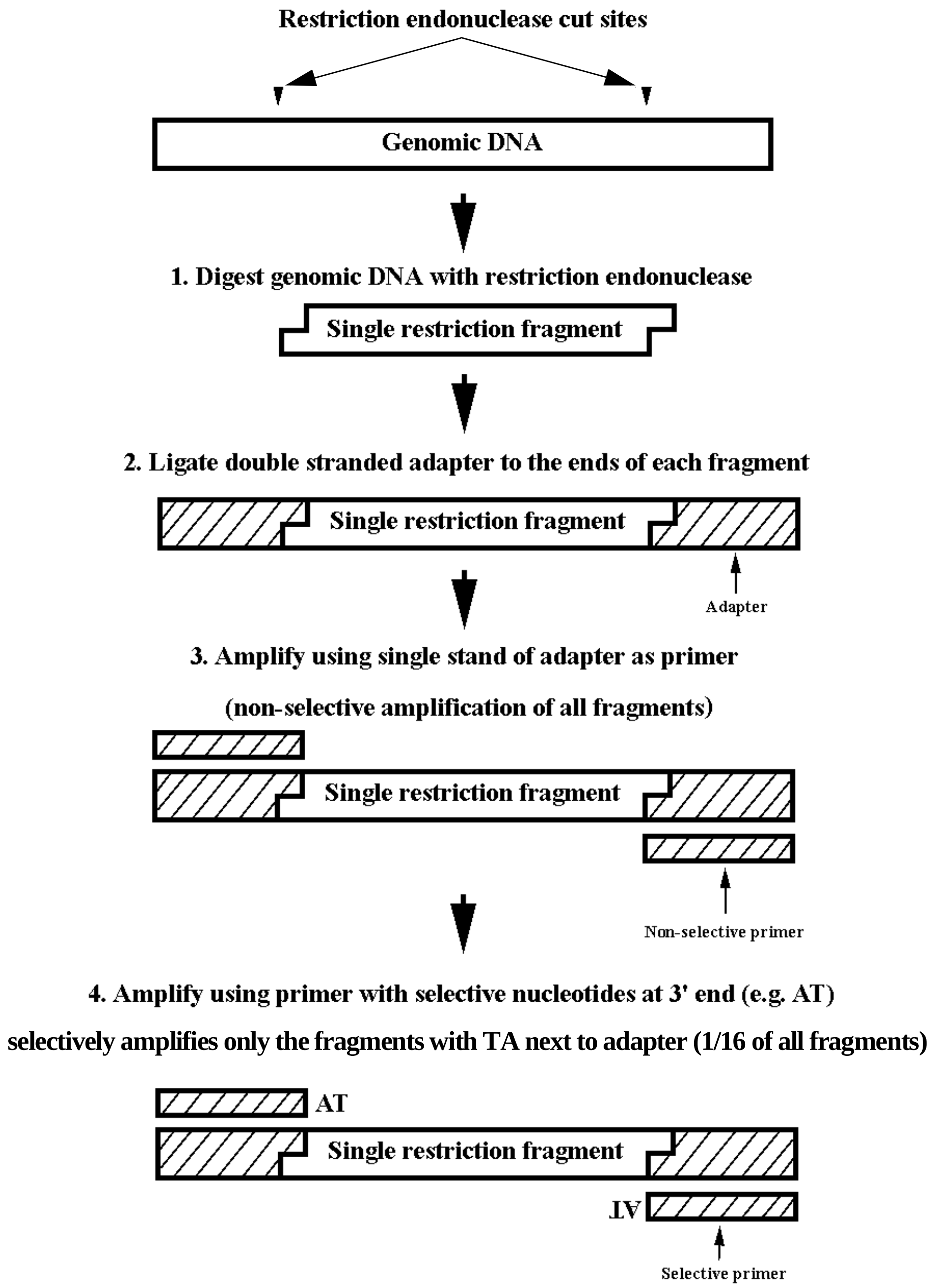


**Figure 1.** Outline of the AFLP technique[2].

In a project funded by DfID (the UK Department for International Development), we have been using the AFLP technique to investigate the levels of genetic variation within populations from the original location of the weed *Mikania micrantha* in the Neotropics, and comparing these with populations from sites where the weed has been introduced in India. When comparing isolates from the original locality of an organism to those from an area where it has been introduced it is important to obtain a large number of samples from the original locality. This ensures that an accurate assessment of the genetic diversity within the original location is obtained. Without such a large sample size it is possible that one may have sampled unusual populations, thus skewing comparisons to those populations investigated from the introduced sites. Preliminary results appear to indicate that *M. micrantha* has been introduced to India on at least two separate occasions, although more analysis of these data is necessary before a firm conclusion can be made.

[1]Vos, P.; Hogers, R.; Bleeker, M.; Reijans, M.; Van de Lee, T.; Hornes, M.; Frijters, A.; Pot, J.; Peleman, J.; Kuiper, M.; Zabeau, M. (1995) AFLP: a new technique for DNA fingerprinting. *Nucleic Acid Research* **23**, 4407-4414.

[2]Method based on: Mueller, U.G.; Lipari, S.E.; Milgroom, M.G. (1996) Amplified fragment length polymorphism (AFLP) fingerprinting of the symbiotic fungi cultured by the fungus-growing ant *Cyphomyrmex minutus*. *Molecular Ecology* **5**, 119-122. This differs from many other published AFLP methods in using a single restriction enzyme (*Pst* I) instead of two and in separating the AFLP products by agarose gel electrophoresis instead of denaturing PAGE (polyacrylamide gel electrophoresis). The adaptation we have introduced is to add a preselective amplification step as we have found this to improve yield and uniformity of our AFLP patterns.

