General News

Europe's New Guidelines

Comprehensive guidelines specifying the information required for regulating import and release of invertebrate biological control agents (IBCAs) into European and other countries of the IOBC/WPRS (International Organization for Biological Control of Noxious Animals and Plants/West Palaearctic Regional Section) are published in the review section of this issue[1]. The guidelines provide detailed advice to applicants and competent national authorities. They advise a two-step process for non-native IBCAs: first, approval for import for contained research, then approval for release for classical biological control or for commercial use as inundative/inoculative agents. The guidelines explain what information is needed for risk assessments for these two steps, and how this differs for IBCAs that have not previously been released in a European or other IOBC/WPRS country, and for those that have. The guidelines also include the information requirements for approving the augmentative release of a native IBCA. Weed biological control agents, however, are specifically excluded from the guidelines.

Previous international documents relating to IBCA introductions were diverse in scope and level of detail, and were consequently difficult for stakeholders to apply or integrate into harmonized national regulatory documents. The new guidelines, the result of an initiative of the IOBC/WPRS funded by the EU (European Union), integrate the previous international guidelines and protocols for IBCAs into one document.

[1]Bigler, F., Bale, J.S., Cock, M.W.C., Dreyer, H., Greatrex, R., Kuhlmann, U., Loomans, A.J.M. & van Lenteren, J.C. (2005) Guidelines on information requirements for import and release of invertebrate biological control agents in European countries. *Biocontrol News and Information* **26**(4). Also available at: www.pestscience.com

Protocol Replaces Kitchen Blender for Rabbit Virus Deployment in New Zealand

Following the illegal introduction of rabbit calicivirus (RCV, the vector of rabbit haemorrhagic disease, RHD) into New Zealand in 1997, the impetus for an official introduction lapsed. Although a product containing RCV was subsequently manufactured in New Zealand, this ceased in May 2002 largely for commercial reasons. However, in the last 5 years in the drier rabbit-prone areas of New Zealand, populations in some places have returned to pre-RHD levels and are again causing significant production losses. With levels of immunity to RHD apparently on the increase, permission to introduce the virus has been given, allowing the import of RCV suspension manufactured by NSW Agriculture in Australia. With this, the focus falls on how to use it most effectively while minimizing further resistance development in the rabbit population.

RCD still causes annual (particularly autumnal) epidemics in most areas of New Zealand, but the proportion of survivors of these epidemics appears to have increased in many areas from about 30% after the first epidemic in 1997 to over 70% in recent years. This includes the accumulation of older survivors of many epidemics, but the percentage of the young rabbits of the year that survive and become immunized seems to be rising. The net result is that rabbit numbers have increased in some places. 'Kitchen whiz' methods of RCV production, poor storage and indiscriminate distribution following the illegal import are blamed at least in part for this. The term 'kitchen whiz' arose from farmers and other affected parties who 'homogenized' infected organs of rabbits which had died from RHD in kitchen blenders. This produced a suspension containing the virus which was used to spread RHD more widely. It was considered an unhygienic and potential dangerous practice.

A consortium of ten regional councils and two unitary authorities (covering almost all of New Zealand) jointly funded the regulatory approvals process, which involved gaining approval to import RCV from ERMA (Environmental Risk Management Agency) and its registration as a veterinary medicine. The consortium will manage the importation and distribution of RCV throughout New Zealand through representatives on the RCV Users Group, for whom specialists with expertise in the use of RHD for rabbit control have developed the RCV Users Protocol. The RCV Users Group will be responsible for maintaining the protocol (reviewing and amending it as necessary), and for monitoring the use and effectiveness of the imported RCV suspension as a biocide in New Zealand. Sale and use of the virus will be restricted to pest management agencies and authorized users.

The RCV Users Protocol is designed for using RCV as a biocide to deal with specific rabbit problems. The initial trial, originally planned for 2005, is aimed at targeting small, isolated populations of rabbits in urban or semi-urban areas, or where other control methods are not feasible or effective. It is *not* intended to start epidemics. Experience indicates that RCV baiting can only start epidemics at times of year when large-scale epidemics can be expected to occur naturally (spring or more commonly autumn). Furthermore, there is operational and scientific evidence that attempts to initiate epidemics artificially may stimulate induced immunity in rabbit populations. As there is still considerable uncertainty and scientific debate about the epidemiology of RHD, the protocol for using the imported RCV suspension has been developed on a conservative basis to minimize the risk of immunity development.

The RCV Users Group has a difficult balancing act, weighing not just the risks of immunity development, but also the efficacy and cost effectiveness of RCV baits over other methods, not to mention the ability to meet public expectations. Many affected landowners would like to believe that RCV is a biocontrol panacea. It is emphasized that the bait is anything but a 'silver bullet'. If immunity in the population is shown by pre-treatment testing to exceed 40–60%, it is advised that it would be a waste of time and money to use the bait, and that conventional methods would not only be more effective but could also help reduce immunity levels. (RHD immunity information is expensive to collect, however, estimated at some NZ$30/sample.)

