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General News

Testing Times for Testing

The high profile reporting of non-target impacts of a few classical weed biocontrol agents over the past few years highlighted one shortcoming of many, if not most, biocontrol programmes – related to not inadequate testing, but inadequate monitoring. In trying to answer the critics of biocontrol, its defenders could only point to the absence of reported problems for the overwhelming majority of the 1150 or more planned releases of weed biocontrol agents that have been made worldwide. An equally overwhelming absence of post-release surveys means that there is little concrete evidence about the non-target impact of most of these releases.

In New Zealand, Landcare Research has been dusting off old files and investigating the safety record of weed biocontrol there since the first biocontrol agent, cinnabar moth (*Tyria jacobaeae*), was released against ragwort (*Senecio jacobaea*) in 1929. This audit will alert the country's biocontrol community to any lurking dangers, and also identify past flaws that will help tighten up testing procedures for the future.

Landcare has been looking at some agents that are now common in New Zealand, checking what testing was done before each was released, and whether non-target attack has occurred – or might yet. Reporting results at the 11th Symposium on the Biological Control of Weeds in Canberra this year, Simon Fowler said that, overall, the reliability of host specificity testing in New Zealand in the past has been good although a few gaps have been identified.

The largest gap in testing probably occurred in some projects conducted between 1943 and 1982. Although early biocontrol projects included native species in specificity tests, during this period 13 introductions of natural enemies were made which relied heavily on testing in other countries, and New Zealand natives were not tested. In one case, thistles, the rationale was that there are no native thistles in New Zealand so there were no closely related native species to test. While there could have been problems where introductions were made against other targets with New Zealand relatives, no non-target impacts have been recorded on New Zealand native plants, and only one potential serious impact has emerged so far. Three agents were released against St John's wort (*Hypericum perforatum*) but they had not been tested against native *Hypericum* species. *Hypericum japonicum* and *H. gramineum* are uncommon plants and, although none of the agents has been recorded on them, they could be at risk. In many other projects during that period, and in all projects since 1990, it has been standard practice to test native plants so the omission of indigenous species from test plant lists should not occur now. However, this does not imply that selecting what plants to test is now always straightforward.

The first agent to be released in New Zealand, cinnabar moth, was tested against eight native species of *Senecio* before permission was given for its release against ragwort. However, when ragwort is defoliated the moth occasionally attacks two species of native *Senecio* (*S. minimus* and *S. biserratus*) which were not tested. Why were these two not included in the test plant list? They were in a different genus at the time. This is the only recorded instance of an introduced weed biocontrol agent attacking a native non-target species in New Zealand, but could such a testing omission happen again? It is unlikely. Plant systematics have clearly progressed since 1929 and if the testing were being conducted now, these two species would be included. However, even with the taxonomic relationships clarified, there is another source of uncertainty.

Alternanthera sessilis, a close relative of alligator weed (*A. philoxeroides*) was not included in host specificity tests in that biocontrol programme. Both are exotic species and indeed there are no native New Zealand plants in the family. But what was not foreseen was that *A. sessilis* would subsequently attain cultural importance as a new vegetable crop for some sectors of the community. Short of including a fortune-teller in the biocontrol project, this would have been hard to predict but Toni Withers (Forest Research), who has been working with Fowler and others on this project, believes that the current rigorous process for drawing up test plant lists means that a similar case would not now be overlooked. Of two agents introduced against alligator weed, one (the moth *Arcola malloi*) attacks other *Alteranthera* species, and although damage to *A. sessilis* has not been observed it remains a possibility.

The above rare instances of the failure of New Zealand's past testing procedures occurred because plants that might have been tested were not. There are just two recorded cases where plants were tested, but the testing failed to predict the non-target attacks that subsequently occurred. The broom seed beetle *Bruchidius villosus* and the gorse pod moth *Cydia succedana* have unexpectedly attacked seed of other exotic Fabaceae, although pre-release testing suggested that this would not happen. Investigations into both are continuing, but Fowler noted that a common link is that both use seasonally ephemeral resources (young pods) whose phenology in comparison to that of the agent differs slightly between Europe and New Zealand, potentially offering novel no-choice situations to agents in the field after release. This gives us a new concept to consider: Do agents introduced for discrete seasonal resources need more careful assessment? Should more rigorous no-choice testing be considered in these circumstances? Withers believes that the answer lies in our ability to accurately interpret the results of host specificity testing, something that retrospective analysis of the methods used in the past, combined with post release field assessment, will help us with.

The message is that if weed biocontrol is to win the confidence of its often vociferous sceptics, it is likely to require more sophisticated yet transparent interpretation of the host range testing carried out, and potentially will become more time-consuming and (therefore) more costly as a result. At a time when time and budgets are being cut this fills the biocontrol community with dismay. As a direct consequence of the greater cost some projects will not be undertaken, while the increased scrutiny is likely to raise the bar so high that potentially useful and harmless agents will be rejected.

Source: Hayes, L (*ed*) (2003) In retrospect. *In*: What's new in biological control of weeds. Annual review. Lincoln, New Zealand; Landcare New Zealand Ltd 2003, No. 25, pp. 7-9.

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Birch Sawflies Seen Off

An Old World birch leaf-mining sawfly, accidentally introduced to Alaska, is the subject of a classical biocontrol programme employing a natural enemy from neighbouring Canada. This programme, capitalizing on the successful biocontrol of birch leaf-mining sawflies in Canada, will also mark the first instance of a natural enemy being released as part of a major programme against an invasive alien species in the wild in Alaska.

Birches have a worldwide distribution in the North Temperate Zone, and some 12 native species are found in North America. They are an important component of the boreal forests that extend north to the treeline. A number of native and exotic species are highly valued and widely planted as ornamental and shade trees in town and cities. The wood from some birch species is used for wood pulp and timber and for a large variety of products, from furniture to canoes to ornaments. Birch sap is starting to find a niche as a non-timber forest product. In the harsh climate of the northern forests, birch buds, twigs, pollen catkins (flowers) and nutlets (fruits) are an important food source for birds, mammals and insects.

Since the early 1900s, North American birches have suffered the invasion of five leaf-mining sawflies, all of European origin. By mining the leaves, their larvae cause extensive discoloration that is unsightly and reduces amenity values. The annual destruction of the trees' photosynthetic capacity has long-term impact on their health, and severe attacks over several years can weaken them and make them susceptible to attack by other insects, diseases and drought. Application of systemic pesticides (dimethoate), the most common means of control for these pests in urban centres, has had significant monetary costs to the public, and an undoubtedly significant environmental cost.

The spread of the leaf miners across the continent was slow but unremitting. Two species, the birch leaf miner (*Fenusa pusilla*) and the amber marked leaf miner (*Profenusa thomsoni*), became particularly widespread and destructive. From their point of introduction on the east coast of North America, these two species spread across the intervening ca. 4000 km to the western Canadian province of Alberta by the 1960s and were soon causing alarm. Once populations were well established, most birch trees in urban centres had turned brown by midsummer, and this level of infestation continued year after year. The additive action of the species heightens the problem: attack begins with first generation *F. pusilla* in early- to mid-May, as the trees begin to break bud. This is followed by new waves of attack in June-July from the univoltine species, *P. thomsoni*, together with a second generation of *F. pusilla*. Although a third species, the late birch leaf edge miner, *Heterarthrus nemoratus*, is present in Alberta, it is very rare and causes little damage.

In the early 1990s, scientists were surprised to notice a dramatic drop in sawfly damage to birch trees in Edmonton, Alberta and even more surprised to find that a native parasitoid was responsible by reducing populations of one of the species, *P. thomsoni*. The parasitoid responsible, *Lathrolestes luteolator*, appears to be native to both Old and New Worlds. It had not previously been recorded from *P. thomsoni*, although it attacks sawflies in the genus *Caliroa* in Europe and North America, and *Profenusa alumna* on northern red oaks (*Quercus rubra*) in eastern Canada and the USA. It is not unusual to find native parasitoids switching to an exotic host, but they are generally not sufficiently efficient to exert effective control – indeed, it is an axiom of classical biological control that co-evolved natural enemies from the area of origin of the pest exert the most effective control because their life histories and population dynamics are most closely linked. However, there are a number of examples of such 'new associations' providing useful levels of control (e.g. citrus leaf miner, *Phyllocnistis citrella*).

