General News

Environment Prize Recognizes Biocontrol's Diversity

Amongst the three recipients of the 2003 Tyler Prize for environmental achievement are two leading lights of the biocontrol world, Hans Herren of ICIPE (International Centre of Insect Physiology and Ecology, Kenya) and Yoel Margalith (Ben-Gurion University of the Negev, Israel). (The third recipient of the Tyler Prize is the pioneering cancer scientist, Sir Richard Doll.) Although both Herren and Margalith are well known and respected for subsequent work, the central achievements for which they are honoured illustrate two different biological control approaches that have led to progress in securing the world's food supply and human health over the last three decades:

- Classical biological control of an exotic pest through the introduction of a natural enemy from their common area of origin
- Inundative biological control using an entomopathogen as a microbial agent, which may be formulated and applied as a biopesticide, against an indigenous or exotic disease vector

During the 1980s, Hans Herren, then at the International Institute of Tropical Agriculture (IITA), led the team that coordinated the implementation of one of the largest and most successful classical biological programmes in the world. The Africa-wide Biological Control Program was responsible within Africa for introducing the South American encyrtid parasitoid, *Anagyrus lopezi* (=*Epidinocarsis/Apoanagyrus lopezi*), to control the cassava mealybug, *Phenacoccus manihoti*, which was devastating cassava production across vast areas of Africa at that time. Uncontrolled, it was feared that the pest, which had been accidentally introduced from cassava's own home range in the New World, would cause catastrophic losses to a crop that has vital significance as a security food crop in Africa. Widespread famine affecting up to 200 million people across tropical and subtropical Africa was feared. At first, headline-catching touches, such as distributing the natural enemies by a low-flying light aircraft, received more publicity than the spread of the biocontrol agent and its impact on the pest and cassava yields. The scientific evidence was clear, however, and public acceptance followed when, within 12 years, the formerly devastating pest was controlled across all of continental Africa. In a rare 'silver bullet' success story, control has been sustained ever since, with this one natural enemy keeping the pest in check. However, the programme was also responsible for introducing the concept of biological control to many countries. The outstanding success of the programme was instrumental in facilitating acceptance of this approach in Africa, and contributed substantially to building the capacity that enabled countries to use biological control against other pests.

In 1976, during a World Health Organization sponsored project in Israel, Yoel Margalith discovered a strain of *Bacillus thuringiensis* in the Negev Desert which was significantly more toxic to mosquitoes than other known bacterial strains at that time. Later identified as *B. thuringiensis* ssp. *israelensis* (*Bti*), it proved to have that useful combination of being both lethal and relatively specific to dipteran immature stages. In particular, it was highly pathogenic to culicids and simuliids. Its potential for controlling the vectors of diseases such as malaria, dengue, yellow fever and river blindness (onchocerciasis) was quickly recognized. Its commercial potential has since been exploited and many *Bti*-based products are now registered. The use of *Bti* transformed mosquito and blackfly control in many countries, with extensive control programmes based on *Bti* implemented in West Africa, the USA and Europe. For example, *Bti* was used against river blindness along the Volta River in eleven African countries. The sight of millions was saved and repopulation of deserted river valleys initiated. What has made *Bti* even more useful is that little resistance has been reported, perhaps owing to synergistic action of the complex of toxic proteins. Use of *Bti* led to malarial infections from mosquitoes resistant to other pesticides dropping by 90% along the Yangtze River, China, which has a population of over 20 million people. Thus *Bti* has had an enormous effect on human health and environmental quality and, with increasing global travel and the emergence and spread of diseases such as West Nile virus to new regions, the existence of this environmentally benign yet effective tool assumes new significance.

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When the Mist Clears, What Will We See?

One of the perceived disadvantages of weed biological control is that because agents are generally chosen that will target a single weed at a time, there is a danger that the plant targeted will simply be replaced by other unwanted exotics. Therefore it is important not only to demonstrate that a weed has been reduced and maintained below a desired threshold, but also to show the end result that is really wanted: that the weed has been replaced by more desirable vegetation. This will be the true measure of whether or not a weed biological control project has been successful.

Mist flower (*Ageratina riparia*, Asteraceae) is an aggressive and fast growing weed originating in Central America. It's a perennial herb or sub-shrub, 0.3-2 m tall which produces masses of small white flowers that develop into highly mobile seeds. The plant is particularly problematic in wet areas (such as riverbanks) in tropical and warm temperate regions including northern Australia, Hawaii and South Africa. In New Zealand it has invaded pastures and native forests in the North Island. Landcare Research has been conducting an active biological control programme against this weed. Following the example of a successful biological control programme against mist flower conducted in Hawaii, two natural enemies of the weed: the white smut fungus *Entyloma ageratinae,* and the gall fly *Procecidochares alani*, were introduced into New Zealand in 1998 and 2001 respectively.

In 1999 Landcare Research established a small, multi-year project, in an area of native forest near Auckland (the Waitakere Ranges), to look at what plants replaced mist flower as its cover (hopefully) declined. Small (4 m^2) permanent monitoring plots were established in the summer of 1999/2000, some with mist flower and others without the weed. In the plots with mist flower, the health of the weed declined between 1999/2000 and 2001/2002, with the percentage of leaves infected by the white smut fungus increasing from 18% to 62%, and the total percentage of dead leaves increasing from 8% to 23%. During these two years the total percentage cover of mist flower decreased from 74% o 16%, a decline of more than 50%. We attribute this decline in cover to defoliation caused by the white smut fungus: the gall fly had

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not yet reached the plots and there appeared to be no other environmental or management changes that could have caused such a dramatic loss of foliage.

When the plots were first examined, in 1999/2000, there were found to be significantly fewer native plant species in the plots with mist flower than in the plots without it. In contrast, there was no significant difference between the number of exotic species (excluding mist flower) in plots with mist flower compared with those without the weed. This appears to confirm the view of land managers that mist flower was having a negative impact on the regeneration of native species while not inhibiting other exotics. At least the presence of mist flower was not correlated with a higher number of other exotic species.

Encouragingly, we didn't find more exotic species arriving in plots with mist flower as the cover of the weed declined. Even better, the change in the number of native species *was* significantly different between the plots with or without mist flower: The number of native plant species present increased in plots with mist flower (as the weed declined in percentage cover over the 2 years). In contrast, there was a small unexplained decrease in the number of native plant species in the plots without mist flower. Overall, it appears that the biological control of mist flower is benefiting native species rather than other weedy exotics.

Further information: Fröhlich, J.; Fowler, S.; Gianotti, A.; Hill, R.; Killgore, E.; Morin, L; Sugiyama, L.; Winks, C. (2000): Biological control of mist flower: transferring a successful programme from Hawai'i to New Zealand. *In*: Spencer, N.R. (*ed*) Proceedings of the X International Symposium on Biological Control of Weeds. Bozeman, Montana, USA, 4-9 July 1999, pp. 51-57.

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Jane Barton works under subcontract for Landcare Research. The project was supported by Auckland Regional Council, with contributions from Northland Regional Council, the Department of Conservation, Environment Waikato and the New Zealand Government. Auckland University students (Jonathan Boow, Krystian Ragiel and Kate Edenborough) carried out most of the fieldwork.

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Biocontrol of Invasive Insect Threatening Galápagos Islands

In January 2002, biological control was used for the first time in the Galápagos Islands with the release of the Vedalia beetle *Rodolia cardinalis* to control the invasive cottony cushion scale, *Icerya purchasi*. In the presence of town officials and with the collaboration of college students, beetles were released simultaneously on the inhabited islands of Santa Cruz, San Cristòbal, Isabela, and Floreana. The release programme was a joint effort between the Galápagos National Park Service (GNPS) and the Charles Darwin Foundation (CDF) and followed a 6-month intensive educational campaign to inform the public of the threats of invasive species and of the rigorous studies carried out to evaluate the safety of introducing this biological control agent. Since then, beetles have been released in priority areas on the islands of Marchena, Fernandina, Pinta, Pinzòn and Rabìda where endangered species of plant are seriously affected by *I. purchasi*. Since releases began, just over 1500 adult beetles have been released.

This is the culmination of a 6-year research programme by the Department of Terrestrial Invertebrates of the Charles Darwin Research Station (CDRS) to evaluate the risks associated with using biological control to mitigate the impacts of *I. purchasi*. In 1996, serious outbreaks of *I. purchasi* on several islands alerted the GNPS and CDF to the threats of this pest to plant species of conservation value. Chemical control was quickly ruled out as a possibility for reducing pest numbers and biological control was considered the only viable solution. Legislation for the release of exotic natural enemies in the Galápagos is only now being developed, and at this time responsibility for importation decisions lay with the GNPS. Consequently, a technical advisory committee was formed with ten members of the CDF and GNPS to evaluate the possibility of employing biological control for the first time on the Galápagos Islands. The committee concluded that given the immediate threat of the cottony cushion scale to rare or endangered species an evaluation of the risks associated with the introduction of *R. cardinalis* should be carried out at the same time as studies to confirm that the impacts of *I. purchasi* merited the introduction of this biological control agent.

A risk assessment methodology was drawn up based on the guidelines of the FAO's Code of Conduct for the Import and Release of Exotic Biological Control Agents. This was expanded on and procedures were developed to address three key questions:

- Does *I. purchasi* weaken plant growth and contribute to the mortality of native flora and fauna in the Galápagos?
- Are there any natural enemies of *I. purchasi* already present in the Galápagos that could be used to suppress this insect?
- Will *R. cardinalis* have any detrimental effects on nontarget organisms or the environment in general?

Field surveys and experimental studies demonstrated that high infestations of the cottony cushion scale were influencing the survival of native plant communities including threatened species or their habitats. However, the paucity of baseline data on these endangered plant species, and the effects of other stress factors such as lack of water and nutrients, made it difficult to isolate the effects of *I. purchasi* in the field. Since it was introduced in 1982, the cottony cushion scale has colonized 15 islands in the archipelago where it attacks 31 endemic species and 31 native plant species, 16 of which are threatened according to the IUCN (World Conservation Union) criteria. Mortality has been recorded on nine endemic and 10 native species so far, including populations of threatened species such as the Critically Endangered daisy tree *Scalesia atractyloides* and the white mangrove, habitat of the Critically Endangered mangrove finch. One species has been reclassified as threatened explicitly as a result of damage caused by *I. purchasi*. Furthermore, local extinctions of specialist endemic arthropod fauna dependent on threatened plant species have been observed.

No monophagous natural enemies of *I. purchasi* were found in the Galápagos, eliminating the possibility of using augmentative biological control. The cottony cushion scale has been successfully controlled in 60 countries by *R. cardinalis*, but virtually nothing was known about the feeding range of this biological control agent and whether it has had any impact on native fauna. Consequently, tests were deemed necessary to evaluate whether *R. cardinalis* would use Galápagos invertebrates as alternate prey. Beetles were donated by CSIRO Entomology (Brisbane, Australia) and no-choice tests carried out in a newly constructed insect containment facility at the Charles Darwin Research Station [See also *BNI* **20(3)**, 71N (September 1999), Host specificity testing of *Rodolia cardinalis*... one hundred years late?]. Immature stages of *R. cardinalis* were unable to complete development or feed on a wide range of prey species. Similarly, adult *R. cardinalis* were unable to use a small range of Homoptera as temporary sources of food. *Rodolia cardinalis* was only able to feed on *Margarodes similis*, the closest relative to the cottony cushion scale, but this species is subterranean and would not be at risk from predation.