The product will be imported and distributed by AgVax Development Ltd to the regional and unitary councils in 10-ml vials (at a cost of NZ$150/ vial), sufficient to prepare 15 kg chopped carrot bait. Given that poor-quality 'homemade' virus product and inappropriate application have been implicated in the build up of rabbit resistance, it is not surprising that conditions for storing, preparing and using the new product are stringent – and revealing; how many of these conditions were met by the 'do-it-yourself' biocontrollers in 1997? For example, long-term storage requires temperatures of -80°C; RCV suspension can be kept for several weeks at -5°C but once unfrozen must be used within 48 hours. Tests should be conducted to check the rabbits will eat carrot, and the complete portion that would be presented in a bait, before the bait is deployed; any RCV-laced bait not eaten within 24 hours of being laid should be removed. These are amongst measures designed to minimize the risk of rabbits eating suboptimal doses of virus or subquality virus, either of which could lead to sublethal infection and subsequent immunity.

It is recommended that the RCV suspension is used as a biocide only during June and July (midwinter) to target rabbit populations at their lowest levels and to maximize the consumption of bait as food is then at its scarcest. Breeding is also at its lowest at this time; exposing very young rabbits to the disease increases the risk of them contracting and surviving the disease, retaining the immunity gained for the rest of their lives. It is believed that females pass on the antibodies, via placenta or milk, as rabbits less than 6 weeks of age can acquire lifelong immunity from an infected mother.

Public education is an important part of the new initiative. In particular, owners of rabbits as pets or for commercial purposes must be reminded of the need to vaccinate their stock. It is considered crucial for members of the public to understand that RCV baits will only be made available under certain conditions (outlined above), and that even in the most favourable circumstances, RCV suspension used as a biocide will achieve at best a 60% reduction in rabbit numbers; 40–60% is more typical.

The official trial release has now been delayed because regulatory and logistic hold ups meant the optimum window for using the baits in 2005 had been missed, but the RCV Users Group is now prepared and anticipating the 2006 season.

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Gall Wasp is Hawaii's Latest Biocontrol Target

Hawaii is no stranger to invasive alien species, but a recent arrival has taken this US island state by storm. The erythrina gall wasp (*Quadrastichus erythrinae*) was first recorded on the island of Oahu in April. In just four months it spread across the island, and was also reported from Big Island, Kauai and Maui. Its presence in Molokai was confirmed in August. The eulophid wasp lays its eggs in the leaves and stems of *Erythrina* spp., including the prized native wiliwili (*Erythrina sandwicensis*) and other species used as ornamentals and windbreaks, commonly called coral trees or tiger's claw. The larvae induce galls on the leaves and young shoots, causing visible distortion as leaves curl and deform, and petioles and shoots become swollen. Heavily galled plants show reduced growth and vigour, and it is feared severe infestations will kill trees.

Non-native *Erythrina* trees have long been popular as ornamentals and as windbreaks, but concern really centres on the fate of the native wiliwili tree. The wiliwili in bloom is a spectacular sight, but it is also a core component of a rare native forest ecosystem. If left uncontained, the gall wasp could affect not just the trees but the many endemic insect and bird species the forest supports. The trees are also culturally important; the lightweight and buoyant wood is used for canoe outriggers, fishing tackle containers, net floats and surfboards, as well as for carving. In addition, the seeds and flowers are commonly used for *lei* (garlands).

A strategy to try to contain the pest was agreed and the measures were implemented. However, larvae pupate in the galls from which adults subsequently emerge. Fears were quickly realized that fallen diseased leaves being dispersed by wind or human-mediated transport would aid the pest's spread, and hopes that it might be possible to confine it to Oahu were also dashed. Furthermore, by October it was being admitted that efforts to suppress infestations by physical means (pruning and destroying the contaminated leaves and stems through composting under heavy plastic) had failed. Indeed, pruning and other measures that promote new growth (e.g. fertilizer use) seem to make the problem worse. Systemic injections of imidacloprid are now being tested as a control measure by the University of Hawaii. Long-term hopes are being pinned on a classical biological control programme being planned by the Hawaii State Department of Agriculture.

The challenge for a biological control programme is all the greater because so little is known about the pest. *Erythrina* species are found throughout tropical regions, with some 110 species worldwide. Many are used as ornamental trees and many have cultural significance in different countries. Nonetheless, the minute insect was described only in 2004 based on specimens from Singapore and from Mauritius and Réunion, submitted for identification to different experts. The samples were of gall wasps reported to be causing considerable damage to *Erythrina* trees in all three countries. Comparison showed them to be the same species.