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## American Insects Feed on English Cordgrass

*Spartina anglica*, English cordgrass, has been isolated from North American herbivores since its 19th Century amphidiploid hybrid origin in the south of England. The parents were *Spartina alterniflora*, smooth cordgrass, presumably introduced to UK as cast-off ship's ballast, and the native European *Spartina maritima*. We have found that a population of this estuarine plant, introduced several decades ago to Puget Sound, Washington State, was highly vulnerable to *Prokelisia* spp. planthoppers from California. These planthoppers are the most widespread and prominent insect herbivores on *S. alterniflora* in areas where this plant is native in North America. With high planthopper densities, more than 90% of the *S. anglica* plants died in our greenhouse experiment, while less than 1% died at low hopper densities. Plant mortalities were also nil for the North American species of *S. alterniflora* and *Spartina foliosa* (which coexist with these planthoppers) even at very high insect densities in greenhouse culture and in the field. The only other cordgrass population known to be intolerant of *Prokelisia* spp. is the alien *S. alterniflora* in Willapa Bay, Washington, which has been exiled from *Prokelisia* spp. since introduction from the Atlantic at least 60 years ago.

English cordgrass invades the open intertidal mud of Pacific estuaries of North America, jeopardizing native flora and fauna of saltmarshes. This invasive plant alters the hydrology of marshes by accreting sediment. If intolerance to *Prokelisia* spp. in the field correlates with that in the greenhouse, biological control by this planthopper could contribute to management of cordgrass populations sensitive to this insect. *Prokelisia* spp. are stenophagous, and could pose little threat to other plant genera. Neither the biological basis nor the inheritance of cordgrass vulnerability to the *Prokelisia* spp. are known. Care would be needed to prevent increase of more resistant clones after introduction of the planthopper for biological control.

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## Fast and Furious: Release Methods

Tapping them out of tubes, blowing them off tissue, shaking them off cotton wool wisps… the business of releasing natural enemies in the field is frequently both laborious and uncertain. One of the biggest challenges for any biological control programme is to get natural enemies out into the field, at the right place, at the right time and in sufficient numbers. In the past, mass release methods have been developed for releasing beneficial organisms over large areas, and inventive approaches were used for releasing them in remote terrain or into the forest canopy. Now, with large-scale implementation of biological control on the increase, particularly in commercial concerns where labour costs are critical, there is room for more innovation. Here we describe some tried-and-tested (and in some cases discarded) methods and outline progress with some novel techniques.

**By Plane**

In the 1980s, the Africa-wide Biological Control Program (ABCP) of the International Institute of Tropical Agriculture (IITA) pioneered the use of aircraft. They experimented with the low-level flying techniques used for crop-spraying to release natural enemies (*Apoanagyrus lopezi*) of cassava mealybug. An Automatic Insect Release System (AIRS) installed in the rear of a twin turbo-prop aircraft released the wasps into the slipstream of the aircraft. In experimental releases (with the aircraft flying very low) in which the wasps were recovered on plastic sheets, natural enemy mortality was judged to be acceptable at a maximum of 50%. However, although experimental releases were made in Ghana and operational releases in Zambia, the technique was found to need more personnel on the ground than conventional release methods. It has been suggested that in perhaps only one case could releases not have been made more cheaply and more easily by car. The current IITA programme for the release of cassava mite natural enemies is relying on land-based methods.

Aerial releases of insects have, however, been used in sterile insect technique (SIT) programmes. During the programme which led to the successful eradication of tsetse fly from Zanzibar, up to 1000 sterile male flies per week were released from the air [*BNI* **18(4)**, 107N-108N]. A method developed for SIT release is being adapted in Guatemala, where augmentative releases of a braconid parasitoid, *Diachasmimorpha tryoni*, are being used as part of a programme to contain the medfly (*Ceratitis capitata*) on the mountainous Guatemalan/Mexican border [***BNI*** **18(4)**, 108N]. In early trials, paper bags containing the parasitoids were released from aircraft. However, packaging the natural enemies in this way was not practical, given the numbers needed for a release area of 100 km² or more. Instead, a method of chilled aerial release developed by the US Department of Agriculture (USDA) for sterile medfly release was tried for parasitoid releases. The wasps were chilled at 2.2-3.9°C before being released at about 6 am (optimum wind and temperature conditions) at 30-80 m above level ground from a twin-engined aircraft travelling at 200-240 k.p.h. Pre-release damage to the wasps was found to be minimal and mortality low (and both were less than for the 'paper bag' method). Although it was difficult to assess post-release mortality with any accuracy as wasp recapture numbers were small, live and active wasps were recovered following both parasitoid and mixed sterile medfly/parasitoid releases. Experimental releases were then made over coffee farms at some 1250-1350 m above the coffee (the lowest possible operational height in the hilly terrain). Live parasitoids were found throughout the dropping zone within 15 minutes of release, and most were recovered within 100-200 m of the flight path. However, before this method can be used on a regular basis, more field trials are needed. Despite an urgency to move forward on the part of the scientists involved, funding is currently constraining further work.

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**Raining Spores**

Aerial release of microbial control agents presents fewer problems than for insects, and equipment similar, or identical, to that used for pesticide spraying can often be used. The *Metarhizium* formulation Green Muscle® for locust control is usually applied by ultralow volume (ULV) methods, and spraying can be done from the air at as little as 0.5 litres/ha, as well as from vehicles or on foot.

In the last issue of BNI, we reported on the use of the fungal pathogen *Phloeospora mimosae-pigrae* against mimosa in northern Australia, where helicopters are being used for large-scale releases. Bertie Hennecke says that when he was considering application methods, he wanted to avoid complicated changes to spraying equipment. Therefore, he used the same equipment used for aerial application of herbicide. The spraytank was rinsed with water before filling it with a 'broth' containing the spores and also methyl cellulose as a sticking agent, so rain did not wash the inoculum off the plants. T Jet 8008E nozzles were used on a 15-m-wide boom and the inoculum was sprayed at a rate of 100 litres/ha, with the helicopter flying about 0.5 m above the plants. Inoculations were carried out late in the afternoon to make use of the calmest possible spraying conditions, and to take advantage of the increasing humidity supported by evening rain.