The control of *F. pusilla* followed more conventional classical biological control lines, utilizing two parasitoids, *Lathrolestes nigricollis* and *Grypocentrus albipes*, which are highly specific to *F. pusilla* in Europe. These parasitoids had previously been released against *F. pusilla* in eastern Canada in the 1970s and the northeastern USA in the 1980s, with excellent results, at least for *L. nigricollis* (*G. albipes* did not establish). Following on earlier successes, scientists from the Canadian Forest Service – Northern Forestry Centre (CFS-NoFC) teamed up with colleagues from the University of Alberta, and contracted CABI Bioscience (then the International Institute of Biological Control, IIBC) in Delémont, Switzerland to supply natural enemies from Austria. *Lathrolestes nigricollis* and *G. albipes* were shipped and released between 1994 and 1996, and both species became established although *L. nigricollis* was most successful. Since then, the wasp populations have increased rapidly and spread throughout the Edmonton area. In 2003, *L. nigricollis* was recovered from *F. pusilla* approximately 300 km from the release sites. It is now difficult to find the birch leaf-mining sawflies in Edmonton. As a result of the impacts of the parasitoids, the city curtailed its expensive (and sometimes controversial) policy of spraying its birch trees on public lands with dimethoate, and initiated a successful communication campaign to dissuade the public from applying insecticide on the grounds that it would disrupt biocontrol. Edmonton's success has been noted by authorities in areas still troubled by the sawflies, and NoFC is currently working with Northwest Territories and Alaska on control programmes.

Alaska remained free of alien birch leaf-mining sawfly pests until about the 1990s when the first damage to birch was noticed. Subsequently, birches in Anchorage began to sustain the greatest damage, which now extends over more than 14,000 ha in and around the city. The pest has also spread as far north as Fairbanks, east to Glennallen and south to Haines and Skagway. It was not until 2002 that the major culprit was positively identified as *P. thomsoni*; however, *F. pusilla* and *H. nemoratus* are also present in Anchorage but very rare. Birch is one of Anchorage's most common shade tree species, and the impact of them turning brown at the peak of the short summer is particularly dramatic. The rapid rate of spread of *P. thomsoni*, coupled with the failure of weekly trapping to find any evidence of the parasitoid, suggested that the sawfly has left behind the natural enemies that now control it farther east. A 3-year cooperative multi-agency programme has been initiated between CFS-NoFC and the US Department of Agriculture Forest Service (USFS) to study populations of *P. thomsoni* in Anchorage, locate populations of the parasitoid *L. luteolator* in Canada and introduce parasitoids to Alaska, in the expectation that it may re-enact its Canadian success and suppress *P. thomsoni* again. Of the known hosts of *L. luteolator*, only *P. thomsoni* and *Caliroa cerasi* occur in Alaska. No other members of these genera occur there so there is low risk of host switching. In 2003, baseline data were obtained on the ecology and mortality of *P. thomsoni* in Alaska, sources of *L. luteolator* were located in the Northwest Territories, parasitoids have been collected and are overwintering in Edmonton before being transported to Anchorage in the spring of 2004, and import permits have been secured to allow the releases to proceed.

While scientists are gaining the upper hand with *P. thomsoni* and *F. pusilla*, they are also keeping a close watch on two more recently introduced species that mine leaves of birch, *Scolioneura betuleti* and *Messa nana*. Both species are currently distributed only in eastern North America; *S. betuleti* has a localized distribution in Ontario and *M. nana* is widely distributed from Ontario to New Brunswick and in the northeastern USA. With its large range and propensity to cause high levels of damage, *M. nana* is a growing concern and warrants increased vigilance.

Sources: Anon. (2003) Science and nature give sawflies a one-two punch. *Solutions* (newsletter of the Canadian Forest Service) Fall/Winter 2002
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End of the Road for the Cane Toad?

Cane toad (*Bufo marinus*), biocontrol's best-known disaster story, may become a model for developing a new form of biocontrol. According to a recent report*, the technical feasibility of producing a viral agent that can disrupt the development of cane toad looks extremely promising, but a number of other issues need to be addressed if the overall objective of producing an effective self-disseminating viral vector is to be achieved.

The report was the result of a review, funded by Department of the Environment and Heritage (DEH) through the National Heritage Trust, of the government-funded 'Development of a cane toad biological control' project. The Australian Government is continuing its support for the approach through the DEH. In September it also announced that an additional A$ 200,000 of funds is being released by the DEH for new projects on short- and medium-term control techniques for cane toads in Australia.

Cane toads were introduced to Queensland in 1935 to control beetle pests in sugar cane, a job to which they proved singularly ill suited. Instead they became a pest themselves, preying on small animals and poisoning larger predators (including household pets) that try to eat them, and out-competing native reptiles and amphibians for habitat and food resources. They have spread beyond Queensland, with a range currently extending from northern New South Wales into the Northern Territory. They threaten the World Heritage Site of Kakadu National Park and are continuing to spread through the tropical north towards Western Australia. There are currently no control measures effective for anything but small, restricted areas.

Investigations into possible biocontrol solutions for cane toad began in 1990, with surveys for pathogens in the toad's area of origin in Venezuela and ecological studies of the pest there and in Australia. More recently, research has focused on investigating potential viral biocontrol agents. A stimulus for this work was rapid advances made in gene technology during the 1990s together with the progress made by CSIRO in genetic manipulation of viruses to interrupt animal development. While this approach fits with cultural pressure for 'humane' control methods, it also needs to address public concerns about the safety of genetic modification. A project aimed at producing a recombinant viral agent was initiated in 2000, and was the subject of the recent review.

The report notes that, although there have been hitches in maintaining a healthy captive colony of cane toads for research purposes, excellent technical progress has been made and objectives have been met on time and on budget. It draws attention to the project's achievements and is encouraging about its prospects for success, while also pointing out areas that need to be addressed:

- A recombinant ranavirus has been created, indicating that genetic modification is a technically feasible approach in this system.
- Methods of attenuation (weakening the ability to cause disease) have been assessed. Attenuation by passaging was successfully demonstrated for a wild-type and a recombinant ranavirus in an Australian native frog, *Litoria infrafrenata.* Attenuation is fundamental to the production of a viral vector that does not endanger non-target species, and its reliability is vital for safeguarding native biodiversity. The report endorsed the need for further research to confirm results so far.
- Genes critical to the development of cane toads have been identified using micro array technology, and potential for progress in this field is promising. Evidence indicates that developmental differences between cane toads and native frogs may be sufficient for a suitable gene to be identified.
- The team has the skills and technology for moving the project forward to create a recombinant virus capable of acting as a biocontrol agent.

The report highlights a number of gaps in the project so far and as planned:

- A comprehensive plan for testing native species is needed to ensure that (a) the viral vector has been weakened successfully and (b) the genes selected to block cane toad development are specific to this species.
- The scarcity of information on the proposed ranavirus vector needs remedying by targeted research.
- Methods for containing the risk of the released virus escaping to other countries need to be considered.

The report questions whether the project team can address these issues and, if not, calls for the Department of the Environment and Heritage to assess the implications of these gaps. The question appears somewhat rhetorical, insofar as the report describes the testing of the attenuated recombinant virus as "a major task that will need substantial expertise from outside the project team." While the report notes that is unlikely to be possible (or necessary) to test the 200 or more native frog species, it argues that the rationale for which species are to be tested, and why, needs to be explained (although this will be made more difficult because the phylogenetics of Australian frogs are not well established.) Factors to be considered include:

- Impact of differences in ecology (e.g. habitat preferences and behaviour) between taxonomically closely related species on susceptibility.
- Impact of an individual's health and environmental conditions on susceptibility.
- Cost, feasibility and ethics of testing threatened species with few remaining wild populations, and whether to test species assumed extinct in the wild.
- Necessity for testing other groups also susceptible to ranaviruses (reptiles, fish).

The report calls for the development of a detailed strategy for comprehensively testing the success of attenuation in Australia's frogs, reptiles and fish, at various life stages, in advance of testing the recombinant attenuated virus. It suggests that the strategy should demonstrate that expertise has been sought from relevant experts in frog, fish and reptile biology, and ecology and virology.

Most aspects of the ecology of ranaviruses, such as survival, mobility and pathogenicity, are little understood, yet would impinge on their success or otherwise as viral vectors. The report calls for research into their ecology, in particular to investigate key questions:

- What is the status of ranaviruses in the Australian native fauna? (Only one in one species has been reported so far.)
- What is their prevalence in wild cane toad populations? Ranaviruses are considered extremely robust in nature and readily transported through the environment. But if ranaviruses are present in wild cane toad populations as thought, why do they not have more impact, given the density of cane toad populations? Perhaps they are not present, or very prevalent? Or perhaps they are less robust, virulent or transportable in the natural environment?
- Once (and if) ranaviruses have been shown to be present at appropriate levels in wild cane toad populations, more questions arise. How does environmental variation affect ranavirus prevalence, mobility, and capacity to infect? Do the wild type and attenuated viruses behave the same in the natural environment?