Later that year *Q. erythrinae* was also identified as the insect that had been causing galls on coral trees in southern Taiwan since winter 2003; by the following spring it had spread throughout the country on various *Erythrina* species. Severe infestations caused curling of young shoots, defoliation, and death of trees. Other parasitic wasps (encyrtids, eupelmids and pteromalids) were also reared from the galls. The biology of these is still to be clarified, and some may prove to be opportune native parasitoids exploiting the new host. Even so, they are not currently providing adequate control, and chemical options are being explored.

The origin of the erythrina gall wasp is not yet known, and this is an immediate focus of attention. A different *Quadrastichus* species is one of a complex of wasps associated with galls on *Erythrina* species in South Africa, indicating that the new pest may have relatives in Africa. Hawaiian entomologists plan to begin their search in tropical East Africa.

The first onslaught of the erythrina gall wasp in Hawaii was so astonishing in its speed and immediate visible impact that the worst was feared. As the native deciduous wiliwili trees come into leaf they are being particularly hard hit. A wiliwili seed collection initiative is being promoted by the University of Hawaii, encouraging the public to help build up a seed bank for the native tree.

An over-riding message, however, is that unless quarantine measures are improved, this will not be the last time that an invasive pest threatens to lay waste to Hawaii's endemic biodiversity.

For further information and references see the erythrina gall wasp pages on the Hawaiian Ecosystems at Risk website:
www.hear.org/species/quadrastichus_erythrinae/

Rust Causes Blackberry Blues in the USA

The leaf rust fungus *Phragmidium violaceum*, which has been used to control weedy blackberries in some parts of the world, has appeared on a commercial blackberry variety in Oregon, USA. First confirmed by the Oregon Department of Agriculture on Himalayan blackberry (*Rubus armeniacus*, formerly also called *R. discolor* and *R. procerus*) along the southern coast of the state in early 2005, as of September 2005 it has been detected in 16 counties, and in three counties on evergreen blackberry (*R. laciniatus*), a commercial variety common in Oregon. So far there is no evidence that it affects Oregon's most valuable commercial blackberry species (marionberry, boysenberry and loganberry), and it is certainly too early to predict the impact of the rust on Oregon's US$30 million industry.

Himalayan blackberry is a weed in many states in western and northeastern USA, where its sprawling canes with piercing thorns overgrow other vegetation. The Oregon Department of Agriculture and the US Department of Agriculture (USDA) had been considering the potential for the rust to be introduced against weedy blackberry varieties, but the pathogen's potential impact on the berry industry created a conflict of interest that needed to be resolved first. The proposal was still at the discussion stage when the pathogen was first discovered in Oregon. How the rust came to arrive in North America is not known, but there is no suggestion of a sinister explanation.

The Oregon Department of Agriculture is now monitoring and sampling *Rubus* species in 18 western Oregon counties to elucidate the geographic distribution of *P. violaceum* and determine its prevalence on the state's blackberries. It is also working with the USDA's Animal Plant Health and Inspection Service (APHIS) and Agricultural Research Service (ARS), Oregon State University, and the Oregon Raspberry and Blackberry Commission to identify effective management strategies, including use of fungicides, to control blackberry rust in commercial evergreen blackberry production.

The origin of blackberry rust is unknown but it occurs on several species of *Rubus*, including *R. armeniacus*, *R. fruticosus* aggregate and *R. laciniatus* in Europe, South Africa and western Asia. It has been introduced as a biological control agent for invasive blackberries in Australia, New Zealand and Chile. Experiences with the rust in Australia [see *BNI* 25(3), 54N (September 2004), Improving biocontrol of weedy blackberry in Australia], where the rust has been introduced against *R. fruticosus* aggregate, may hold some hope for the Oregon berry industry. Studies of genetic variation in the rust showed there to be many strains which vary widely in their ability to infect different *Rubus* taxa. The Australians have identified a number of strains that attack *R. fruticosus* but not commercial blackberries or native Australian *Rubus* species, and eight such strains have now been released and are being monitored.

Further information on the Oregon Department of Agriculture website at:
http://egov.oregon.gov/ODA/news/050720rust.shtml

Native Herbivores Have Exotic Tastes

The natural enemy release theory of invasive species success, which underpins classical biological control, has been questioned in a recent study[1] that compared feeding preferences of some native and exotic generalist herbivores in North America. The authors found that the majority of the native herbivores preferred exotic plants over native plants, while no consistent pattern was discernible for the exotic herbivores. Although most arguments surrounding natural enemy release and invasiveness have focused on specialists, the authors of this paper argue that generalists are important because they are more willing to eat novel foods and thus form a 'first line of defence' against invasions. Although it has yet to be shown that the laboratory feeding preferences they documented translate into impacts in the field, it could be that generalists have a much bigger effect on invasions than has previously been recognized.