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Forest pests and weeds in the canopy are difficult to reach with any form of control agent, but some ingenious methods have been used to propel pathogens from the ground up into the treetops.

**Bombing *Beauveria***

In the 1970s, 'mortar bombs' containing firecrackers were used for *Beauveria bassiana* release in tall pine plantations in southern China for control of the Masson's pine caterpillar (*Dendrolimus punctatus*), and proved to be an effective method of application. However, the technique was abandoned in the 1980s as the increasing price of firecrackers made it prohibitively expensive and the regulation of such goods as firecrackers and fireworks became stricter. It was a potentially dangerous carrier, although there were no reports of any accidents during the decade it was used. Nowadays, the Chinese have reverted to more conventional techniques for releasing the fungal preparations.

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**Cleaning Up**

Graham Greene may have thought of it first, but 'Our Men in Queensland' put it to practical use. Allan Tomley and Graham Hardwick incorporated the humble vacuum cleaner into an efficient system for collecting fungal spores of rubber vine rust, *Maravalia cryptostegiae*, and delivering them to *Cryptostegia grandiflora* in the canopy, at sites reached on foot, and by four-wheel drive vehicle and light aeroplane. [Also see *BNI* **18(3)**, 66N.]

The fungus was bulked up by culturing on rubber vine seedlings. Spores were harvested using a large cyclone type spore collector manufactured from PVC tubing and powered by suction from either a battery operated mini vacuum cleaner or a domestic vacuum cleaner with a restrictor fitted to the inlet to reduce airflow. The spores once dried could be stored at 4°C for 7-10 days after harvest without losing viability. In the field, a rainwater based spore suspension, containing approximately $1.5 \times 10^4$ spores/ml, was prepared and applied using a 35 cc 1.25 kW petrol powered knapsack misting machine to the foliage of rubber vine at several half-hectare sites in the remote Gulf country of North Queensland. This method allowed the placement of spore suspension on leaves of rubber vine towers up to 20 m above ground level, which led to establishment of the rust and facilitated its early dispersal. The method proved very practical for remote sites, as the misting machine was small and quite portable. They flew around the Gulf country in atrocious wet season conditions, landing on wet slippery bush airstrips, but this ensured the rain necessary for germination of the spores.

Source: Tomley, A.J.; Hardwick, G. (1996) Bulking up, field distribution and establishment of rubber vine rust, *Maravalia cryptostegiae* in far north Queensland. In: 11th Australian Weeds Conference Proceedings, pp. 237-238.

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Speed is of the essence where cost is concerned. Commercial companies are leaders in developing automated release systems, but USDA Agricultural Research Service (ARS) scientists have come up with some novel inventions designed to cut down labour costs.

**Flying Saucers**

Sightings of UFOs bearing alien species may soon escalate if current work by ARS scientists in California bears fruit. They have developed a device to deploy beneficial insects and mites strategically in crop fields, and have applied for a US patent.

The Aerodynamic Transport Body (ATB) is more descriptively called the Bugslinger. Based on the design of targets used in clay pigeon (skeet or trap) shooting, the ATB is a lightweight, disk-shaped container for housing the beneficial insects, with suitably sized exit holes for their escape after landing. The launcher for the disks can be mounted on the back of a vehicle and, because the disks can thus be launched from the edge of fields, both natural enemy deployment time and crop damage/soil compaction are reduced. The disk reaches a maximum speed of some 175 k.p.h. (110 m.p.h.) with a 175G rotational force before landing, but good survival of these relatively astronomical stresses was recorded for *Aphelinus* nr. *paramali* wasps in field trials. The prototype devices are about 10 cm in diameter and 2.5 cm high, and are made of powdered limestone, but disks could be of more degradable materials such as paper, oatmeal, tree bark, alfalfa hay, compacted fertilizer pellets or compressed peat moss.

**Shaken Not Stirred**

Speed, precision and high survival rate are described as outstanding features of the Mite Meter. The prototype of this machine consists of a small chilled holding tank in which the beneficial mites or predators rest within vermiculite or other carrier material. A tiny gate dispenses precise amounts of the mite/carrier mix onto a variable-speed narrow conveyor belt. At the end of the belt, the mixture falls to the ground.

The Mite Meter, mounted on a tractor, can dispense 500-20,000 mites per hour over a 4-ha (10-acre) area, in a form of carpet bombing. In field trials, more than 95% survival was recorded for the predatory mite *Galendromus occidentalis* and the predatory bug *Geocoris punctipes* – but it did prove too rough a journey for parasitic wasps.

Crucial to the success of this apparatus is the design of the holding tank, which consists of an inner 1.5-litre bottle fitted into an insulated jug. Keeping the beneficials cool and comfortable is critical, otherwise they would start to move around quickly in the tank, notably upwards and away from the gate and metering belt, and this could lead to significant variations in application rate. The relatively small amount of carrier is also an advantage: beneficials could come supplied in the dispensing flasks in the appropriate volume of carrier, with no need for any on-farm mixing. This would both save time and minimize handling and, therefore, mortality.

**On the Siegfried Line**

A US-patent has been granted for a loading device invented by ARS scientists in Georgia, which attaches beneficial insect eggs onto strings. The system, suitable for insects such as lacewings, saves time as laying strings laden with eggs onto plants is far quicker than tapping the eggs out of tubes. It also reduces wastage: some eggs emptied from tubes inevitably fall to the ground and are eaten by predators, but the attached eggs are far more secure on the plant and the strings don't blow away – but neither do they impede plant growth.