The answers to these questions will confirm whether or not the ranavirus is a good choice of vector, and suggest whether additional dissemination mechanisms might be needed.

The report praises the project team for ensuring that results are relayed to the public. However, it encourages them also to share results with scientists in other disciplines. It notes that the project will interest "a diverse range of scientists and practitioners from amateur herpetologists to ecologists and virologists" and suggests that they may be able to assist if kept informed of progress – and furthermore that keeping the entire community informed will tend to prevent a build up of concern that could develop in a vacuum of information.

The potential for mutation and host range expansion in a virus being released into the environment is a natural cause of concern. Ranaviruses are considered stable and the likelihood of the one chosen for this project reverting back to its pathogenic form is described by the project team as close to zero. However, according to the report not all scientists share this confidence and they need to be presented with the evidence rather than reassurances. It stresses the importance of engaging the scientific community on the issue of safety, as dissent between scientific camps is likely to deepen public anxiety. The report makes the point that: "Confidence from the broader community will be essential if the virus is eventually to be released." Any such release would be controlled by the Office of the Gene Technology Regulator (OGTR), after an extensive programme of consultation with community groups.

The report also discusses the issue of international commitments. National interests need to been weighed against those of other countries, which brings different elements of risk into consideration – some of the 'plus' points at a national level may be negatively viewed by other countries. For example, ranaviruses can survive in the environment (i.e. outside the host) for extended periods under conditions of fairly high temperature and desiccation (which is good for agent dissemination). However, the virus could be transported by unwitting human agents (on boots or fishing equipment, for example) to another country, which may have (a) susceptible native species of amphibians, reptiles or fish that have not been tested under protocols designed to safeguard Australian native species and (b) native cane toads. With international travel and trade at unprecedented levels, these risks cannot be dismissed.

Clearly this is an issue for quarantine authorities (although they are more used to keeping organisms out of, rather than within, a country's borders). The report states that no recombinant form of a ranavirus should be released unless it is feasible to contain it within Australia. This is not a limitation put on release of other, naturally occurring, biological control agents in Australia, and is likely to provoke protest (and counter-protest). The report also notes, however, that molecular techniques may be able to manipulate the virus, for example to reduce its survival outside the host without significantly compromising its effectiveness as a biocontrol agent, which could contribute to its safety from the quarantine perspective.

Whether an attenuated recombinant self-disseminating ranavirus will prove to be the answer to the cane toad in Australia will take another 10 years to determine, according to this report – it does not pull its punches in laying out the of the size of the challenges ahead. In the meantime, the report calls for more resources to be provided for the complementary areas it asks to be researched, and for other avenues to be investigated to alleviate the cane toad problem in Australia in the short- to medium-term.

In addition to evaluating the cane toad project, this report makes an important contribution to the debate on the future of disseminating viruses as biocontrol agents. It highlights the excellence of the research, the promise of the results so far, and the capabilities that Australia possesses, and is optimistic about the successful outcome of the technical aspects of the project. However, it also identifies obstacles to transferring this technology safely to the field and endorses the need for cooperation between scientists of different disciplines to overcome these. Above all, the report recognises the importance of perception over evidence-based argument in making judgments about risk, not only amongst the lay public but also within the wider scientific community.

Effective safe control of cane toad would be welcome, not just in Australia, but throughout the world biocontrol community, for whom constant references to its introduction are a depressing reminder of the poor public perception of biological control's safety record. Experts and stakeholders, including members of conservation groups and research organizations, will attend a workshop early in 2004 to discuss how to take the research forward.

*Hazell, D.; Nott, R.; Shannon, M.F. (2003) Review of the project 'The development of a cane toad biological control'. Canberra, ACT; Department of the Environment and Heritage, National Heritage Trust, 18 pp.
www.deh.gov.au/biodiversity/invasive/pests/canetoad

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Winning Water Lettuce War

A project that has successfully controlled water lettuce (*Pistia stratiotes*) in a nature reserve in the Eastern Cape Province of South Africa has demonstrated the effectiveness of the control agent under some difficult conditions. Water lettuce, originally from South America, is a declared weed in South Africa. A leaf- and stem-feeding weevil, *Neohydronomus affinis*, was first released against it in 1985. It causes considerable damage and has controlled the weed in a number of situations. However, the Eastern Cape has a fairly temperate climate with cool winters and in addition the water bodies where control was achieved are highly eutrophic. Thus success under these conditions indicates that there really is no need to consider any other control methods.

The Cape Recife Nature Reserve near the city of Port Elizabeth incorporates two water treatment settlement ponds that are also used extensively by birding enthusiasts as they attract many species of waterfowl. In 2001 one of these ponds was invaded by water lettuce, which by 2002 had covered the entire 1.5 ha pond and had also moved into the second pond. In August 2002, 240 adult *N. affinis* weevils were introduced to the first pond. A quantitative post-release evaluation was initiated at this site in January 2003 by the Department of Zoology and Entomology at Rhodes University, Grahamstown. Initially the plants were very large, averaging nearly 1 kg wet weight per plant. By March 2003 the mat of water lettuce had started to break up and the average wet weight of the plants had dropped to less than 100 g per plant – and there were on average 26 adult weevils per plant. The weevils also dispersed to the other pond. By June 2003, the entire mat had sunk and only a few scattered plants were found in the riparian vegetation. The evaluation will continue through the summer to document any reoccurrence of the weed.

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Donald Dahlsten

Donald Dahlsten, a leading expert in biological control and forest entomology, and a professor of insect biology at the University of California, Berkeley died on 3 September 2003 at the age of 69.

Over the course of his 40-year career, Dahlsten developed a reputation as one of the world's most respected leaders in biological control. His research focused on the development of ecologically sensitive methods for controlling insects that feed on trees in forests and in urban environments, which ultimately gave California a critical weapon in their fight against psyllid pests that were spreading fast through the state's eucalyptus trees. In the early 1990s, he found a species of *Psyllaephagus* wasp that effectively controlled the blue gum psyllid (*Ctenarytaina eucalypti*) infesting blue gum eucalyptus trees in nurseries throughout California. Two years after the parasitoid's introduction, it was hard to find any psyllids. It was a classical biocontrol success story.

Dahlsten's expertise was called upon again when the red gum lerp psyllid (*Glycaspis brimblecombei*) began attacking and killing California's red gum eucalyptus trees in 1998. Following surveys in Australia, he imported another species of *Psyllaephagus*. The efficacy of this wasp is still being evaluated, but it has thus far been most successful in the state's coastal areas.

In addition to his work on psyllids, Dahlsten distinguished himself with his research on the population dynamics of tree-killing bark beetles and the factors that attract their natural enemies. Other projects included research on how the methods used to control Pierce's disease, which affects grapevines and is spread by the glassy-winged sharpshooter (*Homalodisca coagulata*), affected riparian habitats, and on the ecological impact of the Sudden Oak Death pathogen, a fungus-like algae that has killed tens of thousands of oak trees throughout the state. Wide interests included ornithology (he maintained one of the largest databases of insectivorous birds in California's forests and riparian areas, and recently contributed a 20-page chapter on the biology of the chestnut-backed chickadee for 'Birds of North America').

An early career dedicated to football was blighted by polio but, undeterred, he shifted his career aspirations to science. He enrolled at UCLA (University of California, Los Angeles) before transferring to UC Davis, where he received his bachelor's degree in entomology in 1956. He continued his graduate studies at UC Berkeley, receiving his MSc and PhD degrees in entomology in 1960 and 1963, respectively. As a graduate student, he had worked as a research assistant in entomology at UC Berkeley. After he finished his studies, he taught at the Los Angeles State College for one year before coming back to UC Berkeley as an assistant entomologist. He worked his way up to a tenured faculty position by 1969, and from 1981 to 1988 served as chair of the former Division of Biological Control.

Known as a dedicated educator, Dahlsten was appointed associate dean for instruction and student affairs at UC Berkeley's College of Natural Resources in 1996. He advised 39 graduate students during his tenure, but he also extended his enthusiasm for insects and education beyond the campus by developing and heading outreach programmes through the college and through the campus's Interactive University Project. In the CityBugs Program, for instance, Dahlsten and his students teamed up with teachers in the Oakland Unified School District to develop interactive lesson plans on insects. In the Environmental Leadership Outreach Program, Dahlsten also helped develop courses in urban environmentalism for Oakland public school students, particularly those in poor or politically disadvantaged communities.