At the request of the advisory committee additional research was carried out to confirm experimentally that the beetle would not impact insectivorous vertebrates such as the finches and other small birds. This was because *R. cardinalis* adults reflex bleed heavily from their joints producing a haemolymph that might contain a toxic alkaloid. Experimental trials were carried out on two species of Galápagos finch, but neither species showed adverse reactions after being fed *R. cardinalis*.

A risk analysis was presented to a technical advisory committee in 2001 and it was concluded that sufficient evidence existed to demonstrate the costs and benefits of liberating *R. cardinalis* into the Archipelago. A post-release monitoring programme involving the participation of the local community has been initiated to determine whether the beetles have established and are reducing cottony cushion scale numbers on threatened plant species. Additionally, information is being gathered on the feeding behaviour of the beetle. This information is particularly important as it will determine whether the beetle is having any negative impact on the Galápagos biota, which in turn will allow us to evaluate whether the risk assessment was accurate in its predictions.

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Tropical Soda Apple Biocontrol Bears First Fruit

Tropical soda apple (TSA), *Solanum viarum*, also known as 'the plant from hell', is a perennial prickly bush (family: Solanaceae) native to Brazil, northeast Argentina and Paraguay. It has been spreading rapidly in the USA since it was discovered in Glades County, Florida in 1988. TSA has become a serious weed of pasture and natural habitats, displacing other vegetation and forming impenetrable thickets. In 1992 approximately 150,000 acres (60,700 ha) of pasture-land was estimated to be infested and economic losses to Florida cattle ranchers at this time were put at US$11 million (or 1% of total state beef sales). Ten years on, the infested area has increased to more than one million acres (some 404,700 ha) of improved pastures, citrus groves, sugarcane fields, ditches, vegetable crops, sod (turf grass) farms, forest lands (including oak- and cypress-dominated tree islands in pasture, which provide shade for cattle), and natural areas. Carrying-capacity falls in TSA-infested pasture both because the plant's foliage is unpalatable to cattle and because dense TSA stands prevent cattle access to shade. TSA also causes as-yet unquantified losses to vegetable growers (a sector worth some $1.7 billion annually in Florida) because six plant viruses are transmitted by insect vectors from TSA to important solanaceous crops.

Although probably first introduced to Florida by unwitting human vectors (likely pathways are on footwear or through escape from cultivation), the rapid spread of TSA in the southeastern USA is attributed to its tremendous reproductive potential and ease of spread. It produces high numbers of viable seeds and can regenerate vegetatively from an extensive root system. Spread is aided by cattle and wildlife which ingest the seeds. The weed can also be spread in TSA-contaminated hay, sod, seed, soil, compost, machinery and running water.

TSA has been reported in nine other states (Alabama, Georgia, Mississippi, Louisiana, Texas, North Carolina, South Carolina, Tennessee and Pennsylvania). The weed has the potential to expand its range even further in the USA, based on temperature and photoperiod threshold experiments conducted in controlled environmental chambers. TSA was placed on the Florida Noxious Weed List in 1994 and the Federal Noxious Weed List in 1995, and it is listed as one of the most invasive species in Florida by the Florida Exotic Pest Plant Council.

The Tropical Soda Apple Task Force was formed to develop appropriate control strategies for this unwanted biological pollutant. The Task Force, composed of research, regulatory and industry expertise, developed recommendations for research, education/awareness and regulatory programmes. It has been active in assisting with the development of Best Management Practices (BMPs), locating funding for research, and ongoing industry/public awareness of the importance of taking appropriate action to control TSA. Regulatory measures have gone in the direction of TSA management using established BMPs, voluntary compliance and contract specifications requiring regulated articles to be free from TSA (e.g. sod has to be certified TSA-free). The eradication of TSA from Florida is not feasible owing to the general infestation of the state and lack of tools and resources. However, the management of TSA is achievable with the application of biological controls as the best long-term strategy to reduce the impact to an acceptable level.

Until now, three types of control have been used to limit the spread of TSA: chemical, mechanical, and regulatory. Herbicides and mowing only provide temporary weed suppression and, in addition to being expensive, they are not always practical in inaccessible areas. Moreover, herbicides can have negative environmental effects, which include leaving undesirable chemical residues in the ecosystem and in commodities, and adversely affecting non-target organisms. Several southern states are trying to prevent the spread of TSA by means of regulatory control, regulating the movement of cattle, hay, sod, manure, seed and soil from infested areas to areas free of infestation. For example, cattle are held in an area free from TSA fruit for a 5- to 7-day period to allow for the seed to pass through the rumen.

A biological control project on this invasive non-native weed was initiated in January 1997 by University of Florida researchers in collaboration with Brazilian and Argentinian researchers. The Florida Department of Agriculture & Consumer Services – Division of Plant Industry and the USDA-APHIS-PPQ (US Department of Agriculture – Animal and Plant Health Inspection Service – Plant Protection and Quarantine) have been providing funding for the project.

From exploratory surveys conducted in South America, several insects were identified as potential biological control agents of TSA. Two chrysomelid leaf beetles, *Gratiana boliviana* and *Metriona elatior* were initially selected for screening because of the extensive plant defoliation attributed to these beetles in their native range. Three other promising candidates currently undergoing host range determination in Florida-quarantine are two more chrysomelid leaf beetles, *Platyphora* sp. and *G. graiminea*, and a curculionid flower bud weevil *Anthonomus tenebrosus*.

Gratiana boliviana was approved for field release in the USA by TAG (Technical Advisory Group for Biological Control Agents of Weeds) in April 2002. APHIS review and analysis of the potential environmental impacts associated with releasing *G. boliviana* into the environment are documented in detail in an Environmental Assessment (EA) (February 2003). A high level of specificity and significant defoliation of TSA were demonstrated in host-specificity tests conducted at the Florida Biological Control Laboratory quarantine in Gainesville, the USDA-ARS (Agricultural Research Service) quarantine in Stoneville, Mississippi and the USDA-ARS South American Biological Control Laboratory in Hurlingham, Argentina, and in extensive field surveys and open-field tests conducted in South America. Field releases of *G. boliviana* in the USA are planned for May 2003.

A virus indigenous to Florida is also showing promise as a biocontrol agent. The tobacco mild green mosaic tobamovirus (commonly called the tobacco mild green mosaic virus, TMGMV) is a common virus that produces a mild mosaic disease in tobacco (*Nicotiana tabacum*). In TSA, however, it has a deadly impact. Young plants are killed most rapidly but even mature plants succumb. Typically plants die within 14-21 days of being inoculated with the virus. In field trials 83-97% control (complete kill) was achieved for plants of different sizes and ages.

The ease with which the virus multiplies in tobacco provides an excellent basis for mass-producing it. In addition, application of the virus is simple: leaf extract prepared from infected plants is applied to a few leaves of the target plant either by hand or with a simple mechanical implement. However, further development as a biocontrol agent means tackling host specificity issues. Literature records indicate that the virus infects at least 15 species in four families. It has been recorded causing severe symptoms in only a few species, but these include several *Capsicum* pepper varieties. This would preclude the use of the virus in these crops, and further screening is assessing whether any other cultivated plants are susceptible. However, it is possible to use the virus in TSA-infested fields without risk of wide dispersal. The fact that TMGMV is not an insect-transmitted virus, and therefore is unlikely to have uncontrolled secondary spread from infected plants, is an important safety feature.

Development of the virus as a bioherbicide involves registration by the US Environmental Protection Agency (EPA), a process which may take about 2 years. However, with the chrysomelid beetle about to be released and this promising bioherbicide in development, the University of Florida biocontrol programme is making significant progress against this noxious weed.

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Bug for Bellyache Bush Biocontrol

A seed-sucking bug from South America is set to become the latest Neotropical biocontrol agent to be released against invasive rangeland shrubs in Australia. Bellyache bush (*Jatropha gossypiifolia*) is a noxious weed across a large proportion of northern Australia. It is naturalized in tropical Queensland, Northern Territory and Western Australia, and its potential distribution includes enormous tracts of these states. Native to the New World tropics and a member of the Euphorbiaceae, it has been introduced to other regions as an ornamental or medicinal plant and has been declared a weed in a number of countries. In Australia bellyache bush invades rangeland, particularly in riparian areas, forming dense thickets which eliminate other more useful species. In addition, all parts of the plant are highly toxic. Although in low doses it is reputed to have medicinal value, in Australia it has been cited as the cause of death of over 300 grazing animals in one shire in one year alone.

In 1997, the Northern Territory Government began funding a CSIRO (Australia's Commonwealth Scientific and Industrial Research Organisation) Entomology project aimed at the weed's biological control, and further funding from the Queensland Department of Natural Resources was made available from 1998. Surveys for natural enemies conducted in eight countries in tropical America and the Caribbean (Mexico, Honduras, Guatemala, Venezuela, Dominican Republic, Puerto Rico, Trinidad and Curacao) led to 60 species of phytophagous insects and one rust fungus being identified from the plant, and promising (i.e. damaging) candidates were selected for further study. Host specificity testing at CSIRO's Long Pocket Laboratory's quarantine facility on more than 70 species of Euphorbiaceae ruled out some of the potential agents, but a species of seed-feeding scutellerid bug, *Agonosoma trilineatum*, proved to be highly specific. These tests, which looked at the potential for development of nymphs, and adult oviposition preferences, mating and feeding on different plant species, indicated that only species of *Jatropha* could act as a host for *A. trilineatum* (four other species of this genus occur in Australia, all originally introduced as ornamentals), but only *J. gossypiifolia* was accepted for oviposition (with one minor exception). In addition, adult *A. trilineatum* mated and fed only on the host plant. An application for release of *A. trilineatum* was submitted in June 2002, and permission to release has now been granted. Insects are being mass reared, and first releases are planned for both Queensland and the Northern Territory in May 2003.

Immature and adult *A. trilineatum* feed only on seeds, and in laboratory studies adults proved capable of completely destroying them. In the field, where seeds are more abundant, the impact is as yet unknown but it is hoped that insect populations will reach high levels, and that under these conditions seeds will be killed or at least damaged and their weight and viability reduced. Bellyache bush is spread by seed, so a reduction in seed production should reduce the rate of spread and the rate of recruitment in established infestations. In addition, as the seeds are the most toxic part of this plant, poisoning of livestock may be reduced. However, a single agent species is not expected to provide complete control, and research on other potential agents is continuing. Successful establishment of a diet-based rearing method for a new *Lagocheirus* species of cerambycid stem weevil means that testing of that species can begin in the Queensland quarantine facility. In addition, the stem boring weevil *Cylindrocopturus jatrophae* has also been imported for screening in quarantine. Two further species, a stem-mining tineid moth, *Xylesthia* sp., and an unidentified brentid beetle have been earmarked as potential agents. Elsewhere, the rust fungus has been identified as *Phakopsora jatrophicola* by CABI *Bioscience* (UK Centre). A preliminary study showed that this rust has some potential as a biocontrol agent.