Source for USDA information: Agricultural Research Service press releases, http://www.ars.usda.gov/is/pr

**Set a Thief…**

From high-tech to low cunning now… some biocontrol scientists are looking to recruit other insects to disperse natural enemies for them. In the last issue, Nguya Maniania and David Nadel of ICIPE described their work on developing a system that uses artificially infected tsetse flies to spread the insect-pathogenic fungus *Metarhizium anisopliae* through a tsetse population [*BNI* **20(1),** 7N-8N].

A number of other studies have investigated the potential of a beneficial species, the honey bee. The honey bee's hairy body, which is adapted for collecting and carrying pollen, also allows it to carry fungal and bacterial spores. It has already been tested for disseminating bacterial and viral agents for control of pests and diseases on crops including strawberries, apples, sunflowers and clover. More recently, honey bees have been shown to be effective vectors of *M. anisopliae*. As the fungus is transmitted by contact and does not need the agent to be ingested, the prospects for commercial development of this system are good.

For field trials conducted at Rothamsted Experiment Station, UK, hives were fitted with inoculum dispensers at their entrances. Each dispenser deposited dry conidia of *M. anisopliae* on the honey bees as they left the hive to forage. Results indicated that the honey bees were an effective agent for delivering the fungus to the flowers of oilseed rape in caged plots, and so disseminating it to a flower pest in this crop. Pollen beetles (*Meligethes aeneus*) are widespread and important pests of oilseed rape and other crucifers throughout Europe; they feed and oviposit in buds and flowers, particularly in spring-sown crops. This causes the buds and flowers to drop and no pods are formed.

In these trials, the presence of fungus-carrying honey bees in the caged plots caused considerable mortality of pollen beetles collected from the plots of both winter- and spring-sown rape and then incubated in the laboratory. Moreover, mortality was greatest (at 61% and 100% in winter and spring rape, respectively) during peak flowering when feeding activity of bees and beetles from flowers was maximal... the optimum conditions for inoculum dissemination and infection. Conidial sporulation was found to occur on a significant proportion of the dead pollen beetles, while there was no evidence that the fungus had any adverse effect on the bees.

Source: Butt, T.M.; Carreck, N.L.; Ibrahim, L.; Williams, I.H. (1998) Honey-bee-mediated infection of pollen beetle (*Meligethes aeneus* Fab.) by the insect-pathogenic fungus, *Metarhizium anisopliae. Biocontrol Science and Technology* **8**, 533-538.

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# Biorational

*Integrated pest management (IPM) involves the use of many techniques, including biological control, to provide effective control of crop pests with minimum harmful side-effects. Those techniques that are compatible with the use of biological control or have little impact on natural enemies have been described as 'biorational'.*

## IPM in Cotton Wins Approval

The success of a bio-intensive IPM module developed for cotton is highlighted in the Annual Report (1997-98) of the Indian National Centre for Integrated Pest Management (NCIPM)*. The Centre has a mandate to develop and promote IPM technologies for major crops to sustain higher crop yields with minimum ecological implications.

Field trials to assess the IPM modules for cotton were conducted at Nanded Cotton Research Station (Marathwada Agricultural University) and in farmers' fields. Bio-intensive, biocontrol + intercrop and biocontrol + insecticide treatments were compared with a pesticide-based treatment. The bio-intensive treatment (which included spraying with the biopesticide Aphidin (against sucking pests), *Bacillus thuringiensis* K II, 5% neem seed kernel extract and sulphur 80 WP, and releasing *Trichogramma chilonis*) gave best seed cotton yields in farmers fields (1304 kg/ha) and the highest net income (Rs23810/ha); this was nearly three times the income derived with the pesticide treatment. The module has been a success with farmers, who are keen to adopt it, and there are plans to make it more widely available for cotton farmers elsewhere in India.

The Centre has also developed IPM strategies for basmati rice, mustard, linseed and ber (*Ziziphus mauritiana*) and these have been fine tuned on the basis of the results of validation field trials, whilst IPM programmes for chickpea and pigeonpea are under development. On the information front, a cotton pest management information system is now ready for release, and databases for rice and some pulse crops are under construction. In an area seen as important for the Centre, forecasting methods are being designed and tested for *Helicoverpa* and for *Myzus persicae* in potato, and forecasting risks to crops from a number of diseases is being studied. The Centre is also involved in a surveillance and management programme for nematodes in rice and wheat in northern India. Distribution maps of 13 pests and diseases of major crops in India are now available.

In the research support and transfer of technology section, there is a strong emphasis on the biological control component of IPM. Research is being conducted on mass rearing techniques, and the centre is mass producing host insects (*Corcyra cephalonica* and *Helicoverpa armigera*), parasitoids (*Trichogramma chilonis, Trichogramma japonicum* and *Chelonus blackburni*), predators (*Chrysoperla carnea*) and pathogens (*H. armigera* nuclear polyhedrosis virus) for field release and for supply to other organizations. Recent activities in the promotion of biological control in IPM have included technical support to the Central Institute for Cotton Research, Regional Station Sirsa on the establishment of biological control facilities. Technology transfer has included facilitating farmer training in IPM techniques in a number of crops in Haryana and Uttar Pradesh, and providing training in cotton IPM for resource personnel from the pesticide industry.

*NCIPM (1998) Annual Report 1997-98. New Delhi, India; National Centre for Integrated Pest Management, 80 pp.