The study began with laboratory choice tests in which two native crayfish, *Procambarus spiculifer* and *P. acutus*, were offered ten phylogenetically paired (same genus or family) native and exotic plants, collected from the same locality where possible (six of the ten pairs). Both species showed a preference for the exotic plants in eight of the ten pairs.

To test whether this preference was widespread, the authors looked at the willingness of the crayfish to feed on 57 native and 15 exotic plants occurring sympatrically in the southeastern USA. Latterly, they acquired Asian grass carp (*Ctenophayrngodon idella*) and conducted similar tests using 33 of the native and 14 of the exotic plants. Exotic plants were significantly more palatable than native plants to the native crayfish, but not to the exotic grass carp.

Lastly, the authors looked at three published studies that had involved feeding large numbers of native and exotic plant species to one native and one exotic slug, three native grasshoppers, and three exotic slugs, respectively. They wanted to see whether the pattern they had found in aquatic systems applied on land too. The original studies had all looked at the effect of successional status on palatability. The results were re-analysed to see how plant origin affected palatability. Feeding preference patterns similar to those above emerged: the exotic and native slugs in the first study preferred exotic plants; so did the native grasshoppers in the second study; the exotic slugs in the third study showed no preference. Because most of the exotic plants were early successionals, the results were analysed again, using only the early successional native and exotic plant data. The patterns, although less dramatic, still held, with two of the three native consumers preferring the exotics among the early successional plants, while the exotic consumers showed no preference.

The authors contend that their results oppose the natural enemy release hypothesis, which holds that native generalists will prefer native prey. They support instead the new association theory, which maintains that exotic species will be vulnerable to native predators because it may be unlikely for exotic species to be pre-adapted for defence against evolutionarily novel predators. The authors cite other published references to support this view. They argue that by selectively feeding on exotic plants in a community, generalist herbivores have the potential to help curtail invasions by exotic plants.

This does not mean that classical biological control has to be written off as a strategy, but it provides some food for thought. If native herbivores could contain all exotic plants, there would be no invasive alien weeds for classical biological control to target. Put another way, by the time an invasive species has become the target for a classical biological control programme, it has shown itself insufficiently susceptible to native predators for them (at least by themselves) to prevent the invasive populations achieving pest status. Some of the exotic plants the authors tested are well-known targets for classical biological control in North America. For example, in the palatability tests, high percentages of both native crayfish fed on *Hydrilla verticillata* and *Pistia stratiotes* but native herbivores have not been able to prevent these exotic aquatics from becoming invasive in the southeastern USA. Yet there are no data to say that invasive weeds would not be even more abundant in the absence of native herbivores. The authors point out that all the exotic plants tested are considered weeds in at least one US state, but they were used because they could be found. They suggest that other exotic plants may be less visible because of greater generalist herbivore impact; thus the studies may have actually underestimated the phenomenon; we see only successful plant invasions, not the ones that native herbivores have eliminated. The authors also note that amongst the exceptions to the pattern of native generalists preferring exotic plants were the invasive weeds *Alternanthera philoxeroides* and *Myriophyllum* spp. They conjecture that the invasiveness of these particular species may have been enhanced by their low palatability to native herbivores.

The authors address the question of why the preference for exotic species they found among native generalist herbivores in the laboratory is not more widely reflected in visible impact in the field. They recognize that it is rare for generalist feeders to prevent invasions completely, and exotic plant populations grow despite them. In any case, most native herbivore communities have been severely degraded or even extirpated by humans: bison in north America, moas in new Zealand, tortoises in the Galapagos... all of these have been largely replaced with exotic herbivores such as cattle, goats and sheep. In most systems there may not be the full complement of native herbivore left to provide biotic resistance. The authors acknowledge that the influence of herbivores on plant invasions is not well understood, but point out that their results challenge the mechanisms and importance of natural enemy release as portrayed in classical theory. They contend that exotic species that thrive (and become invasive) because they *do* manage to escape herbivore pressure are the exceptions and not the general rule.

Whatever the implications for biological control theory, this study highlights that native generalist herbivores have a role in introduced plant population dynamics, underlining the importance of considering the contribution native natural enemies might be having on an invasive species when designing a classical biological control programme.

[1]Parker, J.D. & Hay, M.E. (2005) Biotic resistance to plant invasions? Native herbivores prefer exotic plants. *Ecology Letters* **8**, 959–967.

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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.

Can Soil Amendments and *Beauveria bassiana* Work Together in the Banana Agronomic System?