In order to be able to measure the impact of this and future agents, Northern Territory and Queensland government field scientists are collecting baseline ecological parameters for comparison with data after the agents are established.

To improve future agent selection, a postdoctoral researcher funded by the Cooperative Research Centre for Australian Weed Management, S. Raghu, is taking an interesting approach. He is evaluating the ability of the weed to respond to different types of simulated herbivory. Agents utilizing the parts of the plant most susceptible to stress, resulting in a negative impact to the plant, will be the focus of subsequent investigations into their suitability and safety for biocontrol.

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Australia Saddled with another Invasive Weed

Camels brought to Australia during a 1930's gold rush are blamed for the introduction of a drought-resistant tree, which is thriving in the current drought and spreading through large areas of northern Australia's rangelands.

Calotrope, *Calotropis procera*, is a small tree rising to 3-5 m in height. It originates in arid regions of Asia and Africa and is believed to have been brought to Australia in camel saddles, in which the kapok-like seed comose (tuft of hair) was used as padding. The camels and saddlery were brought from India to Chillagoe in north-east Queensland during a gold rush in the 1930s. When the saddles broke down, seeds, which had been inadvertently included, were released.

The plant has large oval leaves. They are a dull, greenish grey and are coated with a waxy bloom. There are relatively few leaves per branch and these are restricted to the ends of the branches. The branches are brown when young. The stems become corky with age, taking on an ash grey colour. Calotrope plants grow rapidly, reaching more than a metre in the first season and reaching full height in 3-4 years. At maturity the tree has 3-5 stems, which have few branches. The trunk is 40-130 mm in basal diameter when mature.

Towards the end of the second growing season, bunches of attractive white flowers with purple tips appear at the ends of each branch. Thereafter flower production is almost continuous. Fruiting pods are mango like in appearance. They are thin-skinned and mostly full of air. The seeds are produced along a central structure. They are initially white, maturing to dark brown. Once mature, the pod splits, releasing about 300 seeds. The comose or tuft of hair, at one end of the seed, aids in wind and water dispersal.

Calotrope is a member of the Asclepiadaceae, the milkweed family. They are so-named because, when injured, a milky latex is produced. This protects the plant and heals the wound. The latex of calotrope is very bitter to taste and is toxic, causing deaths of livestock in some countries. Anecdotal reports in Australia suggest that livestock stressed by drought may die from eating the plant.

Within Australia there is some confusion regarding the spread and distribution of the plant owing to the use of several different names. These include rubber bush, rubber tree, kapok tree, king's crown, cabbage tree and giant milkweed. The common name changes from one district to the next. To add to the confusion, some of these names are used for completely different weeds in different regions. Additionally there is a second species, *C. gigantea*, which has white flowers and is larger than *C. procera* but is otherwise similar in appearance. Within Australia, *C. procera* is able to produce abundant viable seeds while *C. gigantea* produces flowers but no viable seeds develop. Its reproduction in Australia is limited to vegetative propagation and hence relies on human intervention. It is thus not considered a weed.

The Asclepiadaceae have very complex pollination mechanisms and self pollination is often genetically prevented. It is possible that *C. gigantea* was introduced as a living plant or cutting and that there is insufficient genetic difference between individual plants to allow successful cross-pollination. Alternatively, complex relationships with pollinating insects may provide the explanation. The genus *Calotropis* is largely pollinated by specific members of the carpenter bee subfamily, Xylocopinae. Although present in Australia, they are not well represented, and it may be that species capable of pollinating *C. gigantea* are absent.

Calotrope prevails in the hot tropics and is spreading rapidly in northern Australia. It survives the driest seasons, establishing on land from which vegetation has been removed by mining, flooding, drought, overgrazing or construction work. It matures quickly into a perennial small tree and once established is difficult to displace. This is due to its ability to colonize exposed areas, put down a deep tap root and reach reproductive maturity rapidly.

The drought now gripping large areas of Australia greatly favours the spread of calotrope. The deep tap root allows the plant to survive and flourish in dry periods. Once established, the mature plant flowers nearly year round and so there are seeds available whenever germination rain falls. This allows the plant to colonize denuded areas. It out-competes useful native pasture plants, rapidly covering areas which would otherwise support grazing. Where thickets occur, mustering cattle becomes difficult and access to watering points reduced.

Calotrope is on the increase in many parts of northern Queensland, as well as the Northern Territory, South Australia and Western Australia. There are no recent audits, but it seems the weed infests tens of thousands of hectares. If it continues to spread unabated, millions of hectares are potentially threatened. There are anecdotal accounts of infestations increasing in area by 250% over a 5-year period. If not controlled, vast areas of Australia will become covered in this weed.

While biological control frequently supplies the best long-term solution, interim measures are needed urgently. Scientists at the Department of Natural Resources and Mines (NR&M) Tropical Weed Research Center, Charters Towers, are conducting trials near Georgetown in northern Queensland to assess the effectiveness of several herbicides using varying rates and different application methods. In conjunction with the Australian Agricultural Company, they are planning aerial application trials in the Gregory River area later in the year.

Herbicides will play only one role in the containment and ultimate control of this weed. Pasture management practices in the form of effective control of grazing pressure and mechanical control will also be essential tools to reduce the risk of further calotrope spread. Evidence from the Northern Territory suggests that a reduced stocking rate and a well maintained competitive pasture is able to reduce the spread and invasiveness of calotrope and in some situations out-compete established calotrope.

NR&M Weed Scientist Peter Wilkinson has recently found a disease on calotrope and, in conjunction with Department of Primary Industries, identified it as a fungal pathogen, with the proposed name, *Phaeoramularia calotropidis*, which has not previously been reported in Australia. The effectiveness of this disease is not known at present. If the disease does not harm native or useful plants, it may be useful as a mycoherbicide. However, development of reliable biocontrol methods takes time and more conventional control measures should be employed until then.

In the mean time landowners should avoid overgrazing and should mechanically uproot the plant or apply registered herbicides for the control of their calotrope problem.

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Revisiting History with Water Hyacinth

Biocontrol of water hyacinth (*Eichhornia crassipes*) has a long history. It was first attempted in 1971 with the release of the mite *Orthogalumna terebrantis* in Zambia, and other agents were released there and in Zimbabwe shortly after. In the next three decades, biocontrol introductions of up to six arthropod agents were made in 34 countries around the world. There is therefore a lot of experience to draw on, but as knowledge has increased, earlier work can also be reconsidered with the benefit of hindsight and advancing technology. Two recent initiatives have done just that. The first is a new look at a previously discarded prospective biocontrol agent, and the second a retrospective look at the water hyacinth infestations on Lake Victoria.

Old Agent Reassessed for New Region

The grasshopper *Cornops aquaticum* was discovered in some of the earliest surveys for water hyacinth natural enemies in South America. In 1974 it was described as one of the most damaging insects associated with the plant in its region of origin. However, it was rejected as a biocontrol agent for the USA, when subsequent investigations indicated that under laboratory starvation trials it could feed and complete development on species other than water hyacinth. More recently, as the suite of agents released in South Africa has still left gaps in control, researchers have been looking at this promising insect again.

Over the last 5 years, researchers at the Plant Protection Research Institute, South Africa have been testing the some 150 South African species in the water hyacinth family Pontederiaceae and related families. These no-choice trials with immature and adult *Cornops* are considered the most cautious of host specificity tests.

The results of the tests indicated that under laboratory conditions *Cornops* could complete development on five other species besides water hyacinth. Two of these, *Pontederia cordata* (pickerel weed) and *Canna indica* (canna), are introduced and potentially invasive in South Africa and thus of no conservation concern. (A taste for pickerel weed, however, precludes *Cornops*' use in the USA because the plant is indigenous there.)

Amongst the indigenous African Pontederiaceae, some specimens of *Cornops* were able to complete development on *Heteranthera callifolia* and plants were quite heavily attacked, but adult females were unable to oviposit on the thin petioles so the grasshopper is not expected to put this species at risk outside the laboratory. Likewise, *Cornops* is not expected to threaten two other African Pontederiaceae that experienced some damage in the laboratory. One incidence of oviposition only was recorded on *Monochoria africana* but complete development was never recorded. Equally, although some individuals completed development on *Eichhornia natans*, neither feeding nor oviposition was recorded, and, as it is a submerged plant, lack of emergent leaf material and submerged petioles are expected to preclude establishment by *Cornops* on this species in the wild.

A series of adult choice trials are being finalized. Once these results have been analysed a release report will be submitted to the National Department of Agriculture and the Department of Environmental Affairs and Tourism for comment. However, it could still be a year before this very damaging agent for water hyacinth sees the outside of a quarantine laboratory.

Remote Sensing for Historical Perspective

Just how much water hyacinth there was on Lake Victoria at the height of the infestations in the late 1990s and what happened to it has been hotly debated in various fora (including this journal). This is not merely a matter of historical interest, for questions of whether water hyacinth populations are on the rebound still surface regularly, and stakeholders are therefore justifiably concerned about the sustainability of the control exerted by the introduced *Neochetina* weevils. Part of the trouble has been a lack of reliable lake-wide year-on-year data on the water hyacinth infestations.

A report* available on the US Geological Survey EROS Data Center (EDC) website fills some of the gaps:

http://edcintl.cr.usgs.gov/lakespecialfeature.html

The report is a result of a study by EDC and Clean Lakes, Inc. funded by a USAID/Uganda, Greater Horn of Africa Initiative (GHAI) cooperative agreement with Clean Lakes, Inc. Scientists from EDC processed and analysed remotely sensed imagery in order to develop a geo-referenced database to quantify the distribution and extent of water hyacinth in Tanzanian, Ugandan and Kenyan Lake Victoria, and in some lakes in the Rwandan-Tanzanian Kagera River basin over a 5-year period from the early stages of the infestation. The study also analyses this information in relation to potentially influential factors such as weather, water level fluctuations and control measures. In particular, it looks at the relationship between dates of weevil introductions (which varied around the lake), *El Niño* events, and water hyacinth decline. An article based on the report appeared in *Water Hyacinth News* No. 6, see:

www.impecca.net/

The study found that:

- Water hyacinth infestations increased rapidly from 1997 and reached a maximum in 1998 with infestations particularly severe in the northern part of the lake.
- A sharp decline in water hyacinth occurred in 1999.
- A low level of water hyacinth has been maintained, although there was a small lake-wide increase in 2001.

The report notes that *Neochetina* weevils were first released in Uganda in late 1995, in Kenya in January 1997, and in Tanzania in August 1997. It points out that the noticeable reductions around the lake that began sometime after early 1999 coincided with rapidly increasing *Neochetina* weevil populations, but also followed the *El Niño* rains of late 1997/early 1998. It describes how records show that the lake rose by 1.8 m, and argues that severe weather created high wind and wave action that may have been crucial to the break up of plants already waterlogged and damaged through weevil activity.

The low post-weevil level of water hyacinth is just what would be expected in a classical biological control success, but the report points out some anomalies in dates of releases and observed reductions in water hyacinth infestations. It concludes that changes in water hyacinth infestations in Ugandan and Kenyan waters were consistent with weevil action (although the role of weather in hastening the disintegration of the mats should not be discounted). However, it points out that water hyacinth decline along the southern shores in Tanzania followed too rapidly after weevil introduction to be attributed to them, and other factors, particularly the weather at this time, are likely to have been critical.