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# Training News

*In this section we welcome all your experiences in working directly with the end-users of arthropod and microbial biocontrol agents or in educational activities on natural enemies aimed at students, farmers, extension staff or policymakers.*

## Kenyan Farmers Validate Traditional Methods

Farmer Field School (FFS) training has been conducted in Kenya since 1996 through a collaborative project of IPM staff at CABI Africa Regional Centre with the Kenya Agricultural Research Institute (KARI), the Coffee Research Foundation (CRF) of Kenya, the Ministry of Agriculture Livestock Development & Marketing (MOALD&M) and the Kenya Institute of Organic Farming (KIOF). The target cropping system is smallholder mixed cropping of coffee and vegetables (mainly kale, cabbage and tomato) in the central highlands. Many small-scale farmers in these areas have virtually abandoned their coffee bushes due to low coffee prices and the rise in pesticide costs. Those growing tomatoes for the local market spend an increasing proportion of their production costs on insecticides and fungicides.

FFS groups were set up in four agro-ecological zones with approximately 65 farmers in total including organic farmers and those using pesticides. Each group carried out weekly observations on small plots in the field to compare their usual cultivation and pest control practices with various IPM options. They also conducted experiments on alternative crop management methods, including traditional methods for insect pest and disease control. The tomato growers, in particular, discovered the benefit of preparing compost and using liquid manures and plant tonics to produce more robust plants. The organic groups learnt to look at the efficacy of botanical and other homemade extracts for pest and disease control and compared the usefulness of different methods for nursery bed soil preparation. FFS farmers in all groups were able to reduce production costs, improve yields and apply the IPM principles learnt to other crops in their farms. However, many questions came up on the effectiveness of traditional methods, and to address these CABI, KARI and KIOF facilitated innovative farmer participatory research methods in 1998 with two established FFS groups.

Organic farmers and an all-women tomato growers group conducted season-long research into traditional methods for pest and disease management according to their particular interests. These validation experiments quantified and assessed the effectiveness of the following methods:

- Nursery bed hygiene methods (trash-burning, hot water and incorporation of Mexican marigold) for control of rootknot nematode in tomato
- Marigold and chilli concoctions for control of aphid and caterpillars in kales
- Pegging (placement of a thin stick next to the seedling stalk so that cut-worm cannot coil around and bite through stem) and ash for control of cutworms
- Foliar sprays of diluted milk to delay onset of blight in tomato

The farmers participated on an equal basis with researchers in trial design, management, data collection and evaluation. Farmers took the lead in teaching researchers the practical use of traditional methods while the scientists advised on trial lay-out, replication and assessment parameters. Farmers were already familiar with weekly field observations for AgroEcosystem Analysis through their FFS experience, where they study crop health, pests, diseases and beneficial insects and record these visually on posters for discussion. These analyses were modified to include macroscopic observations such as percentage germination, root-shoot length measurement, rootknot nematode galling index in tomato seedlings, and kale leaf quality scoring. Field observations were backed up by microscopic laboratory assessments such as nematode counts from soil samples and sampled seedlings. The farmers divided into three groups to organize observations and data collection via AgroEcosystem Analysis preparation and presentation. The group secretaries entered the data collected into structured record sheets. In the plenary, each secretary presented data, which was filled into a large flip chart. The facilitator encouraged discussions, which formed the basis for the next course of action. In the discussions, the researchers, farmers and extension staff participated in contributing ideas. In the nursery bed hygiene experiment, questions included:

- What are the differences in seedling establishment in each treatment?
- Which nursery is preferred and why?
- What should be done and by whom before the next meeting? (e.g. weeding, watering)
- Are there any specific materials or tools that need to be brought along in the next meeting? If yes, who will bring what?
- What went right today (facilitation, time keeping, learning)?
- What went wrong? How will this be corrected?

At the end of the session, scientists took back the record sheets with records to the office for statistical analysis while the facilitator copied the same in his/her field note book. The data on the large flip chart remained with the FFS group; thus the farmers developed their own learning materials and records.

Preliminary analysis of results showed that trash-burning was the most effective soil treatment in terms of overall seedling health, followed by dried marigold. In the experiment on botanical concoctions for aphid and diamondback moth (DBM) control in kales, Karate™ (lambda-cyhalothrin) application produced the best quality leaves but there was no difference between the insecticide and highly concentrated chilli solution treatments in production of marketable leaves. The groups found that fresh marigold tea repels DBM larvae for a few hours only. Chilli sprays reduce pest numbers by 50% in the first week after application but these build up again so chilli needs to be sprayed every 14 days for effective control. In the cutworm experiment, no kale seedlings were lost in either the pegging or the ash treatments, compared to 5% loss due to cutworm damage in control plots. Farmers decided to use pegging as the favoured control option as it keeps cutworms available for natural enemies. In the tomato disease experiment, the fungicide treatments and control plots performed better than milk spray plots although some farmers want to repeat the experiment under dry season conditions when they claim milk can be effective.

Joint evaluation of the results has enabled the farmers to compare different traditional methods with synthetic pesticide treatments and no-intervention control plots in terms of cost, labour, efficacy, duration of effect, quality of produce and possible side-effects on beneficial insects. These comparisons help them to make better informed decisions on their crop management options. The research organizations involved have benefited by more direct links with farmers and are now expanding their research agenda to include on-farm experimentation on traditional methods, in close collaboration with farmer trainers from extension and KIOF. Further research will look in detail at the efficacy of chilli solutions for kale pest management and their effect on key syrphid natural enemies. The facilitators have gained useful experience and confidence in conducting simple but rigorous experiments to answer questions posed by farmers. Conducting research as an FFS group also provided material benefits to each member and strengthened group cohesion. Fresh produce from the kale sampling sessions was shared between participants and each member took home 200 seedlings from the nursery experiments to plant on individual plots. The remaining seedlings were sold to neighbours and the profits entered into the FFS group account. Farmer participatory research of this type reinforces IPM training programmes and stimulates the adaptation and implementation of IPM options which address the problems of smallholder farmers.