Bananas (*Musa* spp.) play a major role in the nutrition, well being and cultural life of millions of people worldwide. In Uganda, declining banana production and yields since the 1970s have been attributed to a wide range of factors, including pests and diseases, soil nutrient deficiencies, poor management, socioeconomic factors, and postharvest handling problems. Banana weevil (*Cosmopolites sordidus*) remains the most important insect pest of bananas of highland banana and plantain, despite a number of control measures implemented as part of IPM.

The potential for microbial agents, such as entomopathogenic fungal strains of *Beauveria bassiana*, to contribute to control of banana weevil under laboratory and field conditions has been well documented. It has also been found that the effectiveness of *B. bassiana* in the field is influenced by an array of biotic and abiotic conditions which vary with banana management practices. Ugandan farmers implement a wide range of banana agronomic, disease and pest management practices; maintaining different plant densities, applying mulches and other organic amendments, and, in some cases, using chemical pesticides. All these may affect the soil's pH, temperature, moisture content, and biological macro- and micro-fauna variably, rendering some of the efforts useless. Some recent research at Kawanda[1] has focused on the influence of soil amendments on the efficacy and persistence of *B. bassiana* in the management of the notorious banana weevil.

This article reports on preliminary outdoor pot experiments set up to assess the influence of soil amendments in the form of coffee husks, decomposed cow-dung manure and inorganic fertilizers, incorporated into loam soil, on the efficacy and persistence of *B. bassiana*. *Beauveria bassiana* strain (G41), known to have high pathenogenicity to *C. sordidus*, was cultured on cracked maize substrate following a method developed at Kawanda. This formulation, previously shown highly effective in laboratory tests, was applied to banana suckers (cv. Mpologoma, AAA-EA) established in large plastic pots. Adult banana weevils were then released into each pot at intervals of 30 days over a 90-day period and their survival monitored. Samples of *B. bassiana* from the pots were also tested for infectivity at 30-day intervals after fungus application. In addition, the appearance and identity of fungal substrate colonizers and decomposers were documented.

Dead *B. bassiana*-infected banana weevils were recovered from the soil surface and banana sheaths, with highest mortality (30–70%) obtained for weevils released immediately after *B. bassiana* application. However, mortality steadily decreased (5–40%) for weevils released 90 days after applying *B. bassiana*. Moreover, in unadulterated soil *B. bassiana* consistently caused significantly higher mortality than in amended soil.

Samples tested in the laboratory confirmed the reduction in *B. bassiana* efficacy over time. Again, highest banana weevil mortality (75–90%) was obtained from samples taken after 30 days; by 120 days, mortality had decreased to 10–20%. *Beauveria bassiana* collected from unadulterated soils tended to produce higher weevil mortality in the laboratory although differences were not significant.

Why did soil amendments decrease *B. bassiana* survival? Analysis indicated that soil with coffee husks and cow-dung manure had higher moisture content, and micro- and macro-biota loads than unadulterated soil. Perhaps the maize-based formulation deteriorated more quickly in these conditions. Published studies[2] have indicated decreased survival of *B. bassiana* at high moisture content, with best survival recorded at 10–30% moisture. In this experiment, the moisture content of soil amended with coffee husks and cow-dung manure was above this range.

Aspergillus flavus and (especially) *Penicillium crysogenum* were the dominant fungal colonizers, observed in all treatments from 28 days onward. Colonization and abundance of these two species was higher in the amended soils.

The organic matter in amendments with coffee husks or decomposed cow dung manure was significantly higher than in unadulterated soil. High organic content is known to double populations of soil arthropods such as collembolans and mites, which reportedly feed on fungal spores.

Whatever the reasons, and many factors including the above may play a part, the infectivity of the maize-based formulation of *B. bassiana* decreased in all soils mixed with organic or inorganic amendments. Nonetheless, the fungus has been demonstrated to kill banana weevils effectively, while soil amendments are beneficial to crop growth, so what is the answer? Two further lines of research come to mind.

- It is increasingly recognized that effective formulations and appropriate delivery systems are keys to the success of microbial pest control. The development of more stable formulations could help overcome the environmental degradation of *B. bassiana* bioinsecticides.

- Spatial separation between *B. bassiana* and the applied amendments could circumvent the problem of amendments affecting fungal function. It would be worth assessing whether lures based on pheromones/kairomones could be used to aggregate the weevils in an amendment-free environment (trap) where they could be infected by the entomopathogen.

[1]This work was funded by the UK Department for International Development (DFID) through a grant to the National Banana Research Programme of the National Agricultural Research Organization, Uganda, based at Kawanda. Technical support from the International Institute of Tropical Agriculture (IITA), Makerere University Kampala, CABI and Reading University is also acknowledged.

[2]Lingg, A.L. & Donaldson, M.D. (1981) Biotic and abiotic factors affecting stability of *B. bassiana* conidia in the soil. *Journal of Invertebrate Pathology* **38**: 191–200.