The report also deals with Lake Mihindi in the Kagera River system in Rwanda, which was more than half-covered with water hyacinth by early 1997. Weevils were not released here until September 2000. Dramatic reductions in this infestation, coincident with declines observed in Lake Victoria, are suggested to have been the result of flood waters associated with heavy rainfall breaching an outlet; the water hyacinth may simply have been washed away. However, unlike Lake Victoria, by September 2000 the water hyacinth infestations had returned. While it may not be entirely valid to make direct comparisons between water bodies of such differing sizes, Lake Victoria had weevils and continuing reduced water hyacinth populations (including along its southern shore where weather was also concluded to be the likely cause of the initial decline) whereas Lake Mihindi had no weevils (at this time) and a resurgence of the weed occurred.

The report contains clear explanations of remote sensing tools and methods, and invaluable discussions on their use as a monitoring tool. It provides fascinating insights into the development of water hyacinth infestations on Lake Victoria, and in doing so raises new questions that will doubtless fuel renewed debate. Importantly, it includes recent data showing that low levels of water hyacinth suitable for growth remain in most parts of the lake, and concludes that continued active and aggressive management will reduce the likelihood of a major resurgence. Whilst the weevils are still very much in evidence, additional measures may be necessary to contain populations in the long term and a sustainable management plan is needed. This study contributes substantially to the baseline knowledge needed to develop a strategy by providing data on the development of the water hyacinth infestation in different parts of the lake.

*Albright, T.; Moorhouse, T.; McNabb, T. (2002) The abundance and distribution of water hyacinth in lake Victoria and the Kagera River basin, 1989-2001. Sioux Falls, SD/Martinez, CA, USA; USGS/EROS Data Center/Clean Lakes, Inc., 42 pp.

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Biocontrol Agent Out-Competes Wine Disease

In recent years, New Zealand's wine has gained a fine reputation and some 1% of the world market. As in many other wine-growing regions, however, disease is a constant threat. 'Bunch rot' or 'grey mould' of grapes, caused by the fungus *Botrytis cinerea*, is arguably the most important disease problem confronting the New Zealand wine industry and is a significant problem for the wine industry worldwide. It has been estimated to seasonally cost the New Zealand wine and grape growing industry up to NZ$18 million in lost grape sales and in addition up to $12 million annually in disease control costs.

Botrytis bunch rot (the correct term for the disease) can occur at any time during the growing season although it's most destructive when warm temperatures follow rainfall either at flowering or later in the growing season. The fungus can develop on dead and dying flower parts, young shoots and newly emerged leaves and as a moist rot on berries in the bunch. Often following rainfall, the fungus is visible as a grey felt-like mat of spores on the infected tissues. The disease spreads easily from berry to berry in the bunch later in the season and from these infected berries masses of airborne spores are produced which are liberated into the vineyard to infect other berries. While limited/managed infection still allows for high quality 'botrytised' wine production, in most cases the fungus continues to rot grapes on the vine reducing yield and causing winemaking problems. In addition, mechanical harvesting means that even low numbers of infected bunches can not be separated during harvesting operations, thereby contaminating the entire crop. Not only does Botrytis bunch rot affect grape-growing but serious damage is also incurred worldwide on berry fruit, kiwifruit, and tomato crops.

Conventional control of *B. cinerea* is based on repeated sprays of chemical 'botryicides', but efficacy may be limited by the development of resistant *Botrytis* strains and regulatory restrictions on the timing and number of applications. In addition, there is growing consumer pressure to reduce the number of chemical pesticides used in the vineyard. These impediments opened the way for researching a biological approach to control the disease. HortResearch, with support from the Winegrowers of New Zealand (now 'New Zealand Wine-Growers') and Technology New Zealand looked for a suitable antagonist: an organism that could out-compete and suppress botrytis without having any detrimental effects on the vine itself. The scientists isolated a naturally occurring saprophytic fungus from dead leaf litter which proved to be an aggressive and successful competitor of *B. cinerea*. HortResearch then applied for a patent relating to the use of this saprophytic fungus as a biological control agent.

In April 2001, Botry-Zen Ltd was set up to commercialize the registered product BOTRY-Zen, marketing it as an alternative *Botrytis* control product for grape growers who wanted to be able to describe their crops as 'sustainably grown'. In addition, Bio-Gro New Zealand (which approves products for use by organic growers) has accredited BOTRY-Zen for use in organic wine production. Botry-Zen Ltd has now gained full product Registration in New Zealand and has recently initiated field trialling in the European Union (EU) and in California (USA). The existing New Zealand factory is being expanded considerably and offshore manufacturing licensing is being closely evaluated so that the product will be available in commercial quantities once Registration is achieved. It is envisaged that final Registration in the EU and the USA will be concluded early in 2005.

The BOTRY-Zen product contains a live preparation of the spores of the non-invasive, non-pathogenic saprophytic fungus isolated by HortResearch. It acts as a true antagonist, aggressively occupying the same physical space and out-competing *Botrytis* for the nutrients in dead and senescent material in the vines, especially flower tissues such as stamens, flowers caps and aborted fruitlets. A significant added bonus is that this mechanism of action makes it unlikely that resistance to the product will develop.

Trials in New Zealand vineyards since 1997 have demonstrated that BOTRY-Zen, applied twice over the flowering period and twice over bunch closure, provides protection against *Botrytis* infection at comparable levels to, or better than, standard fungicide programmes.

BOTRY-Zen does not control other grape diseases such as powdery or downy mildew but research commissioned by Botry-Zen Ltd has shown that some commonly used fungicides are compatible with BOTRY-Zen, with some being able to be tank mixed. This is an exciting new development with both botrytis and powdery mildew almost completely controlled this last season with tank mixes. Research is continuing at HortResearch to assess compatibility with other fungicides used for these diseases.

The discovery and underpinning research was undertaken and funded by HortResearch. Subsequent developmental research was jointly funded by HortResearch and by the Wine Institute of New Zealand Incorporated and the New Zealand Grape Growers Council whose commercial arms, Winegrowers of New Zealand Ltd and New Zealand Grape Growers Ltd formed a joint venture called Winegrape Tech. Winegrape Tech has the right to commercially exploit the HortResearch patent rights and other intellectual property rights associated with the saprophytic fungus organisms themselves and has granted to Botry-Zen Ltd an exclusive licence of those rights in all countries that are parties to the Patent Co-operation Treaty. The research was also funded by the Foundation for Research Science and Technology and through a Technology Business Growth grant.

Source: Botry-Zen Ltd website:

www.botryzen.co.nz/INDEX.HTML

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Brazil Quarantine Laboratory Celebrates 12 Years

The Brazilian National Quarantine Laboratory 'Costa Lima' Embrapa Environment has for the last 12 years fostered international exchange and undertaken quarantine of beneficial organisms for biological control. It is the only institution in Brazil authorized, since 1991, by the Ministry of Agriculture and Supply (MA) to introduce natural enemies for pest control and other beneficial organisms for scientific research. It is also one of the mandates of the laboratory to interact with foreign institutions for export of biocontrol agents.

The main services provided by the Quarantine Laboratory are:

- To prepare documents needed by interested professionals to request permits for importation (which are issued by the Ministry of Agriculture).
- To assist interested professionals in locating suitable sources of biocontrol agents for introduction.
- To collect and evaluate information concerning import and export of natural enemies.
- To provide information to the Ministry of Agriculture concerning safety of proposed introductions, in consonance with a supporting Technical Committee of Brazilian researchers expert in biocontrol.
- To provide quarantine services.
- To monitor releases and evaluate efficacy.
- To collaborate with international research institutions in the exploration and exchange of native natural enemies under a previous cooperative agreement.

During the 12 years of activities, the laboratory has processed 181 introductions of biocontrol agents and other microorganisms involving 17 species of insect parasitoids, two of predators, nine of mites, seven of nematodes and 146 of different microorganisms. Also several international biological control projects have received cooperation from the quarantine laboratory, including USDA-ARS (US Department of Agriculture – Agricultural Research Service), University of Florida (USA), IITA (International Institute of Tropical Agriculture), IRD (Institut de Recherche pour le Développement, France), CIAT (Centro Internacional de Agricultura Tropical) and Amsterdam University (the Netherlands) amongst others.

Other activities carried out by the laboratory are:

- To manage the International Information System on Biological Control via the Internet: www.bdt.org.br/bdt/biocontrol together with a discussion list: biocontrol-l@bdt.org.br
- To maintain a database about biological control agents in Brazil.
- To alert the public about bringing organisms into Brazil that are not officially approved, providing pamphlets, information brochures, meetings, videos and lectures.

The Brazilian Quarantine facility intends to be an overseas laboratory for foreign research institutions around the world in order to promote biological control programmes, and biocontrol workers are welcome to contact us to discuss possible initiatives.

By: J. Tambasco; F. Lucchini; L. A. N. de Sá; E. A. B. De Nardo and M. A. B. Morandi

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Indian Bio-Control Research Laboratories Progress

Bio-Control Research Laboratories (BCRL), established at Bangalore in 1981, is the R&D division of Pest Control (India) Private Ltd (PCI). BCRL is engaged in research, production and field trials with biological control agents and pheromones. Since February 2001, when it moved into a newly constructed laboratory complex, staff have been busy with, amongst other activities, scaling up and increasing the range of biocontrol products. The new facilities include a laboratory complex for production and quality testing of biological control agents, walk-in incubators and cold storage rooms, along with glasshouses and experimental fields. The construction of the state-of-the-art laboratory complex was a major landmark in the history of biological control of crop pests in the country. BCRL, which is a Department of Scientific and Industrial Research (Government of India) recognised laboratory, was also the recipient of its National Award for Excellence in R&D Efforts in Industry in the Agro Industry Category for the year 1993.

BCRL has made several innovations and standardized mass production techniques for a variety of natural enemies and their hosts. These include:

- Development of a breeding-cum-shipment container for the predatory mite *Amblyseius tetranychivorus*
- Design and development of a unique, easy-to-use insect water trap for mass trapping of sugarcane borers and pests of other field crops, in association with sex pheromone lures
- Establishment of a mass production facility for continuous year-round laboratory production of *Helicoverpa armigera* and *Spodoptera litura*
- Doubling productivity of eggs of the alternate laboratory host *Corcyra cephalonica*
- Increasing temperature tolerance and searching capacity of *Trichogramma* spp.
- Devising blister packing for shipment of *Cryptolaemus montrouzieri* grubs to avoid cannibalism during transportation
- Development of technology for mass production and formulation of entomopathogenic fungi

In addition, under an innovative industry-institution partnership project with Tamil Nadu Agricultural University, Coimbatore it has successfully developed methods for improving commercial scale production, formulation and field efficacy of nuclear polyhedrosis viral (NPV) pesticides under the National Agricultural Technology Project, Indian Council for Agricultural Research (ICAR).