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## Augmenting Liriomyza Parasitoids

An ingenious method being developed by Indonesian plant protection staff to enable farmers to augment *Liriomyza* parasitoid populations was described at an international workshop held at Tanah Rata, Cameron Highlands, Malaysia in January 1999. The workshop was organized by the CABI South-East Asia Regional Centre (SEARC) and was held to collate information on the state of *Liriomyza* in South-east Asia and to identify national needs and criteria including inter-country linkages.

In western Sumatra, field laboratory staff survey areas of a farmer's crop (cauliflower, for example) that are attacked by *Liriomyza* but where pesticide usage has been low. A small number of old leaves are sampled, and the numbers of *Liriomyza* and parasitoids (principally *Hemiptarsenus* spp. and braconids) are compared. If parasitoids represent 75% or more of the total number, then the leaves are regarded as suitable for use as parasitoid carriers for augmentation release.

Farmers collect *Liriomyza*-attacked leaves from the area from which the samples were taken. These leaves are tied in bundles of five. Each bundle is hung on the tip of a 50-cm-long stick, which is pushed into the ground, with one stick for every 10-m² area. Then – in a simple but clever step – a small depression is made around the stick. The *Liriomyza* larvae are first to emerge from the leaves, and they drop down to the ground to pupate. Five days after the stick was planted in the ground, the depression is filled in by heaping up earth, and the *Liriomyza* pupae are buried and die. The parasitoids emerge later: *Hemiptarsenus* pupates in the leaf gallery made by *Liriomyza* and the adult emerges by piercing the epidermis, but braconid larvae crawl out of the leaf, drop to the ground, and pupate on the fresh soil surface.

In some areas augmentation is conducted about every two weeks after planting, elsewhere, action is based on observation. However, the efficacy of this method has not yet been assessed, and the need to do this is beginning to be addressed by two- or three-weekly sampling and comparison of parasitoid and *Liriomyza* populations.

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# Internet Round-up

*By: Tony Little, Technical Support Group to the Global IPM Facility, CABI Bioscience.*

In this issue, 'Internet Round-up' focuses on augmentative biocontrol. There is in fact quite a lot of information out there, but you have to know where to look for it – using the search engines gets you nowhere fast.

I started with Radcliffe's IPM World Textbook at

**http://ipmworld.umn.edu/**

This is the University of Minnesota's electronic textbook of integrated pest management featuring contributed chapters by internationally recognized experts, and is rapidly becoming one of my favourite sites. I increasingly use it as starting point for biocontrol information searches; since the book is fairly comprehensive, the chances are you will find something of relevance. So it proved to be here. The chapter 'Biological control: approaches and applications' has a section on augmentation, which serves as a nice introduction to the subject. But the other reason I like this site is that it is fantastically well linked, listing close on 100 sites relevant to IPM.

Of these I chose Mid-West Biological Control News Online at

**http://www.wisc.edu/entomology/mbcn/mbcn.html**

which I have found useful from time to time. Augmentative biocontrol crops up in a couple of back issues (Volume I, No. 4, ‘Augmentation: the periodic release of natural enemies’ and Volume VI, No. 1, ‘Quality of natural enemies’).

Parasitoid rearing systems are discussed at several sites, for example the Technology Transfer Information Center (United States Department of Agriculture (USDA)) at

**http://www.nal.usda.gov/ttic/tektran/tektran.html**

which has a database of selected pre-publication notices of recent research results from the Agricultural Research Service (ARS) of USDA. Staying with USDA, the Insect Biocontrol Lab at

**http://www.barc.usda.gov/psi/ibl/ibl.htm**

gives details of its work on physiological contributions to augmentative biocontrol of whiteflies and weeds.

Some of the biocontrol companies web pages are also worth a visit, particularly Koppert’s at

**http://www.koppert.nl/english/resear.htm**

Wageningen Agricultural University has a database that lists its research publications at

**http://www.agralin.nl/luwpubs/**

which includes a few papers on augmentative biocontrol, and is quite a useful resource generally.

The LUBILOSA (for French speakers: LUtte BIologique contre les LOcustes et les SAuteriaux) site at

**www.cgiar.org/iita/research/LUBILOSA/index.htm**

describes the exciting project involving the inundative release of the entomopathogenic fungus *Metarhizium anisopliae* for the control of locusts and grasshoppers, and the development of a commercial product, ‘Green Muscle’, which was registered in South Africa last year [see *BNI* **20(1)**, 5N].

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# Announcements

*Are you producing a newsletter, holding a meeting, running an organization or rearing a natural enemy that you want other biocontrol workers to know about? Send us the details and we will announce it in* BNI.

## *Invasive Alien Plants*

The 5th International Conference on the Ecology of Invasive Alien Plants will be held on 13-16 October 1999, at La Maddelena, Sardinia, Italy. This is the continuation of a series of meetings, (the last held in Berlin in 1997 [see *BNI* **19(1)**, 8N]) and will concentrate on issues of invasions and their effects on ecosystems that have been identified as important during these preceding meetings. The Conference will be of interest to biological control practitioners since it emphasizes the scale of weed problems around the world. In addition, it will be attended by potential collaborators and would provide a good forum for pre and post-release studies.

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## *Brighton Conference Focuses on Weeds*

The control of temperate and tropical weeds will take centre stage at this year’s Brighton Conference, to be held on 15-18 November 1999, organized by the British Crop Protection Council (BCPC). Herbicide use will be contrasted with biological and organic control systems, and there will discussion on advances in precision farming and in-field weed management techniques. Sessions will also be held to review new regulatory issues and environmental issues such as herbicide-tolerant crops. Communication will be the subject of the 26th Bawden Lecture in which Professor Christine Bruhn, Director of the Centre for Consumer Research at the University of California will open the Conference with a paper entitled ‘Public communication: the foundation of global progress’. The week in Brighton begins on Monday 15 November with a highly topical one-day symposium entitled ‘International crop protection: achievements and ambitions’.