Source: Magara, E., Nankinga, C.M., Gold, C.S., Kyamanywa, S., Tushemereirwe, W.K., Moore, D., Gowen, S.R. & Ragama, P. Influence of soil amendments in the efficacy of *Beauveria bassiana* for control of the banana weevil, *Cosmopolites sordidus* (Germar) in Uganda. Paper presented at the African Crop Science Conference, Nairobi, Kenya, 12–17 October 2003.

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Beauveria bassiana in Rice Hispa Management in Assam

Research spanning 15 years in Assam has led to *Beauveria bassiana* being included in the strategy for controlling the rice hispa (*Discladispa armigera*), a widespread and increasingly damaging chrysomelid pest in southern Asia.

Rice hispa is a major insect pest of rice in many rice-growing parts of southern Asia and Australia, more particularly in Bangladesh, India, Nepal, Mynmar, Thailand, Cambodia, Indonesia, Laos, Malaysia, China, Pakistan and Sri Lanka. The pest has recently become increasingly menacing to rice production causing yield losses of 20% in Nepal, 28% in India and 52% in Bangladesh. In the northeastern part of India, i.e. Assam, the post-flooded rice suffers 100% loss due to its attack. Besides rice, the rice hispa attacks other crops like wheat, maize and sugarcane, and several grasses and sedges belonging to the Poaceae, Cyperaceae and Commelinaceae.

The first report of rice hispa dates back to 1892 in Bengal. From the 19th century onwards, it was regularly reported from various parts of India and Bangladesh. The pest has four larval instars, moulting inside the feeding tunnels in the plant. It is oligophagous, long lived and fecund, and has the ability to disperse easily.

Adult beetles scrape off parenchymatous tissue, leaving only the epidermal membranes, which produces characteristic white streaks along the long axis of the leaf. Larvae cause injury to rice plants by tunnelling inside leaves. Mouthparts in both stages are of the orthopteroid (chewing) type. Adults and larvae have different modes of feeding (though both chew on leaves) which may reduce intraspecific competition as well as protect the larvae.

The incidence of the rice hispa in different rice-dominated localities varies with climatic factors, geography, season, rice varieties, management practices and stages of the crop. Therefore, the economic threshold level (ETL) may be as low as one adult insect/hill during the early- and mid-tillering stages of rice plants, but ETLs as high as 526 adults/m^2 have been reported from Nepal. The lower ETL during the early stages indicates the high potential for damage to future yield from early attack.

Control of rice hispa has been a major problem for the farmers who depend primarily on rice as a subsistence crop. Efforts exerted by the concerned government departments also fail to contribute substantially to controlling this pest because the available protection technology (insecticide application) becomes totally ineffective and impractical for combating the pest during its widespread outbreaks. Aerial spraying was undertaken in Bangladesh and Assam during the critical outbreak periods in 1960–1973 and 1966–1967, respectively. Chemical control may sometimes prove to be detrimental by creating additional problems, such as environmental hazards, development of insect resistance and resurgence, killing nontarget organisms especially aquatic fauna, and so on.

Research: 1990 to Date

The search for an alternative to chemical control resulted in the identification of a mycoinsecticide, an indigenous strain of the white muscardine fungus, *Beauveria bassiana*, in field populations of the rice hispa. The pathogen has long association with the insect complex of northeast India. During the last few decades, the fungus has been thoroughly studied in our laboratory with the aim of utilizing it as an efficient biocontrol agent for the management of rice hispa. The fungus has been found to have virulence of 78–87% with an LC_{50} value of 90.16. During the last few years, methods and technologies have been generated for its mass production (which can yield 39.33×10^7 spores/ml) and field application. The pathogen has the capacity to spread widely and cause an epizootic in a very short period as the fungal spores disseminate quickly. The pathogen is harmless to parasitoids and predators, and field performance is very encouraging. Compatibility of various agrochemicals (fertilizers, pesticides, growth regulators and many others) with *B. bassiana* has been found to be encouraging. Very recently *B. bassiana* was found to be compatible with half of the commercial dose of chlorpyriphos. In six different localities of Assam where rice hispa is endemic (in *ahu* [autumn] and *sali* [summer] rice crops) combined application of *B. bassiana* and half of the commercial dose of chlorpyriphos was found to be effective in managing the pest resulting in increased yield.

Beauveria bassiana was found to attack all the stages of rice hispa causing up to 90% mortality in the laboratory. Natural occurrence of this pathogen varies with stages, season and hosts on which *D. armigera* feeds. Several field trials have been conducted over the last 15 years in different rice seasons in farmers' fields in Assam where rice hispa is endemic to assess the efficacy of the pathogen for controlling the insect. Multilocational field trials with *B. bassiana* (10 million spores/ml dilution), 1% neem-seed oil and a conventional insecticide (0.072% monocrotophos) revealed that the mycoparasite was superior to neem-seed oil and monocrotophos in controlling the rice hispa, leading to increase in yield. The cost–benefit ratio is 1:7.66 for *B. bassiana*, compared with 1:2.92 for the chemical.