The efforts made by BCRL have played a crucial role in popularizing and transferring biocontrol technology from research laboratories to farmers' fields in India. An exclusive Field Extension and Education Unit was established in 2002 to create awareness about biological control technology at the grass root level. Qualified supervisory staff and trained field assistants are being recruited and posted in different parts of the country for carrying out field demonstrations to validate the performance of biocontrol products in farmers' fields. The service network of 85 establishments of the parent company is increasingly being used to provide biocontrol inputs directly to the farmers all over India.

BCRL has been an active participant in the All India Coordinated Research Project on Biological Control since its inception. In 2003 it signed a Memorandum of Understanding with the University of Agricultural Sciences, Bangalore for collaborative teaching, research and extension. In addition, it has been operating collaborative projects with international research organizations such as Natural Resources Institute, UK.

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Guidance for Inundative Biocontrol

The European Union-funded ERBIC (Evaluating Environmental Risks of Biological Control Introductions into Europe) project has published a paper proposing methodology for assessing the risk of biocontrol introductions*. However, *BioControl*'s editor-in-chief and project team member Heikki Hokkanen notes in the Editorial to the issue, the topic is a controversial one, so the paper should be viewed as opening scientific discussion on how to demonstrate the safety or otherwise of candidate biocontrol agents.

In the last issue of *BNI*, a news article on proposals for the revision of the Code of Conduct for the Import and Release of Exotic Biological Control Agents (ISPM No. 3) reminded us that ISPM No. 3 does not set out in detail how to assess whether a proposed introduction is safe. No risk analysis process is explained, although the requirement for collection of information in dossiers implied that risk analysis would be the basis of decisions. The article highlighted the need for detailed guidance, and thus the ERBIC-authored paper is very timely.

The paper points out that although biocontrol has a good track record in terms of safety, the current popularity of commercial inundative biocontrol may result in problems as an increasing number of activities are undertaken without appropriate training or understanding of risk. It is this area of biocontrol that the ERBIC project has focused on (although some of the principles and approaches will apply to classical biocontrol). The authors recognize that the challenge is to achieve a balance in developing protocols and guidelines to prevent serious mistakes occurring in importing and releasing harmful exotic species while still allowing safe biocontrol to proceed. They identify the most critical ecological issues as being able to estimate (a) the probabilities of attack on non-target organisms and (b) the dispersal and establishment capacities of the biocontrol agent. The methodology described in this paper integrates information on the potential for an agent to establish in a non-target habitat, its potential dispersal distance, its host range (number of species), and its potential direct and indirect effects on non-target organisms.

One of the most difficult parameters to assess is the potential for adverse effects on non-target organisms (and the ecosystems in which they function), especially for generalist natural enemies that impact on many species. Host range forms a central element of the described risk evaluation process, because a lack of host specificity could lead to unacceptable risk if such an agent were to establish and disperse widely whereas, in contrast, a strictly monophagous agent would not be expected to pose serious risk however well established or widely dispersed it became. Although few natural enemies are truly monophagous, many have a restricted host/prey range. For classical biocontrol, the narrower the host range, in general, the better. However, the biocontrol industry sometimes favours the more polyphagous natural enemies precisely because they will control a range of taxonomically unrelated pests. This tendency is particularly likely to give rise to non-target effects.

In an illustrative case history exercise, the proposed methodology is applied to a number of natural enemy species currently mass reared and released for biocontrol of pests in glasshouse and open-field conditions in Europe, drawing on published information and expert opinion. Agents are assigned a numerical value (1-5) for the likelihood and magnitude of each criterion considered, and these values are used to calculate a risk index for each agent**. The results obtained in this exercise confirmed a number of expectations in relation to previous experience. The authors also identified both under- and over-estimates of risk by this method (and under-estimates particularly where there is limited knowledge of the release area ecosystem). In addition, attention is drawn to variations between risk index values for the same species in different release areas. Based on their collective experience the authors give index ranges for three risk categories: low (usually meaning no objection to release), intermediate (where further specified information would be requested before a decision was made) and high (indicating that release would normally be advised against).

The potential for the use of such an index is clear. For example, agents used against a single pest could be ranked in terms of risk for a given release area. In addition, while the current study does not allow conclusions about risks for specific groups of natural enemies to be drawn, analysis of more cases might allow such generalizations to be made. The authors caution, however, against narrow interpretation of the index, noting that different criteria may be more or less important in different circumstances, and that high risk values are not by definition negative. They conclude that while meaningful ranking of natural enemies in risk categories now seems possible, such an index should be used by biological control experts as an element in a wider assessment of the safety of a potential biocontrol agent.

The authors recognize the biocontrol industry's fear that the common trend towards more stringent regulatory requirements by countries will lead to lengthy procedures and thus high costs, which in turn could threatens the sector's financial viability. However, they argue that the risk assessment procedure they propose is a first step towards light and harmonized registration that will not be prohibitive for the industry.

*Van Lenteren, J.C.; Babendreier, D.; Bigler, F.; Burgio, G.; Hokkanen, H.M.T.; Kuske, S.; Loomans, A.J.M.; Menzler-Hokkanene, I.; Van Rijn, P.C.J.; Thomas, M.B.; Tommasini, M.G.; Zeng, Q.Q. (2003) Environmental risk assessment of exotic natural enemies used in inundative biological control. *BioControl* **48**, 3-38.

**See the ERBIC website for further information:

http://honeybee.helsinki.fi/MMSBL/MAEL/Hankkeet/ERBIC/index.htm

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UK Non-Natives Review

The UK Government has recently published its non-native species policy review. A series of working groups were set up to consider current arrangements for dealing with the introduction, establishment and spread of non-native species, and assess the main pathways through which non-native species are introduced and spread. The report makes recommendations to improve measures to limit the ecological and economic impact of invasive non-native species in Great Britain. In general the review follows the recommendations of the Convention on Biological Diversity (CBD) guiding principles on invasive alien species and the three-stage hierarchical approach.

As readers will be aware classical biological control is considered novel in the UK as well as in Europe so it is an important fact that the review recommends that: "strategic funding should be made available to support the development of novel control techniques for invasive non-native species". Furthermore, in the draft of their first Science and Innovation Strategy, the Department for Environment, Food and Rural Affairs (DEFRA) have followed up the review team's recommendation and committed to launching a new research programme on alien and invasive species including further work on biological control of Japanese knotweed (*Fallopia japonica*) which was one of the case study species in the original review.

This represents an important endorsement of biological control by the UK government and should lead to more use in the UK of what has become the mainstay of sustainable control for arthropod and plant pests in many countries around the world.

Review of Non-native Species Policy:

www.defra.gov.uk/wildlife-countryside/resprog/findings/non-native/index.htm

Science & Innovation Strategy: Delivering the Evidence:

www.defra.gov.uk/Science/S_IS/

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IPM Systems

This section covers integrated pest management (IPM) including biological control, and techniques that are compatible with the use of biological control or minimize negative impact on natural enemies.

Creating Semiochemical Diversions to Control Sugarcane Borers

Sugarcane has been cultivated for well over a century in KwaZulu-Natal and more recently in the Mpumalanga low-veld in South Africa. Currently, areas under sugarcane exceed 400,000 hectares, which feed a total of 16 sugar mills. It is grown commercially, creating revenue (about 2 million tonnes of sugar is produced annually) as well as employment opportunities (about 1 million people are dependent on the sugar industry) for the country. Around 66% of sugarcane produced is grown commercially by 2000 large-scale commercial growers, with the balance produced by 45,000 small- and medium-scale growers.

The pyralid moth, *Eldana saccharina*, originates from indigenous wetland and large-grass habitats in Africa, and is now the primary insect pest in sugarcane in South Africa. The females lay well-hidden eggs, so that they are protected from predators and parasitoids. The larvae bore into sugarcane stalks where they feed and ultimately pupate. Here too, they are well protected, not just from natural enemies, but also from the influence of insecticides. The larvae are the damaging life-stages, and as they bore into the sugarcane stem, they not only cause feeding damage, but also create entry points for fungal and bacterial infection into the sugarcane stalk, thereby further decreasing the sugar yield from the crop.

Specimens of *E. saccharina* have been collected in Africa since the early 20th century. Walker in 1865 first described it from sugarcane in Sierra Leone, West Africa. In West Africa it is a well-known pest of maize, sorghum and millet, but only a minor pest in sugarcane. In 1954 it was observed as a pest of sugarcane in East Africa. The first signs of *E. saccharina* in sugarcane in South Africa appeared in 1939-1940 near Umfolozi, KwaZulu-Natal, but the infestations dissipated about 5 years later. During 1970 a severe outbreak occurred near Hluhluwe, KwaZulu-Natal and *E. saccharina* regained its pest status. Since 1970 it has become widespread in the KwaZulu-Natal, Mpumalanga and Swaziland sugarcane belt. It is now the most damaging insect pest in sugarcane, causing on average 1% loss in sucrose for every 1% of internodes bored. The most recent estimates made in 1995 suggest that *E. saccharina* causes a revenue loss of R60 million [~US$7.7 million] per annum.

Various control methods are under investigation, but all have some limitations. One of the biggest constraints of insecticidal control is the cryptic nature of *E. saccharina*. The least cryptic life-stages are the adult moths or neonate larvae that have just hatched. These have been targeted in this approach, as they are exposed and vulnerable while mating and seeking feeding sites respectively. *E. saccharina* is multivoltine and occurs all year round, which would require continual applications of insecticides and/or more persistent insecticides, both of which are not always ideal because of cost and potentially negative environmental effects.

Cultural control of *E. saccharina* has proved successful to some extent. Measures include avoiding 'stand-over' cane (cane allowed to grow longer than the recommended 12-14 months in coastal conditions), whenever possible. In addition, cane is cut at or below ground level so as to prevent larvae in the stumps infesting ratoon crops; after cutting, all residue stalk material is removed, and exposed cane stumps are covered with soil to kill eggs and young larvae. Plant resistance research has produced varieties of sugarcane that are more resistant than others to *E. saccharina* infestation under South African conditions, but there are currently no varieties that are completely resistant to this pest.

The biocontrol programme at SASEX (South African Sugar Experiment Station) has investigated two sources of parasitoids to test against *E. saccharina.* One source is indigenous parasitoids of this insect in its natural habitats within South Africa and other African countries, ('translocation of natural enemies'). The other is parasitoids from related borers of graminaceous crops from other continents at the same latitudes as the southern African sugarcane belt ('new associations').

The ultimate aim is to find a parasitoid, from either source, which will accept and establish on *E. saccharina* in southern African sugarcane. Problems, however, have included climatic incompatibility of parasitoids introduced to South Africa, and the cryptic nature of *E. saccharina* in sugarcane, which places it out of reach of a large proportion of parasitoids collected from indigenous habitats. In addition, *E. saccharina*'s ability to encapsulate parasitoid eggs and larvae, and the apparent inability of introduced parasitoids to remain in and search the sugarcane habitat for any length of time for the large number of hosts present in the crop are further compounding establishment attempts with parasitoids. Another constraint has been the recent discovery of the potential existence of biotypes of *E. saccharina*, the west and central African populations forming one group, and the east and southern African populations forming another. Parasitoids from one population may not perform as well on the other population.