His more than 200 publications were a significant contribution to the field of biological control and he was a member of several professional societies. His efforts and outstanding contributions earned him earlier this year the UC Berkeley Distinguished Service Award and the College of Natural Resources Citation. Dahlsten received numerous other honours throughout his distinguished career, including the UC Berkeley College of Natural Resources Outstanding Teaching Award in 1995. For 2 years in a row, he was chosen to be a member of a research team visiting the People's Republic of China as part of an exchange programme in integrated pest management. One of Dahlsten's last honours will be given posthumously in November by the Western Forest Insect Work Conference – the 2003 Founder's Award – in recognition of his contributions to the field of forest entomology.

David Rowney, a research associate at Dahlsten's lab and a friend for 32 years said, "Generations to come will benefit from the reduction in pesticide use that Don accomplished through his successful biological control efforts both in California and around the world."

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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.

Harmonization Sounds Good for Biopesticide Business

The drive to improve farmer uptake of IPM technologies takes many forms, from participatory research at the field level to policy change. A meeting in Tanzania this July signalled the beginning of a process to overhaul legislation on biopesticide registration in eastern Africa. This initiative is intended to make it more straightforward and profitable for the small- to medium-sized producers, who are the mainstay of the biopesticide sector, to market their products throughout the region.

The selectivity of biopesticides makes them good for the environment because they have fewer non-target effects than conventional broad-spectrum pesticides, but makes them bad for business because the narrow target range means a restricted market niche. This paradox at least partly explains why, despite the growth of the environmental lobby and more stringent pesticide legislation in recent years, biopesticides still account for less than 1% of the global pesticide market (and a large proportion of that is accounted for by *Bacillus thuringiensis*, or *Bt*).

Conventional synthetic chemical pesticides typically have a broad host range: most insecticides usually kill many kinds of pest insects. Therefore, one product can be profitably produced for many uses. The development and registration costs for a pesticide are high, so the major agrochemical companies are compelled to target their research at agents with a broad spectrum of activity. However, broad-spectrum action means the products can kill beneficial insects.

In contrast, biopesticides have a narrow host range and are safer for use in IPM systems. However, the cost of developing and registering a biopesticide makes it a poor commercial proposition unless the market is particularly profitable. *Bt* is a case in point. It is effective against widespread lepidopteran pests of cash crops such as cotton, maize and vegetables – a market sufficiently large to make it a commercially attractive product. Even so, the global value of this market is estimated at some US$120 million (for all *Bt* products) – small in comparison to the average broad-spectrum insecticide (e.g. a new neo-nicotinoid). Yet, no other biopesticide has come close to reaching a market of this size, with the products in the sector usually worth less than $10 million.

The costs of developing and registering a biopesticide must be overcome by the small- to medium-sized enterprises that usually market them. Although the costs are less than for a conventional agrochemical, they are still disproportionately high compared to those for a major agrochemical company registering a new chemical pesticide. To add to the trials of the biopesticide manufacturer, the problem of inherently small markets is compounded because countries have different registration requirements. In spite of harmonization initiatives, different information is still required for markets covering several countries. Therefore biopesticides development is often not economically feasible, even when a product could potentially be used against a regional pest.

Recognizing both the potential for biopesticides in sustainable agriculture and the difficulties they face to become registered, the pesticide authorities of eastern Africa are seeking to harmonize biopesticide registration procedures in the region. They argue that by opening the potential market to the whole of the region, biopesticide development will become more profitable, making commercial development more cost-effective and attractive to manufacturers. This in turn would lower the purchase price and ultimately increase the uptake of the technology by farmers.

The Desert Locust Control Organization for Eastern Africa (DLCO-EA) hosted a workshop on 1-4 July 2003 in Arusha, Tanzania to begin the harmonization process. Members of the national registration authorities of five countries (Tanzania, Djibouti, Ethiopia, Kenya and Uganda) met to review a candidate biocontrol agent in a mock exercise designed to highlight the differences in how such a product would be treated according to the existing different national guidelines. The product chosen for this review by the 20 workshop participants was Green Muscle, a locust biopesticide based on the fungus *Metarhizium anisopliae* var. *acridum* that infects only locusts and grasshoppers.

The participants of the Arusha workshop on biopesticide harmonization committed themselves to revising guidelines by September. With some further revisions, a document will be presented for consideration by all member countries of the Southern and Eastern African Committee on Harmonization (SEARCH). SEARCH is a non-governmental organization comprising government regulators from countries spanning South Africa and Madagascar to Ethiopia. The group's ultimate goal is to develop guidelines that may be uniformly adopted throughout the region.

This workshop was funded by support from the African Emergency Locust and Grasshopper Assistance (AELGA) project of the US Agency for International Development (USAID). AELGA's biopesticide project is managed by Virginia Polytechnic Institute and State University in the USA, with partner institutions in Kenya, Ethiopia, Senegal and France.

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Commercial Success from 15 Years Trichoderma Research

Several biological control products recently introduced to the market for control of crop diseases in New Zealand owe their success to a long running research programme that has involved both fundamental and applied research to optimize their efficacy. The products, produced and marketed by Agrimm Technologies Ltd of Christchurch, New Zealand, consist of selected *Trichoderma* spores formulated for targeted application to specific crops and cropping systems. This achievement was spearheaded by Alison Stewart, Professor of Plant Pathology at Lincoln University and Director of the newly established National Centre for Advanced Bio-Protection Technologies, whose research team has specialized in studying biocontrol mechanisms for control of soil-borne pathogens.

The diseases at the centre of this investigation were two economically important fungal pathogens of vegetable crops. *Sclerotium cepivorum* is the causal agent of onion white rot which results in losses of 30-70% p.a. of New Zealand's largest export earning vegetable crop, whilst *Sclerotinia* species cause soft rots in a wide range of fruit and vegetable species. Neither pathogen is well controlled by existing chemical sprays owing to difficulties in targeting soil-borne pathogens and, in *S. cepivorum*'s case, the chemicals are no longer effective due to accelerated microbial degradation in soil. The pathogens' problematic nature is compounded by the fact that both may persist in cropping soils for many years owing to the presence of hard, over-wintering structures called sclerotia.

Research on biocontrol of onion white rot was begun by Professor Stewart in 1985, when large numbers of soil microorganisms were screened for antagonistic activity towards the pathogen. Promising microbes were then incorporated into *S. cepivorum*-infested soil in large boxes for glasshouse-based trials, in which a *Trichoderma atroviride* strain was found that gave between 40-75% disease control compared to untreated boxes.

The research group then entered into a joint partnership arrangement with Agrimm Technologies Ltd to facilitate commercialization of this strain. Agrimm, run by directors Dr John Hunt and Mr David Gale, was already formulating *Trichoderma* spp. as soil bio-inoculants, and brought to the partnership a wealth of technical experience. This expertise enabled the researchers to test a wide range of delivery strategies to best target the pathogen in field trials.

Fundamental studies complemented these applied studies by enabling the researchers to optimize the biocontrol activity. To determine the best time for application, a genetic fingerprint of the biocontrol agent was developed and used to track its survival and spread in field sites. Other studies indicated that the biocontrol agent antagonized the pathogen via several means: antibiotic production, competition for nutrients, and plant growth promotion.

The research on onion white rot control had provided plenty of insights into the issues involved in developing biocontrols for sclerotial pathogens. This experience was then used in developing a biocontrol agent for control of *Sclerotinia minor* lettuce drop. Using similar glasshouse and field based screens, a *T. hamatum* strain was identified that directly affects the pathogen by occupying the root zone space and competing for nutrients. Field evaluations over the last 5 years have shown that by applying the biocontrol agent around seedling roots and stem bases, protection that equalled or bettered that of chemical fungicides was obtained. This work, conducted on both Lincoln University and growers' properties, culminated in successful commercial scale trials during 2000-2002.

Currently, several bio-inoculant products are utilizing proprietary strains of *Trichoderma* from the above research as the active ingredient. Trichopel™Ali 52 is a granule that is applied to the furrow during seed sowing, and uses *T. atroviride*'s growth promotion properties to help establish vigorous roots in onion seedlings. The sustained release formulation enables the beneficial fungus to colonize the soil around developing seedlings, and to grow with the roots throughout the life of the onion. Use of Trichopel Ali 52 typically increases harvest yields of field onions by 8-12% and spring onions by 34%.