Recommendations for Rice Hispa Management

The following strategies are suggested for managing the rice hispa in Assam:

1. As the initial population build up of rice hispa take place on *boro* and early *ahu* (irrigated summer rice) crops from February onwards, appropriate protection measures must be taken when the population reaches the ETL of one adult or one damaged leaf per hill.

- Draining of water at the time of population build up for 2–3 days may help decrease the rice hispa population.
- Weed-free cultivation can be encouraged.

2. In areas where *boro* and *ahu* rice are not widely grown, small, swampy areas and roadside patches containing alternative hosts may provide breeding pockets of rice hispa during February to April. Such infested pockets are easily identifiable from a long distance because of the vegetation's characteristic withered condition and burnt appearance. These pockets are also not very large in size. Therefore, it is advisable to destroy these weeds by mechanical methods (cutting and burning). This operation will minimize further multiplication and dispersal of adults into the *bao*/*sali* (winter rice) crop. Use of insecticides cannot be advocated because the areas are used for grazing and natural fisheries.

3. Routine monitoring at weekly intervals must be undertaken from April onwards to detect the initial population build up in and around *bao* fields followed by similar surveillance in July onwards in s*ali* crops. Similar monitoring is advisable for the next year in the rice hispa-affected regions from the middle of February to April.

4. Once the appearance of the pest is detected and the population reaches the ETL, control measures must be taken immediately at the breeding site, and in *ahu* and *bao* as well as s*ali* rice fields.

5. Whenever and wherever possible, staggering of transplanting should be discouraged; early transplanting helps *sali* rice to escape rice hispa attack.

6. Initial protection of the seedlings in the main fields may be provided by following the standard package of practices (apply carbufuran at 3 g/m^2 in the moist seedbed 5–7 days before uprooting of seedlings). Seedlings may also be prepared by dipping the root portion in 0.25 a solution of chlorpyriphos (1 ml/litre of water) along with 1% urea for 3 hours.

7. Clipping of leaf tips of seedling must be done.

8. All the currently recommended insecticides are effective; however, based on the superior performance of chlorpyriphos and quinalphos, use of these insecticides may be encouraged. On the other hand, given the toxicity of endosulfan to aquatic fauna, its use may be restricted, though endosulfan is still listed as effective insecticide.

9. Farmers must be educated on the importance of applying recommended insecticides at the proper dose and spray volume. Many insecticides at sublethal or below-recommended doses do not work but instead produce some undesirable effects, such as development of resistance, resurgence (abrupt population increase of the target pest) and secondary pest outbreaks.

10. Spraying operations should be done early in the morning and late in the afternoon as rice hispa feeding, mating and oviposition are maximum during this period.

11. As a mechanical method of control, clipping affected leaves up to about 6 inches (15 cm) from the top and then destroying the clippings should be strongly encouraged. These leaves contain eggs, larvae and pupae.

12. October spraying should be avoided, as the natural enemies are maximum during this period. Given the proven bio-efficacy of *B. bassiana* against rice hispa in the field, *B. bassiana*-impregnated RHSDRB (rice husk, saw dust and rice bran) medium can be applied at 3 kg/ha. On preparing the solution in water containing liquid detergent, the solution will contain 10^7 spores/ml.

13. After harvesting of *sali* paddy, burning of stubble in November–December should be encouraged so as to kill the hibernating adults.

14. Deep ploughing of rice hispa-affected fields during February and March can be encouraged.

15. Training students and other youths on the rice hispa problem must be undertaken. Bringing people to an understanding of rice hispa management is the best way to deal with this problem. No programme is more successful than the degree of commitment made by the people involved.

16. Public support must be created for managing this pest. Collection of adult hispa in rice fields, and hand picking of larvae in the roadside swamps and pits can

be encouraged among schoolchildren and village youths.

Current Work

Work on mass production of *B. bassiana* in liquid state fermentation using potato broth, sugar mill effluent and other liquid media is in progress in this laboratory in order to produce more virulent infective propagules. It is known that conidia are more successful than blastospores in infecting insects, either because they form penetration structures with greater frequency or because their germ tubes avoid host defences more effectively. The work is also aimed at production of wettable powder formulations of the fungus with a longer shelf life by adding chitin (addition of chitin results in luxuriant growth of the fungus) from various sources and certain inert materials, including dispersant and wetting agents with different carbon and nitrogen sources. Standardization of the storage conditions with special reference to temperature and shelf life is also under consideration for research.