The indigenous host plants of *E. saccharina* are large-stemmed grasses and wetland sedges in the genus *Cyperus*. It is believed that the host shift to sugarcane and other introduced crops occurred because these crop plants were planted into the wetland areas. The sedge habitats, in comparison to sugarcane, have high levels of parasitism of *E. saccharina*, and it is assumed that these parasitoids have not yet associated sugarcane with harbouring their insect hosts, and therefore do not readily forage in sugarcane. This has led Dr Des Conlong, from the Entomology Department at SASEX to initiate investigation into the potential of Stimulo-Deterrent Diversion (SDD) systems to control *E. saccharina* in sugarcane. This intercropping system has shown great success in Kenya by controlling *Chilo partellus* in maize (Dr Z. R. Khan, International Centre for Insect Physiology and Ecology, Kenya) and may have application in sugarcane.

SDD systems rely on trap plants that attract ovipositing females of pest insects away from the crop, and deterrent plant species that repel pests from the crop. By taking this system to the next trophic level, one can include plants that attract parasitoids of the pest into the crop areas. Parasitoids are believed to respond to chemical cues produced by the habitats of their insect hosts as long-range kairomones, before responding to short-range cues emanating directly from their hosts. This two-tiered effect can be exploited in an SDD system.

Our study has thus far focussed on potential trap plants for *E. saccharina*, investigating various grasses in comparison to sugarcane, tested in cage and field trials. Oviposition behaviour of female moths was investigated in cage trials by comparing egg batches and egg numbers laid on non-crop plants in comparison to sugarcane in two way choice tests. Initially, five grasses were tested and although eggs were laid on all of them, three species (*Panicum maximum*, *Bothriochloa insculpta* and *Hyparrhenia dregeana*) had an average of less than two egg batches and 20 eggs laid on them, in comparison to averages greater than three and 100 respectively in associated sugarcane plants. These three grass species are therefore not attractive to egg-laying females. Two grasses, wild sorghum (*Sorghum bicolor*) and Napier grass (*Pennisetum purpureum*), received about 50% oviposition in comparison to sugarcane, and may make more adequate trap plants. This study reveals that ovipositing females show some level of host plant selection. Non-crop plants had either around 50% of total egg load in the cage or negligible numbers, which suggests that females may have a yes/no response in selecting hosts for oviposition, and for this reason repulsion may be more important than attraction in controlling *E. saccharina*.

In the field trial, where the same five grass species and sugarcane were planted in a quasi-complete Latin-square, *E. saccharina* larvae were recovered predominantly in sugarcane and wild sorghum, and only very rarely in *P. purpureum*. This indicates that female host plant selection is not related to offspring feeding sites. Survival of larvae fed on *P. purpureum* has been shown to be very low, which may explain the negligible numbers found on *P. purpureum* in the field. However, dead larvae were not collected, and borings were seldom noted in *P. purpureum*, which may indicate that the plant kills larvae at very early, pre-boring, stages or larvae disperse from *P. purpureum*. This finding initiated research into host selection in neonate larvae. Research is currently underway and is focussed on sugarcane and two sedges (*Cyperus dives* and *C. papyrus*), which are known indigenous hosts of *E. saccharina*, and the two grasses mentioned above.

Cage trials showed that *E. saccharina* females oviposited almost exclusively on dead leaf material (>99%) in all plants tested. However, when neonate larvae were offered a choice of dead or green leaf material in bioassay trials, they almost exclusively selected green plant material of all host plants tested. This reinforces the hypothesis that oviposition sites are not related to feeding sites. This finding is of importance, as the general belief was that young larvae fed in decaying material behind older leaf sheaths and/or in the soil before boring into the stalk at a later stage. In addition, neonate larvae in choice trials are showing a preference for the leaf material of their indigenous host plants (*C. papyrus* and *C. dives*) rather than sugarcane. What needs to be determined is the type of response of the larvae, whether it is to tactile or volatile chemicals. There is much conflicting data on dispersal capabilities of neonates, which still needs to be clarified so that testing can commence on larval preferences in cage trials. This research is promising with regards to trapping the insect pest, and shows the importance of not neglecting other mobile life-stages when considering an SDD to control insect pests.

Parasitoid response and activity to stalk borers in sugarcane and the five grass species mentioned above was also investigated. In the quasi-complete Latin Square field trial, natural parasitism of stalk borers was monitored. Parasitoid activity was greatest in wild sorghum, which was to be expected, as this grass is a natural host of *E. saccharina* and *Chilo partellus*. What is interesting is that parasitoids did not limit their foraging to wild sorghum, but parasitism was frequently observed in borer species collected from plant plots neighbouring wild sorghum. This is promising, especially as natural parasitism was observed in sugarcane plots neighbouring wild sorghum on two sides. Natural parasitism in neighbouring control sugarcane monocrops has been negligible. Sugarcane in the study site also had comparatively lower percentage internodes damaged in comparison to neighbouring control sugarcane, an effect that can be partly explained by parasitoid activity and partly by the variable habitat of alternate hosts for *E. saccharina*.

Laboratory studies, using two-way olfactometer and two-choice cage trials, were restricted to the ichneumonid wasp *Xanthopimpla stemmator*, a new association parasitoid from *Chilo sacchariphagus* in sugarcane in Mauritius, and the tachinid fly *Sturmiopsis parasitica*, a translocated *E. saccharina* parasitoid collected from maize in Benin, West Africa. Various *Melinis* species (Graminae) and silver-leaf desmodium, *Desmodium uncinatum* (Leguminosae) appear to be attractive to both parasitoids. *Bothriocloa insculpta*, a grass on which *E. saccharina* oviposition was lowest and which may be repellent to the moth, was attractive to *S. parasitica*. The effects of these grasses in the field still need to be evaluated. However, thus far indigenous parasitoids are attracted to certain indigenous hosts, and exotic parasitoids have shown responses to various grasses, which may aid in enticing parasitoids into our sugarcane environment.

The SDD system certainly has potential to control *E. saccharina* in southern African sugarcane. *Eldana saccharina* moths appear to show some selectivity of host plants for oviposition, and they are highly selective with regards to actual oviposition sites on those plants, choosing dead and senescing material and very cryptic sites. This study showed that some plants might have deterrent effects on female moths, although this still needs further research. Olfactometer trials showed female moths responded least to molasses grass (*Melinis minutiflora* – South African seed source), and this plant is currently being tested under field conditions as a potential repellent to the pest. Repellent plants need to be effective at the orientation stage of host searching by moths, not at a landing stage, because the aim is to repel the moths away from the general vicinity of the crop.

Plants that do repel moths almost certainly do so through the release of volatile chemicals, and this opens opportunities for synthesizing the active chemical components and utilizing these in the field. Perhaps a moth and parasitoid attractant may be discovered from indigenous host plants that could be synthesized and used, for example in baited traps for the pest. Once candidate push-and-pull plants have been identified, they need to be tested together under field conditions. Implementation of such a system in big commercial farms will also need some consideration. Possibilities of utilizing some of the plants in green manuring, or ensuring that non-crop plants utilized have other uses and values (preventing soil erosion, nitrogen fixing, cultural uses such as thatch grass, alternate crops, etc.), may aid in its application on farms. Integrated approaches and multiple benefits, such as these, will make the concept more appealing to farmers, and will hopefully together cause increases in sucrose yield, through reduced pest incidence and longer cropping cycle, and gain greater return per hectare from the land.

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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.

TEAMwork against Leafy Spurge – Part 2

"Got a bug for that?"

A few short years ago that question, and the questioner, a frustrated area rancher, would have caught the noxious weed researcher by complete surprise, but today, thanks to the spectacular accomplishments of millions of *Aphthona* spp. flea beetles, the inquiry has become increasingly routine.

The weed-eating beetles have been distributed in the USA through a unique, biologically based research and demonstration programme aimed at curbing the problematic Eurasian perennial leafy spurge (*Euphorbia esula* complex) [see also *BNI* **22(1)**, 1N-2N (March 2001), TEAMwork against leafy spurge]. TEAM Leafy Spurge (TLS) is credited with much of the expanded interest shown by ranchers and public and private land managers in biological control as the cornerstone of a successful weed management programme.

TLS was first formed in 1997 when the US Department of Agriculture's Agricultural Research Service joined forces with its sister agency the USDA Animal and Plant Health Inspection Service in the first area-wide, integrated pest management programme targeting a noxious weed.

This biologically based IPM programme focuses on researching and demonstrating effective, affordable and ecologically sustainable leafy spurge management techniques. The 6-year, cooperative programme stresses teamwork, resulting in a network of partnerships between the two USDA agencies, land grant universities and numerous other local, state and federal entities. Fields of study have included, in part, classical biological control, multi-species grazing and judicious herbicide use. In addition, TEAM Leafy Spurge also stresses information and education, two components vital to ensuring the continued application of successful biocontrol and other IPM strategies developed under the programme.

Its efforts have been well-rewarded. Not only has the programme successfully demonstrated dramatic reductions in spurge densities across wide areas, but its education efforts have garnered it the top Technology Transfer Award for 2002 from the USDA's scientific research arm, the Agricultural Research Service, for Outstanding Effort. In a ceremony at ARS national headquarters in February 2003 TEAM members were recognized for their efforts in "spreading the word" about ways to combat leafy spurge, and more importantly for equipping its customers with the tools needed to do the job.

In particular, recognition was given to TLS efforts in the widespread distribution of more than 48 million leafy spurge flea beetles to ranchers and land managers throughout much of the Western USA, enough flea beetles to establish 16,000 new release sites. Many of the insects were distributed during the programme's numerous field and demonstration days, all of which included 'hands on' instruction in flea beetle collection and redistribution with additional information provided on how to use them successfully and combine them effectively with other IPM techniques.

In addition to providing the living tools needed to effectively and affordably manage leafy spurge, TLS was also honoured for its education efforts, as well as development of more than 20 informational products including brochures, reports, CD-ROMs, news articles, a 30-minute documentary aired regionally on US Public Television stations and a series of 'how-to' IPM manuals that have proven wildly successful with their intended audience. The first, a 24-page, full colour offering entitled 'Biological control of leafy spurge', has been the most sought after, with more than 40,000 manuals distributed in 27 American states and four Canadian provinces. But it's not the only popular outreach product. More than 10,000 'how-to' manuals on multi-species grazing have also been distributed, along with several thousand copies of the newest offering 'Herbicide control of leafy spurge'.

The 30-minute documentary entitled 'Purging spurge: corralling an ecological bandit', developed by TLS in cooperation with Prairie Public Broadcasting in Fargo, North Dakota, aired regionally in June of last year and is now being offered nationwide in the USA. It was also nominated for several broadcast awards. TLS efforts have also been featured in other broadcast programming including a BBC documentary entitled 'Aliens from Planet Earth: Earth report', and Public Broadcasting's 'Living on Earth' series in the USA.

But the true measure of success for TLS has been the customer uptake of its researcher-developed IPM technologies. One testimonial, from South Dakota rancher Larry Nelson, illustrates the point: "The ranchers are feeling better about the options that they now have against leafy spurge. TEAM Leafy Spurge has been a big plus for area producers. As of 3-4 years ago we knew nothing about biocontrol… TEAM Leafy Spurge has done a remarkable job of getting the word out. People in this area are now seeing the benefits of an IPM approach."