The lettuce product was formulated with the transplant lettuce nursery industry in mind. A combination of two formulations ensures the establishment of dominant beneficial fungal populations in the root zone of the lettuce, thus producing a strong seedling for field planting. Trichodry™6S flake is incorporated into the seedling mix prior to cell tray filling, and a top-up of Trichoflow™6S WP is applied to each lettuce seedling 'plug' several days prior to planting out. Treatment of seedlings in this way typically increases harvests giving pack-outs of 85-90% due to improved seedling establishment and stress tolerance.

The commercial products are currently marketed in New Zealand and are likely to soon be available in other countries through arrangements with local distributors. Whilst they have no withholding period and are certified as suitable for organic farming by AgriQuality in New Zealand, the products are also compatible with most fungicides applied after plant establishment. Research in this area is continuing, with Agrimm hoping to extend the market into Australia through an active research programme in collaboration with the Department of Primary Industries at Knoxfield, Victoria, in which the products are being tested under Australian cropping conditions.

All parties involved in this programme believe that the success of the commercial implementation of these *Trichoderma*-based products has been due to good science backed up by a sound commercial outlook. With this success under their belts, Prof. Stewart, Dr Hunt and Mr Gale are keen to expand their collaboration to combat other crop diseases.

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Strawberry IPM Paradox

In Queensland, Australia, two-spotted mite (*Tertranychus urticae*) is the major pest of strawberries and can greatly reduce both yield and quality in this high-value crop. So it might come as something of a surprise to learn that most strawberry growers in southeast coastal Queensland are deliberately releasing the pest in their crops.

Biocontrol of the pest mite using the predatory mite *Phytoseiulus persimilis* is an established component of an IPM management system in strawberries. The predators are traditionally supplied on bean or soyabean leaves, with instructions to release them in the field by placing them among the foliage of infested plants. However, under a release system developed by Horticultural Crop Monitoring (HCM) consultant Paul Jones, the predatory mites are released at marked sites through the crop, together with relatively high numbers of the two-spotted mite prey. The prey population grows and provides a concentrated breeding site for the predatory mite, which can thus increase in numbers and disperse through the crop before natural pest mite populations reach damaging levels. Although initially rather cool to the concept of releasing the pest, once the logic was explained the growers were prepared to try, and they were rewarded with substantially reduced mite damage. Miticide resistance is a serious issue, so a biological control that works and reduces the need for spraying is very welcome. The 'simultaneous releasing' technique has now been successfully used for the last 7-8 years and has significantly reduced miticide use. Rarely, HCM may recommend two miticides per season, but in the majority of cases no miticides are used. In contrast, without the predatory mites some growers will use up to 12 miticide sprays per season.

There is a double paradox in this story, however. Jones comments that good IPM practice in the strawberry sector is compromised in southeast Queensland if the crop is to be exported to Victoria. In this case, there is a requirement to apply dimethoate (in the first week of September). The requirement is targeted at eliminating Queensland fruit fly (*Batrocera tryoni*) from imports to the more southerly state, but the practice disrupts IPM and can cause mite outbreaks. Although fruit fly baits have been shown to be successful in trials, they are not yet permitted as an alternative to the dimethoate sprays.

The conflict between maintaining effective IPM in strawberries in Queensland and preventing the fruit fly's possible incursion further south is a tricky issue to resolve. The fruit fly, a tropical and subtropical species with a wide host range, is Australia's most costly horticultural pest. A number of countries refuse to import Australian horticultural produce because of the fear of importing the fruit fly along with the produce, while in others, market access for Australian citrus and stone fruit depends on areas maintaining 'area freedom' from the fly. An outbreak of fruit flies in such areas prohibits exports of fruit until they are certified free of this pest again.

A Fruit Fly Exclusion Zone (FFEZ) was created in southeastern Australia, spanning the three states of New South Wales, Victoria, and South Australia. Because this zone is considered to have area freedom from fruit fly, produce grown there has a greater market value nationally, and can also be exported to countries with stringent quarantine regulations designed to prevent introduction of the fruit fly. Although it can live and breed in the FFEZ area, the fruit fly does not normally occur there and is (expensively) eradicated when found. It is not known whether or not a permanent population could be established if eradication were abandoned, so preventing incursions is seen as the best strategy for this otherwise costly pest. Unfortunately, this has a knock-on effect on IPM for other pests, and other farmers, outside the zone.

Sources: Australasian Biological Control News, August 2003. Horticultural crop monitoring develops new release technique for persimilis in strawberries.
www.goodbugs.org.au/news.htm
The ABC (Australasian Biological Control) website is the virtual home of the Association of Beneficial Arthropod Producers, Australia.
www.goodbugs.org.au/default.htm

Fruit fly: www.ento.csiro.au/research/pest-mgmt/IPMModellingNetwork/QFF.htm

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Hot Pepper Source for Strawberry Protection

Colletotrichum and *Phomopsis* fungi are economically important pathogens, inflicting significant damage to small fruit crops such as strawberries in the USA. A naturally occurring compound found in cayenne peppers may soon add heat to the battle to control them.

US Department of Agriculture – Agricultural Research Service (USDA-ARS) scientists have been awarded a patent for a novel fungicide, CAY-1, which was isolated from cayenne peppers by Anthony De Lucca (ARS Southern Regional Research Center, New Orleans, Louisiana). De Lucca isolated the saponin 5 years ago while screening for natural compounds to protect crops from fungi. Found widely in plants, saponins have detergent properties that allow them to penetrate fungal cells.

Since then, De Lucca has teamed up with David Wedge (ARS Natural Products Utilization Research Unit, Oxford, Mississippi) and Barbara Smith (ARS Small Fruit Research Station, Polarville, Mississippi) to test its efficacy against fungi attacking strawberry. A year of successful laboratory and plant-based trials has allowed the testing to progress to the greenhouse stage, which may pave the way for commercialization. CAY-1 has been shown to be effective at low application levels against both *Colletotrichum* and *Phomopsis*. In addition, the compound has a range of other potential applications, including as a mosquito larvicide or molluscicide, and for mildews in domestic situations. This has led to a welter of interest from commercial companies; a number of them have been supplied with the cayenne extract by ARS and are investigating its potential.

Source:
USDA-ARS news release, 29 August 2003
www.ars.usda.gov/is/pr/2003

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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.

More Than Biocontrol to Citrus Blackfly Management

A classical biological control project often has to overcome both scientific and political obstacles. A training course in Trinidad on the biological control of citrus blackfly (CBF), *Aleurocanthus woglumi*, was designed to tackle both aspects. This is an invaluable approach for scientists new to biocontrol. They need to be able not only to handle the technical aspects of implementing a biocontrol project, but also to deal with understandable concerns about the safety of introducing exotic species. The dual focus of such a course is particularly useful for countries with little or no experience of classical biological control, where scientists new to biocontrol will, in the absence of colleagues with experience, have to deal with both the scientific challenge and public anxiety.

CBF is an important pest of citrus and other crops (as well as being one of many 'black' whiteflies). Originating in Asia, it has spread around the world and was first recorded as a pest in the Caribbean in 1913. CBF is not a virus vector, but causes direct damage by feeding, as well as giving rise to sooty moulds. These grow on the copious honeydew that the nymphs excrete, and can substantially reduce the plant's photosynthetic area. Several attempts at classical biological control over the past 70 years have met with varying degrees of success. Following devastating infestations in Dominica in the mid 1990s, the apparently very host-specific parasitoids *Amitus hesperidum* and *Encarsia perplexa* were introduced from Texas and subsequently gave satisfactory control throughout the island. Taking their cue from this success, the Trinidad Ministry of Agriculture, Land and Marine Resources (MALMR), after pressure from the Cooperative Citrus Growers' Association of Trinidad, commissioned CAB International to undertake the importation and release of the same two species from Florida. On this occasion, the introductions were undertaken in accordance with the IPPC (International Plant Protection Convention) Code of Conduct for the Import and Release of Exotic Biological Control Agents, making the programme, from start to finish, a model for future classical biocontrol introductions. To be able to refer to such a model example is particularly important when addressing the commonly encountered, and understandable, suspicion of classical biological control programmes. Following the introductions into Trinidad in April 2000, several stakeholders, including most members of the CBF project management committee, undertook a short training period. Trainees from that course became resource persons for the present course, bringing the CBF management experience in Trinidad to representatives of the rest of the Caribbean region. The course was attended by trainees representing Antigua & Barbuda, Dominican Republic, Grenada, Guyana, St Kitts & Nevis, St Lucia, St Vincent & the Grenadines and Surinam. Resource persons were mainly from Trinidad, Dominica and Europe.