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## *Vertebrate Conference*

The 19th Vertebrate Pest Conference will be held in San Diego, California on 6-9 March 2000. This is the latest in a biennial conference series held to bring together vertebrate pest management specialists from around the world, and aims to make significant contributions toward the understanding and resolution of vertebrate pest problems. Papers are expected to include aspects of vertebrate pests related to: their management; urban wildlife; reforestation problems; new conventional and alternative management methods and materials; human, domestic animal and wildlife health; endangered species programmes; and economic, social and political issues.

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The proceedings of the 18th Vertebrate Pest Conference have been published and are available from Sydni Gillette at the above address [e-mail: skgillette@ucdavis.edu]. Price: US$25.00 +$4.00 postage and handling (USA); overseas postage rates available on application.

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# Conference Reports

## Nicaragua Hosts Joint Event

Concurrent society and professional meetings are becoming more popular because they unite a larger group of people with overlapping interests. Such was done in Montelimar, Nicaragua on 26-30 October 1998, to bring together the VII International Integrated Pest Management Congress, the VII Caribbean Latinamerican Whitefly and Geminivirus Workshop and the XXXVIII Annual Meeting of the Caribbean Division of the American Phytopathology Society (APS). The joint event was made possible through the combined efforts of various people and institutions. The interinstitutional organization was fundamental to the development of the three meetings. The relationships between different groups and disciplines permitted a greater coverage of technical areas. Contacts with international and Nicaraguan specialists for organizing the different scientific activities were accomplished through a collaborative network among international and Nicaraguan institutions.

Four magistrate conferences were presented: (1) 'Gender and agriculture: ideological obstacles to a gender focus' by Lic. Irma Ortega and Lic. Victor Flores; (2) 'The current context of IPM' by Dr Keith L. Andrews; (3) 'The evolution of viral diseases in traditional and export crops in Latin America' by Dr Francisco Morales; and (4) 'Participative implementation and IPM: lessons and future directions' by Dr Ann Braun. For the IPM Congress there were five special conferences, one forum ('Politics, strategy and incentives for international organisms to implement IPM'), one symposium ('World initiatives in IPM') and two panel discussions ('Biological control in vegetables, and 'Gender in agriculture'), plus 144 short presentations and 45 posters. For the Whitefly Workshop, three special conferences were presented, plus three panel discussions ('Regional efforts on whitefly control', 'Impact of whitefly on agriculture in the region' and 'Review of whitefly research in the past decade') and 28 posters. During the APS meeting, four special conferences were given, along with one symposium ('Diseases caused by phytoplasmas and spiroplasmas'), 21 short presentations and six posters. All field trips, except a visit to the biological control facilities at the Universidad Nacional Agraria in Managua, were cancelled due to adverse weather conditions caused by Hurricane Mitch.

A copy of the event proceedings may be obtained from Ing. Gregorio Varela, Escuela de Sanidad Vegetal, Universidad Nacional Agraria, Managua, Nicaragua
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The VIII International IPM Congress will be held in Panamá in 2000. The XXXIX APS-CD meeting will be held in Puerto Rico in June 1999 and the XL meeting will be in Guatemala in 2000.

By: Ronald D. Cave and Gregorio Varela

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## Barn Owls Set the Tone

The Symposium on Biological Control in the Tropics was held at Serdang, Malaysia on 18-19 March 1999, organized by the Malaysian Agricultural Research and Development Institute (MARDI) and CABI International's South-East Asia Regional Centre (CABI-SEARC), and heralded the establishment of Malaysia's new National Council for Biological Control, an innovative partnership of universities, government research institutes and industry to promote and lead biological control initiatives in the country. Participants came from many South-East Asian countries, as well as Australia, New Zealand, the UK and Canada. The emphasis was on new developments in biological control, and this permitted some very exciting sessions on such distinctly Asian biological control successes as the manipulation of ants in fruit and nut crops, the use of barn owls and other vertebrates for rat control, and the biological control of golden apple snail with fish and botanicals.

Nest boxes full of live barn owls were one of the Symposium's more enduring and unusual images of biological control, and underlined the unique blend of thinking at this meeting between successful use of local, 'traditional' natural enemies like owls, ants, fish and ducks and the latest advances in microbial and biotechnological methods for biological control. Biological control of plant diseases, both of field and plantation crops, emerged in particular as a very active and promising area of research in Malaysia and the region. A number of keynote papers explored some provocative subjects like biotechnology in biological control, the failure of the agrochemical industry to deliver new biological control products, and the role of farmers in biological control research.

The proceedings of the meetings have been published* and can be obtained from:
The Regional Representative,
South-East Asia Regional Centre,
CAB International, P. O. Box 210,
43409 UPM, Serdang, Malaysia.
Price: RM 75.00 (Malaysian Ringgit) including postage and handling charges.
Enquiries:
Email: SEARC@cabi.org
Fax: +(603)-9436400/9426490

*Loke, W.H.; Sastroutomo, S.S.; Caunter, I.G.; Jambari, A.; Lum, K.Y.; Vijaysegaran, S.; Yong, H.S. (eds) (1999) Proceedings of the Symposium on Biological Control in the Tropics, Serdang, Malaysia, 18-19 March 1999. SEARC-CAB International.

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# New Books

## New Edition of 'Julien'

The new, fourth edition of this Catalogue* has now been published, co-edited by Mic Julien and M. W. Griffiths. By providing a periodically updated and comprehensive reference source to the use of biotic agents in weed control, the Catalogue has become the essential reference for anyone working in weed biocontrol.