That acceptance of IPM strategies outlined by TLS is borne out in a new report issued by North Dakota State University researchers Nancy Hodur, Larry Leistritz and Dean Bangsund. The report was designed to measure how successful the TLS programme has been in reaching its target audience and in influencing their weed control plans. Key findings in the report, which included surveys of individual ranchers, and public and private land managers, include the following:

- Noxious weeds were increasingly seen as an important problem by both ranchers and land managers.
- Both groups reported extensive and growing use of biocontrol and the IPM approach, as a complement to previously lone, herbicide treatment programmes.
- TLS appeared to successfully influence landowners' weed control plans, particularly with regard to biological control. Eighty per cent of private land managers, approximately 60% of public land managers, and 42% of ranchers indicated TLS had influenced their plans to use biocontrol, in part because many of the constraints to its use cited in earlier studies had moderated. Those constraints were identified as not having access to sufficient insects and lack of knowledge in how to use them. In the latest survey the number of land managers who viewed these two issues as significant had dropped from 30-40% in 1998 and 1999 to under 8% in 2002.
- TLS also appeared to reach a substantial percentage of its target audience, with one-third of ranchers and 70% of private and public land managers attending at least one TLS event or demonstration site, and indicating that they were pleased with the information received.
- And finally, 92% of local decision makers, 71% of public land managers and 70% of ranchers supported extending funding for the programme, and a large majority of respondents believe the TEAM Leafy Spurge model would be applicable to other problem weeds.

Now, as the TEAM Leafy Spurge programme winds down, many participants are finding that their adoption of tools developed under TLS has led to dramatic reductions in spurge infestations in the field. In fact, researchers believe that if the same integrated management plans are carried out over even larger areas, leafy spurge could ultimately be reduced to an incidental weed in North America. A summary of some TLS findings to date follows.

Biocontrol

Flea beetle establishment improved dramatically at all demonstration sites over the course of the project, with 100% establishment at 101 release sites in the state of North Dakota. Across all four states in the programme, black flea beetle (*A. lacertosa*) populations increased their numbers exponentially (as much as 8-fold) in the first 3 years following release. Resulting canopy levels declined from averages of about 40% to 5% or less and reductions in infested acreage ranged from a norm of about 50% over a 3-year period to 80% in North Dakota through 2002. In addition, TLS researchers demonstrated that insects combined with multi-species grazing by sheep produced the best control over the shortest time, while biological control combined with fall herbicides provided the most economical and long-term control of leafy spurge. Together, the findings clearly demonstrate the advantages to be gained from adoption of biological control combined with other IPM measures.

Multi-Species Grazing

Combining sheep with *A. lacertosa* led to the control of between 90% and 99% of the 453 acres [~185 ha] infested with leafy spurge studied under the programme. Those reductions were achieved without negative impacts to cow or sheep average daily gains, clearly demonstrating the economic and environmental advantages of combining these two biologically based IPM strategies.

Herbicides

Improved herbicides, applied at smaller rates, are gaining greater acceptance, cutting the amount of chemical released into the environment. Fall herbicide use was also demonstrated to improve biological control in areas where insects were only marginally successful, particularly in high density areas. Once leafy spurge densities were reduced, *Aphthona* flea beetles maintained control as determined in observations of several research sites over the past 7 years. It was also determined that the impact of grasshopper control on leafy spurge biological control can be minimized if treatments are applied when the grasshoppers average above the third instar development stage.

For additional information about TEAM Leafy Spurge or any of the informational products mentioned, please see the TLS website at:

www.team.ars.usda.gov

Or email: teamls@sidney.ars.usda.gov

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ICIPE Technology Transfer Unit Celebrates First Birthday

The ICIPE (International Centre of Insect Physiology and Ecology) Technology Transfer Unit (TTU) celebrated its first birthday on 1 February 2003. The Unit was established in February 2002 with seed funding from the BioVision Foundation, a Swiss not-for-profit institution founded and supported by a cash award from Dr Hans R. Herren, 1995 World Food Prize laureate and the Director General of ICIPE.

Started in the year 2001 as an NGO, the BioVision-funded programme initially operated from ICIPE's Mbita Point Research and Training Centre (ICIPE-Mbita) on the shores of Lake Victoria to serve the community in the Suba District of Kenya. However, based on the fact that Dr Herren's vision was to use the World Food Prize money to enhance environmentally and socially acceptable technologies across Africa, in February 2002 he spearheaded the formation of a TTU at ICIPE with a regional mandate to facilitate appropriate participatory technology development and transfer. Some of the prize money is still being used as seed funds to support the activities of the TTU, which is currently operating in eastern Africa (Kenya, Tanzania, Uganda and Ethiopia).

The programme at ICIPE-Mbita has been operational for the past year with emphasis on promoting community-based activities in bee keeping, tsetse trapping, push-pull management of stemborers (lepidopteran) and *Striga* weed, and indigenous vegetable farming through farmers' groups and associations. The technologies are being promoted in close collaboration with Kenya government departments and local and international NGOs operating in Suba District. The programme's close associates in the district include the Agriculture and Environment Programme of the Diocese of Homa Bay, CARE Kenya, Kenya Institute of Organic Farming, the Ministry of Agriculture and Rural Development and the Kenya Agricultural Research Institute (KARI).

The activities of the TTU are not solely confined to Suba District. ICIPE-TTU is active in other parts of Kenya and neighbouring countries. Initiatives include:

- Mango IPM in Maragua ridge of Central Province
- Coping strategies for the larger grain borer (*Prostephanus truncatus*) in the semi-arid areas of Mwingi District, Eastern Province
- IPM in French beans for Kenyan small-scale growers
- IPM for brassica crops in East Africa (Kenya, Tanzania and Uganda)
- Community-based tsetse (*Glossina* spp.) control in Ethiopia.

The TTU mandate and emphasis is on training of trainers (ToT) and technical backstopping to ensure effective and sustainable technology transfer from ICIPE to national extension systems. How this works in practice is illustrated by recent activities supporting diamondback moth control (*Plutella xylostella*; DBM) in Kenya and Tanzania.

Building DBM Biocontrol-based IPM Capacity in East Africa

The ICIPE DBM research project is based on the need to import and release the parasitoid *Diadegma semiclausum* in Eastern Africa as a component of an effective IPM strategy for effective control of DBM, a notorious pest of brassica crops in the region [see *BNI* **24(1)**, 3N-4N (March 2003), DBM stretching biocontrol in East Africa]. In October 2001, *D. semiclausum* was introduced from Taiwan into Kenya by the ICIPE-DBM Biocontrol Project. The first field release was made in July 2002 at a pilot site in Taita Hills, and after only two weeks, the first field recoveries were made. Additional releases in western and central Kenya were made in September and October 2002, respectively. Releases were also made in Arusha, Tanzania in November 2002.

Following these field releases, TTU, in close collaboration with the DBM project and the ministries of agriculture in Kenya and Tanzania, organized an intensive hands-on one-week ToT course to capacitate the national programmes in effective biocontrol-based IPM for brassica pests in their respective countries. For each country, a total of 14 ministry extension staff were trained between August 2002 and January 2003. This was done in anticipation that the respective countries would integrate the new technology and information in on-going national extension programmes. In Kenya, Kiambu District, which provides most of the cabbage and kale consumed in Nairobi, has proved to be a role model. The District Crops Officer has integrated the information in the District Crop Development activities and biocontrol-based IPM of brassicas is being promoted in a number of farmer field schools (FFS) in the District. In Tanzania, the GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit, Germany) IPM project in Kilimanjaro and Arusha has also adopted and integrated the new technology in the District Crop Protection Programmes. The ICIPE-DBM project is still providing the parasitoids to the national programmes. However, in realization of the fact that the national programmes will need logistical and technical support to facilitate sustainable transfer of the technology, funding is being requested for scaling up in East Africa (Kenya, Tanzania and Uganda).

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Announcements

Are you producing a newsletter, writing a book, 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.

Good Deal from CABI Commodities

Coffee Futures and Coffee Farmers

Eighteen months ago *BNI* announced the publication of Coffee Futures*, a stimulating and informative sourcebook, which deals with some of the critical issues facing the international coffee industry at the start of the twenty-first century. This book is now available with a free Manual for Collaborative Research with Smallholder Coffee Farmers** for just US$28.

Published to coincide with the 2001 World Coffee Conference in London, Coffee Futures' purpose was to inform and stimulate discussion on contemporary issues affecting the coffee industry. With contributions from 20 international experts from the full spectrum of the industry, each chapter outlines the latest thinking on a range of topics. Technical developments such as mechanical harvesting and GM coffee are assessed. Coffee diseases and health implications for human consumers are outlined, together with measures farmers/producers can take to minimize the contaminants. Of particular interest to *BNI* readers, there is a strong emphasis on the future prospects for coffee smallholders. Economic problems and gaps in knowledge are identified. The roles of a variety of measures from participatory research to telecentres in plugging the gaps are examined. What is meant by 'sustainable' is explained in the context of coffee production, and illustrated by describing some of the methods used for raising healthy coffee and managing pests and diseases. Coffee diseases are seen as a particular threat, and these are dealt with in detail. Some possible ways forward are considered for those who hope to continue making a living from coffee, including speciality, organic and biodiversity friendly production. Finally, the role of smallholder coffee in biodiversity conservation is highlighted.

The Manual for Collaborative Research with Smallholder Coffee Farmers was produced out of a Common Fund for Commodities funded project, which aimed to develop cost-effective and environmentally friendly ways of controlling the world's most serious coffee pest, coffee berry borer (*Hypothenemus hampei*). New methods are of no use if not adopted and the intention of this manual is to explain some of the principles and practices of new 'participatory' ways of working with farmers to those interested in improving the situation of smallholder coffee farmers, especially in the context of the secular, global change the sector is facing.

*Baker, P.S. (*ed*) (2001) Coffee futures: a sourcebook of some critical issues confronting the coffee industry. Cenicafé, Colombia/CAB *International*, UK; The Commodities Press, 111 pp. Pbk. ISBN 958 33 2356 X

**Bentley, J.W., Baker, P.S. (2002) Manual for collaborative research with smallholder coffee farmers. Cenicafé, Colombia/CABI *International*, UK; The Commodities Press, 131 pp. Pbk

Ants as Friends

Tree crops are increasingly being protected by agrochemicals, endangering the environment and human health. This manual* provides practical tips on making optimal use of the beneficial weaver ant (*Oecophylla smaragdina*) in tree crops, based on improved insights of underlying ecological principles. Dr Paul Van Mele, a farmer participatory research and extension specialist at CABI *Bioscience*, and Dr Nguyen Thi Thu Cuc, an entomologist at the Cantho University, Vietnam, have combined the rich sources of scientific and farmers' knowledge into this manual. It will appeal in particular to university students, NGO workers, extension staff and all those engaged in communicating science to farmers.

*Van Mele, P.; Cuc, N.T.T. (2003) Ants as friends. Improving your tree crops with weaver ants. The Commodities Press, 67 pp.