The training course, coordinated by CAB International and held at its Caribbean and Latin America Regional Centre (CABI-CLARC) on 23-28 March 2003, was one of the initiatives of the Caribbean Agriculture and Fisheries Programme – Integrated Pest Management Project. The Integrated Pest Management Project encompasses specialist activities financed by the European Union through the Caribbean Agriculture and Fisheries Programme (CAFP). CAFP is a €22.2 million European Community – CARIFORUM initiative aimed at strengthening the economies of member states by enhancing the contribution of the agriculture and fisheries sectors.

The subject matter covered included principles of classical biological control, especially within the Code of Conduct guidelines, and illustrated by the examples of CBF control from Dominica and Trinidad. Detailed information was provided on natural enemies of whiteflies worldwide, with emphasis on the region, and on *A. hesperidum* and *E. perplexa* in particular. Special attention was given to monitoring and surveillance and to public awareness programmes. Practical sessions on whitefly and citrus leaf miner (*Phyllocnistis citrella*) parasitoid identification were included, as well as fieldwork.

Participants found the course both useful and enjoyable. Most felt the necessity for verification of available information concerning the current distribution of CBF and its natural enemies in the region, and for greater transparency concerning the distribution of quarantine pests in general. A natural reluctance on the part of some countries to be open about the occurrence of new pests, due to the effect on exports, needs to be countered with regional, coordinated initiatives on the containment and control of pests. Above all, no state should be punished for being open on such matters. Plans for a detailed regional survey of whiteflies and their natural enemies are currently being developed, and those interested in participating should contact Andrew Polaszek (see below).

Source: Polaszek, A. (2003) The citrus blackfly workshop. International Whitefly Studies Network, Norwich, UK; *IWSN Newsletter* No. 17, p. 3.

For further information on CBF natural enemies or in connection with setting up workshops similar to that described above, contact:

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Announcements

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

Whitefly Group Spreads Its Wings

Whiteflies are one of the most serious agricultural pests in most continents, dramatically reducing crop yields through direct feeding damage and transmission of plant viruses. In addition, increasing movement of plant material and produce between countries raises the risk of whiteflies and associated viruses spreading to new areas. The ready flow of information generated on global whitefly research, crop protection studies and growing practices is vital to combating these threats. In response to this, the European Whitefly Studies Network (EWSN) has gone global and become the International Whitefly Studies Network (IWSN).

The new IWSN newsletter, which replaces its EWSN predecessor, will continue to be edited by Ian Bedford, David Oliver and Liz Robertson. The first issue is out, and is available in print and on the IWSN website. The newsletter will adopt an international profile, reporting and disseminating whitefly-related information worldwide.

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Sunn Pest Conference

The Second International Conference on Sunn Pest will be held on 18-22 July 2004 at ICARDA (International Centre for Agricultural Research in the Dry Areas) in Aleppo, Syria, in collaboration with the University of Vermont. The theme will be, ‘Enhancing international cereal production capacity for food security.’

A major pest of wheat and barley, sunn pest accounts for annual yield losses of 20-30% for barley and 50-90% for wheat in central and western Asia and eastern Europe. The name ‘sunn pest’ encompasses a group of insects representing several genera of the shield bug (Scutelleridae) and stink bug (Pentatomidae) families, with the species *Eurygaster integriceps* being the most economically important. Over recent decades problems have intensified, largely due to changes in farming practices. This threatens food security and reduces the stability of traditionally wheat-based agricultural systems.

Since the first international conference in 1992, significant progress has been made towards the development of an IPM package. The goals of this second conference are to review research, disseminate knowledge on recent advances towards management, and develop international networking among sunn pest researchers and managers. Topics to be covered include:

- IPM tactics for management of sunn pest: recent advances in IPM research, cultural practices, biological control, chemical control and host plant resistance.
- Socioeconomics of sunn pest: farmer participatory activities, impact assessment methods, farmers’ constraints in adoption of IPM, economic returns and environmental benefits of IPM.
- Sunn pest biology and ecology: recent advances in the characterization of sunn pest, pheromone research, and ecology and physiology.

More on sunn pest and recent research can be found on Sunn Pest Net at:

www.uvm.edu/%7Eentlab/sunnpest/index.html

Conference information:
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Weed Biology Conference

The 12th International Conference on Weed Biology will be held in Dijon, France on 31 August – 2 August 2004. The provisional programme includes:

- Physical and cultural weed control: development and implementation in sustainable agriculture.
- Crop-weed interactions: fundamental understanding of processes and utilization of this knowledge for improved weed management.
- Site specific weed management: state-of-art of sensors, GPS/GIS hard- and soft-ware and machinery (sprayers) for monitoring and management.
- Other cropping situations: biology and control in tropical crops, biological control, biodiversity and endangered species.
- Herbicide resistance: cultural and chemical methods to prevent further development of resistance, management strategies for resistant populations.
- Optimization of herbicide dose: chemical weed control in crop production, dose adjustment, reduction of herbicide inputs.

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New Books

Enhancing Quality of Commercial Biocontrol Agents

In the fast changing agriculture scenario in the current WTO (World Trade Organization) regime, avoiding chemical pesticide residues in agricultural produce and enhancing environmental protection and sustainability of crop production have gained importance to be competitive in global trade. The value of biocontrol agents in bringing down population densities of major crop pests has been recognized since the 1870s. Nevertheless, natural enemies are available commercially only for control of a limited number of crop pests and that too mainly in Europe and North America. The situation is paradoxical considering the fact that mass production of insect biocontrol agents for augmentative releases is not a new concept in developing countries, particularly India. Thus, establishment of parasitoid breeding laboratories there in 1926 for control of coconut black headed caterpillar (*Opisina arenosella)* can be considered as one the earliest organized attempts for the biological control of an insect pest. Similarly *Trichogramma* spp. are used extensively to control sugarcane borers in India, and several sugar factories either produce or procure the egg parasitoids from commercial producers. Nevertheless, only a handful of natural enemies are available commercially in India, in spite of the fact that the first commercial biological control laboratory in the country was established in the year 1981. On the other hand, about 125 species of natural enemies are available commercially in Europe and North America.

Among the bottlenecks limiting the progress of biological control, the absence of standardized methods of production and quality control is the most important. Unless this problem is solved and natural enemies of reliable quality are made as readily available as chemical pesticides, biological control is likely to be treated only as a matter of academic interest. Adoption of standardized production techniques for superior quality natural enemies is crucial for both the practice of biological control and also for convincing the users that biological control is a dependable pest management tool. The need for maintaining quality of mass produced biocontrol agents has been an area of concern for many years and has often been the topic of discussion in many conferences worldwide. Nevertheless, standardized protocols for production and quality testing have neither been formulated nor available, especially to commercial producers in the developing countries. The quality control guidelines outlined in this excellent book*, the first comprehensive publication on this topic, specifically for biocontrol agents, will be of immense value to students, scientists and commercial producers involved in the mass production of biocontrol agents throughout the world, and fulfils a long felt need.

The book consists of 20 chapters, divided into six convenient sections, starting with the need for quality control to the actual quality control tests for 30 parasitoids and predators. The sections in between provide background information and insights into mass production of natural enemies including sources of variation in behaviour, suggested methods of coping with these variations, an overview of species of mass produced natural enemies and the developments that resulted in evolving guidelines for quality control in Europe and North America.

Mass production of natural enemies is an essential prerequisite for the adoption of biological control in pest management. Many of the units engaged in mass production of biocontrol agents are unaware of the sources of variability of natural enemy behaviour and methods to prevent their genetic deterioration. It is important that the condition of individual units of a natural enemy production system be understood for effective implementation of a total quality control system, which consists of management, research, methods development, material, production, utilization, personnel and quality control. Such a system, the procedure for implementation of which is succinctly elucidated in the book, will help in increasing production efficiency and cost-effectiveness, besides assisting in the identification of the causes of the problems encountered during the rearing process. This in turn will ensure that these organisms are utilized effectively in the field, in addition to providing the information required for the use of biocontrol agents in pest management.