When the first edition was published in 1982, it was not envisaged to be merely a compilation of records. It was seen as a resource base for weed biocontrol scientists, to help in making sound choices among prospective agents and, importantly, to stimulate much-needed basic research to provide biological control of weeds with a sound theoretical and practical basis. In the years since, the concern of ecologists for native flora has increased and has become an issue with conservation groups in a number of countries. This has had the desirable effect of drawing the attention of biological control practitioners to their responsibilities to the community as a whole. Biological control needs to justify support not only by its track record but also by its ability to predict probable benefits as well as any level of risk. We still need to know more about the impact of different agents on weed populations and non-target populations under different conditions. This catalogue remains the best resource base and starting point for much of the research required, and for scientists who need to explain more and more what they are doing and, indeed, to justify this approach, when necessary, by reference to its success and its inherent safety.

Researchers in the field continue to be extremely generous with their time in providing the information that is presented in the Catalogue (although some have been omitted from the credits!), and this probably attests more than anything else to its usefulness.

*Julien, M.H.; Griffiths, M.W. (*eds*) (1998) Biological control of weeds: a world catalogue of agents and their target weeds, 4th edition. Wallingford, UK; CAB Publishing, 240 pp. ISBN 0 85199 234 X. Pbk. Price: UK£27.50/US$50.00

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## Biocontrol Bibliographies

### Biological Control of Tobacco Pests in India[1]

Tobacco is one of the most important commercial crops to be cultivated in India over the past century. The economic viability of tobacco in the Indian scenario is well documented and it earns Rs 825 crores [1 crore = 10 million, or 100 lakhs] foreign exchange annually and more than Rs 500 crores excise revenue. The employment potential in the rural and tribal sector is enormous, with nearly 32 million people working on this crop. It is grown in almost all states of India. There are some ten major pests that inflict economic losses in tobacco. Biocontrol agents have been in use against tobacco pests in India since the beginning of this century and results of research have been published in various Indian and foreign journals, in workshop/ symposium proceedings, books and bulletins. It was, therefore, felt imperative to consolidate the entire body of work done in this field in India in order to make better use of it. Hence, an annotated bibliography on biological control of tobacco pests in India has been compiled, which contains 154 references for materials published from 1938-98, with annotations on the use and potential of biological control of tobacco pests. This bibliography should be useful to all those interested in the pest and natural enemy fauna of tobacco in India as it covers all aspects of biological control of tobacco pests, including bio-ecology and population dynamics of pests and natural enemies, improved methods of mass-breeding of host insects and natural enemies, genetic improvement and pilot plant production of natural enemies, biochemical potentiation of microbes, Biointensive Integrated Pest Management (BIPM) practices using botanical pesticides, mechanical control and trap crops as well as natural enemies, field release rates of natural enemies and insect biotechnology. Subject and author indices are provided.

### Biological Control of Sugarcane Pests in India[2]

An annotated bibliography of biological control of sugarcane pests in India has been compiled. Sugarcane is one of the most important crops in India, covering an area of about 2.92 million hectares with 25 million farmers being engaged in sugarcane cultivation. In addition, the sugarcane industry contributes about Rs 700 crores annually to the central exchequer by way of excise duty. Each year, more than 10% of the yield is lost due to insect pests and diseases. Nearly 225 species of pests are known to infest the sugarcane crop. As biological control has emerged as one of the sustainable methods of pest management, the need was felt to compile the sum total information available on the biological control aspects of sugarcane pests in India. The bibliography consists of 614 abstracts and is based on research papers/reports/book chapters on research work carried out during the period 1919-1998 in India on biological control of sugarcane pests. The abstracts cover aspects of biology, ecology, production, utilization, etc. of natural enemies of sugarcane pests. A subject index and an author index are also provided. This publication would be useful for both research workers and students who need information on various aspects of biological control of pests of sugarcane.

[1]Singh, S.P.; Venkatesan, T. (1998) Annotated bibliography of biological control of tobacco pests in India (1938-1998). Bangalore, India; Project Directorate of Biological Control, Technical Bulletin No. 23, 56 pp.

[2]Singh, S.P.; Ballal, C.R. (1998) Annotated bibliography of biological control of sugarcane pests in India (1919-1998). Bangalore, India; Project Directorate of Biological Control, Technical Bulletin No. 23, 191 pp.

One copy of either bibliography can be obtained (until stocks are exhausted) from:
Project Director,
Project Directorate of Biological Control,
Post Box No. 2491, H. A. Farm Post,
Bellary Road, Bangalore, 560 024, India.

By: Dr S. P. Singh

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## Does It Eat Vegetables?

This illustrated guide* is the result of both field observations and the collection and rearing of thousands of immature and adult arthropod specimens from farmers' vegetable and soyabean fields in South-East Asia. It covers more than 250 species of arthropods, and many of these are new records or were previously identified only to the genus level. Diseases caused by fungi, protozoa, viruses and nematodes are also described. Each entry contains good colour photographs of one or more life stages. For pests, notes on the life cycle are given, damage symptoms and pest status are described, and brief notes on important natural enemies are included. For natural enemies, known crop and host associations are listed and, where available, information on life cycle, ecology and behaviour is given.

The authors note that the guide is not meant to replace field observation, but as a starting point to inspire readers to go out into the field to acquaint themselves with the dynamics that make up the vegetable/soyabean ecosystems. It is emphasized that most of the species inhabiting the fields are not pests. Even those that feed on crops will rarely reach a damaging level, and plant feeders are useful in low numbers as they provide food for beneficial species, which in turn keep potential pests in check.

*Shepard, B.M.; Carner, G.R.; Barrion, A.T.; Ooi, P.A.C.; van den Berg, H. (1999) Insects and their natural enemies associated with vegetables and soybean in Southeast Asia. 108 pp. ISBN 0 9669073 0 2. Pbk. Price for developed countries US$28.50 + $8.50 airmail postage. Contact Merle Shepard for developing country prices. Cheques payable to The Clemson University Foundation.

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