All books available from: Simon Lea, CABI *Bioscience* (UK Centre), Bakeham Lane, Egham, Surrey, TW20 9TY, UK
Email: cabi-commodities@cabi.org
Web: www.cabi-commodities.org/
www.cabi-bioscience.org

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Managing Bushland Weeds

Limited numbers of this Australian book* are available, which will be of particular interest to those in Mediterranean climates doing on-ground weed control in remnant vegetation. Funded by the Natural Heritage Trust (NHT) and the Cooperative Research Centre (CRC) for Weed Management, it is the result of 4 years work on this topic by Environmental Weed Action Network (EWAN) staff, providing information on biological features of weeds and control methods.

*Brown, K.; Brooks, K. (2003) Bushland weeds, a practical guide to their management. Perth, Western Australia; EWAN, 108 pp. Price: A$38.50 + p&p

Orders: Wildflower Society of Western Australia, P.O. Box 64, Nedlands, WA 6909, Australia
Website: http://members.ozemail.com.au/~wildflowers/index2.html

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Slugs and Snails Meeting

The meeting 'Slugs and Snails – Agricultural, Veterinary & Environmental Perspectives' will be held on 8-9 September 2003 at Christ Church University College, Canterbury, UK. It will consider issues of pest control relating to slugs and snails on land and in water. Experience of both farmers and researchers will provide the basis for discussion. More general aspects of conservation and biodiversity will also be relevant, as will newer methodologies of molecular biology.

Slugs and snails can cause enormous amounts of economic, medical and veterinary damage to human societies. Modern reduced-tilling methods of agriculture can promote the development of high populations of slugs in crop fields and even resistant crops such as maize and turnip can suffer 20% reductions. The aquatic golden apple snail has become a serious pest, destroying rice, maize and citrus crops in the Philippines, and in Taiwan US$2 million is spent annually to control snails on 100,000 ha of paddy fields. Aquatic snails spread diseases such as liver and blood flukes in many parts of the world. In China, after the completion of the Three Gorges Dam, 58 million people will be at risk of new infection by snail-borne diseases which have a secondary host in water buffalo.

Sessions will be held on:

- Economic aspects and snail farming
- Physiology and function
- Behaviour and ecology
- Prospects for improved control
- Integrated pest management
- Population regulation/environmental aspects
- Conservation, evolution and biodiversity
- Molluscs, molecules and man

Further information is on the BCPC website:

www.bcpc.org/Events/Slugs&Snails/index.htm

Or contact: Prof Georges Dussart, Symposium Chairman, Ecology Research Group, Canterbury Christ Church University College, North Holmes Road, Canterbury, Kent CT1 1QU, UK
Email: gbd1@cant.ac.uk

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Latin American Fungi and Entomopathogenic Nematodes

A Latin American symposium on fungi and entomopathogenic nematodes is being held on 18-22 August 2003 at the Universidade Estadual do Norte Fluminense, Rio de Janeiro, Brazil.

Speakers will include Robin J. Stuart (University of Florida, USA), Edwin E. Lewis (Virginia Polytechnic Institute and State University, Blacksburg, USA), Nigel Hywel-Jones (BIOTEC, Pathumthani, Thailand), and Carlos Peres da Silva and Richard I. Samuels (Universidade Estadual do Norte Flumenense).

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Entomopathogenic Nematodes and Symbiotic Bacteria

The 3rd International Symposium on Entomopathogenic Nematodes and Symbiotic Bacteria will be held on 4-7 September 2003 at Ohio State University, Wooster, USA. It is being organized by Harry K. Kaya (University of California), Heidi Goodrich-Blair (University of Wisconsin), Steve Forst (University of Wisconsin) and Susan Forst (Marion College).

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Eradication of Island Invasives

The Proceedings of the International Conference on Eradication of Island Invasives is now available for purchase*.

The conference, which was held at the University of Auckland, New Zealand in February 2001, attracted 52 papers and 21 abstracts focusing on methods used and results achieved, and covered a wide spectrum of methods. The term 'eradicating' included work to remove invasive species where complete eradication was some, or many, years away but the methods used were achieving positive results or providing a significant learning experience. The term 'island' included true islands, natural habitat islands, remnant and artificial habitat islands, or new invasions of natural ecosystems where eradication is deemed feasible. Significant learning experiences included methods that had failed.

Turning the tide of biological invasion by eradicating invasive species can yield substantial benefits for biodiversity conservation. As more eradications are attempted worldwide, it is increasingly important that lessons are learned from each and every one of these attempts, whether successful or unsuccessful. By bringing together all the papers and abstracts from the conference in this book, the publishers are making the insights and practical experience gained on combating the threat of invasive alien species available to a wider audience.

*Veitch, C.R; Clout, M.N. (*eds*) (2002) Turning the tide: the eradication of invasive species. Proceedings of the International Conference on Eradication of Island Invasives, University of Auckland, New Zealand, February 2001. Cambridge, UK; IUCN Publications Services, 424 pp. Cost: UK£24.50/US$36.75. ISBN 2 8317 0682 3

See website for book contents and abstracts, postage costs and ordering details:

www.issg.org

Or contact: IUCN Publications Services Unit, 219c Huntingdon Road, Cambridge, CB3 0DL, UK
Email: books@iucn.org
Fax: +44 1223 277175

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African Mycological Association Revival

The African Mycological Association (AMA) promotes mycology through contact amongst members in Africa and abroad, and also in organizing regional congresses. A current aim is to hold the 5th African Mycology Conference (RMC5) in South Africa in 2005 in conjunction with the 43rd Southern African Society for Plant Pathology (SASPP) Congress and the 4th International Workshop on Grapevine Trunk Diseases (jointly organized by the International Council on Grapevine Trunk Diseases).

The AMA has recently launched a website which aims to revitalize the society and to increase the potential for regional and international collaboration by providing a members' directory and highlighting the research activities throughout the region. See:

www.AfricanMycology.org

At the present time, the society is updating membership details to enable them to create the on-line directory, and is calling for members to fill in a questionnaire and provide other relevant information.

Contact: Joanne E. Taylor, Department of Biological Sciences, University of Botswana, Private Bag UB 00704, Gaborone, Botswana
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Water Hyacinth Ups and Downs

With regret, the organizers announce the cancellation of the 3rd meeting of the IOBC (International Organization for Biological Control of Noxious Animals and Plants) Global Working Group for the Biological and Integrated Control of Water Hyacinth, which had been planned for Uganda this August.

On the bright side, there is a new website at:

www.waterhyacinth.org

This has not only information about the Working Group but also pages on water hyacinth biology, its weed impact and management, recent and on-going research, and photos of the weed and its natural enemies, together with downloadable pdf files of the proceedings of previous workshops.

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Conference Reports

Have you held or attended a meeting that you want other biocontrol workers to know about? Send us a report and we will include it in BNI.

Giant Hogweed Biocontrol Workshop 2003

An international workshop on the taxonomy, biology, and potential biocontrol of giant hogweed (*Heracleum mantegazzianum*) was held in Jelgava, Latvia, on 5-6 March 2003. It was attended by more than 50 researchers and practitioners from 13 European countries, of which half were participants in the European Union funded research project 'Giant Alien' [see *BNI* **22(3)**, 54N-56N (September 2001), Europe acts on invasive alien weeds).

The first session of the workshop (Wednesday afternoon) addressed general aspects of invasive species and biological control, as well as the current knowledge of the species' taxonomy and ecology. It quickly became evident that more than one invasive plant taxon is around in the European countries. To the west a species known as *H. mantegazzianum* prevails, whereas in the former Eastern-block countries a species known as *H. sosnowskyi* is dominating. These species seem to very similar in overall growth-form (monocarpic perennial) and habit, but can be distinguished by the shape of the leaves. They may be regarded as subspecies of the same species. It remains to be investigated how similar they are biologically. A third species, probably *H. persicum*, is found in northern Scandinavia, and differs somewhat in habit (shorter) and growth form (polycarpic perennial).

In the second session (Thursday morning) preliminary results of the Giant Alien project were presented. The population biology (including flowering, dormancy, and individual longevity) has been studied by a team from the Academy of Sciences of the Czech Republic. Among the noteworthy results were that less than 4% of the seeds shed in one growing season remained viable in the soil until the next season. Studies of annual growth rings in the roots of giant hogweed had revealed ages up to 8 years, considerably more than previously believed. Preliminary results of studies on potential insect and fungal antagonists were presented by researchers from the University of Berne and CABI *Bioscience* UK Centre, respectively.

The third session (Thursday afternoon) addressed the invasion in Europe of giant hogweed and methods to control it. Prior to the workshop, scientist and practitioners in 17 countries had compiled reports on the current status of the species and its control. See 'Status reports' at:

www.flec.kvl.dk/giant-alien/

Experiments conducted by the Danish Forest and Landscape Research Institute suggested that sheep grazing is the cheapest non-chemical control method known so far.

The Giant Alien project continues for another 2 years. Hopefully, insect and /or fungal antagonists will be found in Europe or in the Caucasus, the native range of the species, potentially controlling this pernicious invasive weed.

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International Congress of Plant Pathology

The 8th International Congress of Plant Pathology (ICPP2003) was held in Christchurch, New Zealand on 2-7 February 2003, and was attended by over 1200 delegates.

The Congress had an overarching theme of 'Solving problems in the real world', with keynote themes of: Plant pathology in the Asia/Pacific region; Towards integrated control of soilborne disease; Host/pathogen interactions and molecular plant pathology; Towards integrated control of airborne disease; and Knowledge transfer for plant pathology. Global Food Security was addressed in a Public Forum evening session, while a wide range of specialist plant pathology topics formed the foci of numerous satellite workshops and evening sessions. Following plenary lectures each morning, delegates were given the choice of four concurrent themed sessions; in total over 150 presentations were made by invited speakers. Two afternoons were set aside during the week for delegates to study and later to discuss the offered posters (over 1200 submissions). A number of cross-cutting topics became evident as the conference progressed.

Quarantine and Biosecurity

Many of the lectures focussed on the importance of quarantine and biosecurity, and the problems associated not only with potential and actual crop losses, but also with financial and political constraints of phytosanitary issues and trade barriers. Prof Mike Wingfield (University of Pretoria, South Africa) also made this his topic for the McAlpine Memorial Address on the increasing threat of disease to exotic plantation forests in the Southern Hemisphere. He chose *Cryphonectria* canker of *Eucalyptus* to illustrate differences in taxonomy and virulence between apparently similar isolates on different continents. More research into taxonomy and reclassification of exotic forestry pathogens was called for. Also, there seems to be increasing awareness of the importance of accurate new geographic records to keep track of the invasive potential of new pathogens.

Food Security

The importance of protecting the world's food supply, especially in developing countries where the population is still increasing and there is poor disease awareness was a theme running through the whole congress. Linking in with quarantine and biosecurity, it also highlighted the continuing need for integrated research and development (chemicals, natural products, biocontrol agents, induced resistance, the introduction of resistance genes from plants and fungi into crops, etc.). Tied in with this is the need for better extension technology and the role of public/private and big company/local farmer partnerships.

Biocontrol of Plant Pathogens

Amongst a wide variety of presentations, Professor Alison Stewart (Lincoln University, New Zealand) detailed the importance of matching the mode of action of the biocontrol agent with the pathogen, using different sclerotial pathogens as examples, while Dr Yigal Elad (Volcani Centre, Israel) described current successes against *Botrytis*.

The 9th ICPP will be held in Turin, Italy on 24-29 August 2008.

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