Crop protection technology is tantalizingly poised at the crossroads today, awaiting the right kind of inputs from the industry. The editor of this book has estimated that the worldwide turnover for the sale of biocontrol agents in 2000 was US$50 million with a predicted annual growth of 15-20%. Nevertheless, consumption of biorational products and biocontrol agents together account for less than 1% of the pesticide consumption in India, as compared to 12% globally. Information is now available in the literature on the field efficacy of a large number of parasitoids, predators and pathogens, in addition to standardized laboratory multiplication methods for many of them. It is hoped that this book will kindle the interests of biological control workers all over the world to develop protocols for mass production and quality control of additional natural enemies and at the same time improve upon the ones described in this book, so that biocontrol agents can be utilized on a larger scale to control more and more crop pests. Availability of standardized products of assured quality will create additional demand for such products and will not only enthuse the existing units to strengthen their facilities but also encourage entrepreneurs to come forward to set up commercial production units. Therein lies the future of biological control, considering the fact that sustained mass production cannot be achieved without establishing professionally managed, fully equipped, specialized facilities exclusively for this purpose.

*van Lenteren, J. C. (ed) (2003) Quality control and production of biological control agents. Theory and testing procedures. Wallingford, UK; CABI Publishing, 352 pp. Hbk. UK£65.00 / US$120.00. ISBN 0851996884.

By: Dr K.P. Jayanth, Bio-Control Research Laboratories, A division of Pest Control (India) Pvt. Ltd.

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Aiming for Better Agent Selection

This publication* is a collection of papers presented at a workshop organized by the CRC (Cooperative Research Centre) for Australian Weed Management, aimed at improving the efficacy and evaluation of biocontrol as well as reducing the chances of any adverse impacts. The ten papers contained in this 99-page volume discuss many of the things that concern modern weed biocontrol practitioners including agent prioritization, host specificity and non-target effects, and suitable evaluation of the outcomes be they measured in ecological or economic terms.

D. T. Briese and co-authors introduce the volume by considering where and how improvements in selection, testing and evaluation of agents might be made. R. McFadyen discusses whether the use of ecology can improve (and improve economically) on the success rates achieved by traditional agent selection methods. A. W. Sheppard deals with the debate on the relevance of using ecological principles to prioritize agents and reviews current methods for predicting efficacy. D. T. Briese examines the rationale behind the centrifugal phylogenetic method (CPM) of test plant selection and discusses how it can be modernized. A. J. Willis and co-authors draw on the results of a study of past releases of agents with known potential to attack native plant species in Australia to discuss the predictability and acceptability of such potential non-target effects. K. Dhileepan and A. E. Swirepik & M. J. Smyth consider ways of evaluating the effectiveness of weed biocontrol on local and regional scales, respectively. D. J. Criticos discusses the role of various types of ecological models in the evaluation of projects and agents. T. L. Nordblum considers ways to improve economic assessments of biocontrol by using realistic assumptions about biological factors in an appropriate socioeconomic setting. Finally, A. W. Sheppard and co-authors summarize the debates and conclusions from the various sessions to present the workshop's views of what is needed to improve selecting, testing and evaluation of weed biological control agents.

Who better than the Australian researchers to draw on their considerable experience in weed biocontrol to pull together these highly important issues in one volume whose contents should influence all workers in the field? Many of the issues raised in this meeting were reiterated at the subsequent 11th International Symposium on the Biological Control of Weeds held in Canberra in April this year, reinforcing the importance of these topics to a worldwide audience. It is valuable to have the diverse but intrinsically-linked themes so well presented in one volume and I am sure all practitioners will benefit from accessing it.

*Spafford Jacob, H.; Briese, D.T. (2003) Improving the selection, testing and evaluation of weed biological control agents. Proceedings, CRC for Australian Weed Management Biological Control of Weeds Symposium and Workshop, Perth, Western Australia, 13 September 2002. CRC for Australian Weed Management Technical Series No. 7, 99 pp.

Obtainable from:
CRC for Australian Weed Management, Waite Campus, University of Adelaide, PMB 1, Glen Osmond, SA 5064, Australia.
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Web: www.weeds.crc.org.au

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Another Testing Book Re-available

A new print run means another host testing publication from the Australasian region is again available*. This, the second printing of the book, publishes papers that were contributed to a workshop sponsored by the Cooperative Research Centre for Tropical Pest Management. Australian and New Zealand scientists summarize and discuss the pros and cons of the common assays used for assessing host specificity for weed and insect biocontrol agents. Recommendations are given on the most appropriate assays to use for host specificity testing, and how we might integrate a range of methods to maximize our ability to interpret insect behaviour accurately.

The book has chapters by some well-known authorities from the region in the field of host specificity testing. For instance, in the weed biocontrol field there are chapters that thoroughly review the methods and best uses for no choice trials (Richard Hill), choice trials (Penny Edwards), open field host specificity tests (David Briese) and overviews on the use of cut foliage in assays (Bill Palmer) and approaches to assay design (Andy Sheppard). This book is not just for weed biocontrol, however, with two chapters that give thoughtful insights into parasitoid host specificity testing (by Barbara Barratt & co-authors and Michael Keller).

*Withers, T.M.; Barton Browne, L.; Stanley, J. (1999) Host specificity testing in Australasia: towards improved assays for biological control. Australia; State of Queensland, Department of Natural Resources and Mines, 98 pp. Reprinted (2003) with permission by Forest Research, Rotorua, New Zealand. NZ$30.

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US Weed Biocontrol Publications

New and updated publications on weed biological control in the USA are available from the Forest Health Technology Enterprise Team in Morgantown, Virginia.

'Biological control of invasive plants in the eastern United States'[1] provides a reference guide for field workers and land managers concerning the historical and current status of the biological control of invasive plant species in the eastern USA. Weeds associated with lakes, ponds and rivers, wetlands, prairies and grasslands, old fields and pastures, and forests are dealt with in separate sections. Each section synthesises knowledge from published articles, unpublished reports and the personal experiences of the authors, who are each leaders in the biological control of the weeds they are discussing. The book thus provides the most up-to-date and accurate status report of weed biocontrol in the region currently available. A concluding section discusses a series of cross-cutting issues pertaining to what will define an appropriate target weed for biological control in the future.

New editions of two practical manuals provide an overview of the biology and biocontrol of weeds in the genus *Centaurea* in the USA.

The first manual[2] covers six knapweed species: squarrose knapweed (*C. virgata* ssp. *squarrosa*), diffuse knapweed (*C. diffusa*), spotted knapweed (*C. soebi*), black knapweed (*C. nigra*), meadow knapweed (*C. pratensis*) and brown knapweed (*C. jacea*). Descriptions are provided for each species together with a key to separate them. Detailed descriptions of 13 knapweed biocontrol insects (eight seedhead feeders and five root borers) include information on identification and lifecycles designed to help identify them in the field.

The second manual[3] is devoted to yellow starthistle (*C. solstitialis*), and provides guidelines on how to establish and manage a biocontrol programme. A description of the weed is followed by detailed descriptions of each of the six insect agents released against it in the USA, again targeted at use for identification the field.

Both manuals also cover, in practical detail, the different elements of a biocontrol programme (planning, implementing and evaluating). They deal with: developing work schedules for field activities; selecting and preparing a release or nursery site; collecting, handling releases of, transporting and shipping agents; and monitoring agents and vegetation at the release sites (with guidelines for each agent). Glossaries of terms ensure clarity, and there are selected references for those wanting to know more. Appendices include useful release and monitoring forms, plus a troubleshooting guide.

Also see the Proceedings section, this issue, for details of the Proceedings of the 1st International Symposium on Biological Control of Arthropods (ISBCA) which was held in Honolulu, Hawaii on 14-18 July 2002. Printed and CD versions of these proceedings are also available from Richard Reardon.

[1] Van Driesche, R.; Lyon, S.; Blossey, B.; Hoddle, M; Reardon, R. (2002) Biological control of invasive plants in the United

States. Morgantown, WV, USA; USDA Forest Service, Publication FHTET-2002-04, 413 pp.

[2] Wilson, L.M.; Randall, C.A. (2003) Biology and biological control of knapweed. Morgantown, WV, USA; USDA Forest Service, Publication FHTET-2001-07, 2nd ed, April 2003, 100 pp.

[3] Wilson, L.M.; Jette, C.; Connett, J.; McCaffrey, J. (2003) Biology and biological control of yellow starthistle. Morgantown, WV, USA; USDA Forest Service, Publication FHTET-1998-17, 2nd ed, July 2003, 76 pp.

[1, 2, 3] Obtainable from: Richard Reardon, FHTET, USDA Forest Service, 180 Canfield Street, Morgantown, WV 26505, USA. Email: rreardon@fs.fed.us Fax: + 1 304 285 1564

[2, 3] Can also be obtained from: Carol Bell Randall, USDA Forest Service, Coeur d'Alene, Idaho, USA. Email: crandall@fs.fed.us

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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.

US Advisors Deliberate Permit Processes

The annual meeting of the Technical Advisory Group for Biological Control Agents of Weeds (TAG), which advises the US Department of Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS) on the introduction of weed biological control agents, was held in Spokane, Washington State on 9-11 September 2003.

TAG is an independent voluntary committee, first formed in 1957. The mission of the group is to facilitate biological control of weeds in North America, namely by reviewing petitions for the release of biological control agents for weeds and giving recommendations to regulating agencies for or against their release. The group comprises 15 members of all relevant US state agencies (e.g. USDA-APHIS, USDA Agriculture Research Service (USDA-ARS), US Fish and Wildlife Service (USFWS), US Environmental Protection Agency (USEPA) and Bureau of Indian Affairs (BIA)), plus representatives from Canada (Doug Parker and Peter Mason, Agriculture and Agri-Food Canada (AAFC)) and Mexico (Jose Gustavo Torres, Comision Nacional de Sanidad Agropecuaria). Al Cofrancesco (Army Corps of Engineers), the current chair of TAG, calls annual meetings to discuss current petitions and controversial issues.

For more information on TAG, the permit process in general and submitted petitions see:

www.aphis.usda.gov/ppq/permits/tag/

About 60 people attended, a larger number than usual, and more than 20 presentations were given on either specific petitions or more general issues of the permit process. The fact that more people than usual participated was in general felt to be advantageous, and the presentations were interspersed with lively discussions.

Jose Gustavo Torres gave an overview on classical biological weed control in Mexico, which targets water hyacinth (*Eichhornia crassipes*), *Salvinia, Convolvulus arvensis*, and saltcedar (*Tamarix* spp.). In Mexico, petitioners use the NAPPO (North American Plant Protection Organisation) format to submit petitions for the release of agents. So far, Mexico has only released agents that have already been approved in other countries, i.e. Canada or the USA. It is now considering *Eccritotarsis catarinensis*, an agent for water hyacinth that has not yet been reviewed by TAG.

Seven presentations reported on petitions that were close to submission or had already been submitted or for which release had recently been granted. For example, John Goolsby (USDA-ARS, Australia) talked about work on potential agents for *Melaleuca* and *Lygodium*. Tim Collier (University of Wyoming) gave an update on a potential agent for Russian knapweed (*Acroptilon repens*) for which a petition will shortly be submitted. James Cuda (University of Florida) presented an interesting idea for overcoming a specific problem, but one that could have more widespread application. Larvae of a potential sawfly agent for control of Brazilian peppertree (*Schinus terebinthifolius*) in Florida are toxic to vertebrates if consumed in large amounts. He suggested releasing unmated sawfly females, which would subsequently only produce males. Judy Hough Goldstein (University of Delaware) gave an update on host range tests with the weevil *Homorosoma chinensis* for biological control of mile-a-minute weed (*Polygonum perfoliatum*), for which investigations are being conducted in collaboration with Ding Jianqing (Chinese Academy of Agricultural Sciences (CAAS), Institute of Biological Control, Beijing). Bill Bruckart (ARS – Fort Detrick) described first releases of *Puccinia jaceae*, a rust recently approved for control of yellow starthistle (*Centaurea solstitialis*); he took the opportunity to encourage the use of pathogens as potential biocontrol agents in general. Rose DeClerck-Floate (AAFC), reviewing biological control projects in Canada, cited the success of *Mecinus janthinus* against Dalmatian toadflax (*Linaria dalmatica*).

Two representatives from the United States Fish and Wildlife Service (USFWS), Shawn Alam and John Fay, responsible for the compliance of petitions with the Endangered Species Act Section 7, also participated. This section of the Act requires all federal agencies to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. Shawn Alam gave a presentation on the general role of FWS within the permit process. Their attendance meant TAG could discuss with FWS representatives issues regarding the processing of petitions by FWS, and the solution to frustration. Conveniently, in this context, two relevant presentations were given: one on the famous (or infamous) 'houndstongue-story' [see *BNI* 23(4), 84N (December 2002), Impasse dogs houndstongue control in the USA] by Mark Schwarzländer (University of Idaho), and the other on the development of test plant lists by Linda Wilson (also University of Idaho), which led to more discussion. The outcome of the exchanges suggest that researchers should: (1) contact the regional FWS office as early as possible when starting a new biocontrol initiative to be aware of any potential threatened or endangered species issues, (2) take the concerns and recommendations of FWS seriously and respond in a constructive manner, (3) try to have a close-to-final test plant list ready as early as possible, (4) be sure to consider threatened or endangered species and justify choices made, and (5) try to engage FWS in finding material of threatened or endangered species for testing. John Fay recommended contacting the Center for Plant Conservation, Missouri Botanical Garden for seeds of indigenous North American plants. Al Cofrancesco suggested a pragmatic view of test plant lists, agreeing that they need to stay flexible to account for the availability of test plants proposed, different agent biologies, and test results.

Bob Flanders (USDA-APHIS Plant Protection and Quarantine (PPQ), Riverdale, Maryland), responsible for signing release permits for biological control agents, gave a presentation on recently planned permit policy changes within his agency, in part triggered by the Agricultural Bioterrorism Protection Act of 2002 and the formation of the new Department of Homeland Security (DHS). Changes will, for instance, involve the development of 'ePermits', which will allow electronic submission and tracking of petitions, development of new, more secure shipping labels, the cessation of the practice of hand-carrying biocontrol organisms, and in general increased oversight and enforcement activities. Details will be posted on their webpage soon. Most of theses planned changes were regarded as positive, since they should make the permit process more transparent and efficient.

Hariet Hinz (CABI Bioscience, Switzerland) gave an overview of what should ideally be included in pre-release studies in the area of origin of target weeds, which linked well with a presentation by Joe Balciunas (USDA-ARS, Albany, California) on the Code of Best Practices. He argued that host specificity does not always equal safety, and cited indirect effects of released agents on foodwebs, interference with other agents or the release of non-indigenous organisms that do not control the target. Currently, information on the potential efficiency of agents or their interaction with other agents is not required as part of the petition process.

The lively meeting ended with Al Cofrancesco, who has been the chair of TAG for the past 12 years, being re-elected unanimously for another 3-year term.

By: Hariet Hinz, CABI Bioscience Switzerland.

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Proceedings

First International Arthropod Biocontrol Symposium

The 1st International Symposium on Biological Control of Arthropods (ISBCA) was held in Honolulu, Hawaii on 14-18 July 2002. This symposium launched a new series of meetings that will be held every 4 years in future – conceived to be the analogue of the long running and highly effective International Symposia on the Biological Control of Weeds, which have been going since 1960. The lack of such a forum until now has held back the discipline of arthropod biocontrol, the organizers felt, and made it less effective in meeting new challenges (which are many and growing) to its practical use. The intent of the initiators of the ISBCA is to create a meeting for practitioners that can build cohesion within the discipline, and foster discussions of issues affecting their work.

The proceedings of the meeting, compiled by Roy Van Driesche at the University of Massachusetts, have now been published and are available free on request*. They are available in a bound, printed edition (573 pp. in length) and also on CD. They will make a valuable addition to any biocontrol library.

The proceedings are divided into two parts. The first part includes 66 oral presentations (all but 13 included as full papers) and the second part contains work presented as posters, 56 in all. The volume provides a unique compilation of the state of research, implementation and thinking in the field of arthropod biological control in 2002, with the main presentations organized as follows:

- Issues and techniques (17 papers): Future expanded use of classical biological control; Methods to colonize, evaluate and monitor natural enemies; Molecular methods in classical biological control; Modelling and theory as tools to clarify causes of success or failure of biocontrol projects.
- Augmentation of natural enemies (15 papers): Successes in augmentative biological control; Economics of production and use of reared natural enemies; Post-release dispersal, distribution, and impact of augmented natural enemies in field settings; Survey of actual and potential use in outdoor crops.
- Conservation of natural enemies (18 papers): Nectar feeding by parasitoids; Alternative hosts and habitat refuges for natural enemies; Effects on natural enemies of using *Bt* crops in IPM systems; Pesticide effects on natural enemies.
- Classical biological control (16 papers): Importation biological control; Monitoring for effects of biocontrol agents on nontarget organisms.

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