Future Plans

Identification of critical gaps in formulation and application of entomopathogenic fungi are potential areas of research. Improvement of stability and quality are the two important topics, which require extensive research. Genetic improvement of strains, toxin production, widening the host range, compatibility with agrochemicals and persistence in the soils are also future research areas that could transform entomopathogenic fungi into a viable technology for management of rice hispa and other pests. Creating awareness amongst the farmers about biopesticides is urgently required. Promotion and extension to increase their use will trigger the growth of the biopesticide industry. DNA fingerprinting of various fungal strains is also needed. Other areas of the study for the management of this insect pest include understanding the migratory behaviour of the insect through satellite mapping, and identification of resistance genes in the plant.

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Developing Greener Baits for Leaf-Cutting Ants in Guyana

In Guyana (as in some other parts of Central and South America), leaf-cutting or acoushi ants (*Atta* spp.) are among the most serious insect pests. Plant material cut by the ants is used as a substrate by a fungus on which the ants then feed. Out of about 10,000 known species of ants, only about 180–200 species exhibit this mutualistic behaviour with fungi. It allows these species to exploit a wide range of crop types, which contributes to their importance as pests. Preliminary studies have indicated a number of alternatives with potential to replace broad-spectrum insecticides in bait-based management in Guyana.

A survey conducted on the distribution of leaf-cutting ants in Guyana established that *A. cephalotes* and *A. sexdens* are the most important species. They are widely distributed and cause the most damage to crops in all the major farming communities. In sandy soil areas *A. sexdens* predominates while in riverine clay soil areas *A. cephalotes* is more damaging. Nests of *Acromyrmex* spp. were also observed on some farms in sandy soil areas but farmers did not rate those as serious pests. In Guyana, acoushi ants have been identified as a major limiting factor to successful crop production in the forested areas, and there is a need for some form of sustainable management.

Control of acoushi ants in Guyana began in the 1950s. Early control programmes used carbon bisulphide and chlorinated hydrocarbons applied with swing fog machines, but those chemicals had severe chronic disadvantages. National control programmes then adopted the use of poisoned baits, initially using imported mirex. Bait-based management takes advantage of the ants' foraging behaviour. The baits are placed on the ants' trails and as they forage they pick up the bait as well and transfer it to their nests.

By 1973–74, aldrin-based baits replaced mirex, which was no longer available in Guyana. A manufacturing plant was subsequently acquired which allowed baits of consistent quality to be produced at the National Agricultural Research Institute (NARI). The current insecticide in the bait is fipronil, a broad-spectrum phenylpyrazole compound which is toxic by contact and by ingestion.

Recently, a study has started to look for alternative products for use in bait manufacture. Eventually, the following categories of products will be assessed by laboratory and field testing (depending on their availability on the local market):

- Synthetic pyrethroids: e.g. alphacypermethrin, cyhalothrin
- Biopesticides: e.g. azadirachtin (neem-based products), natural pyrethrum, *Bacillus thuringiensis* (*Bt*), insect growth regulators (IGRs)
- New plant biopesticides: e.g. Mammey (*Mammea americana*) seed extracts

Initial laboratory work, which began in October 2004, centred on studies in which soldier ants are placed on a substrate (filter paper) treated with 0.0001–0.1% solutions of fipronil, alphacypermethrin or natural pyrethrins. The ants were collected from the farming communities of St Cuthbert's Mission.

Although speed of kill is generally a key factor in insecticide efficacy, the rationale behind the bait method necessitates a delayed killing action. The optimum insecticide treatment allows the ant to survive long enough to carry the poison back to the colony where it can affect non-foragers.

Initial results indicated that the higher concentration used gave 100% mortality too fast (within one hour) while lower concentrations allowed exposed ants to stay alive longer than 24 hours before dying. In further experiments at concentrations between 0.01–0.05% using alphacypermethrin, pyrethrum and fipronil, only alphacypermethrin at 0.05% gave 100% mortality in the first hour; whereas the remaining insecticides (fipronil and pyrethrum) gave less than 100% kill which was achieved after 24 hours of exposure. The current study has thus demonstrated that insecticides other than fipronil have potential as bait components.

Baits are particularly useful for controlling leaf-cutting ants. Individual ants forage and cause damage over a larger area than the area they normally reside in. At any one time, foraging ants are a small proportion of the overall population of ants in the nest. More foragers are normally found in the nest and these can potentially cause subsequent damage. Consequently, killing foragers where they are causing damage does not necessarily protect the crop, and it is better to deal with the nest population. An *Atta* spp. nest may have a surface of disturbed earth of about 250 m^2, may reach a depth of 5 m, and at times may contain up to 5 million ants. Since ant nests are deep underground and difficult to find, locating and killing the ants when they are not foraging is equally difficult. As noted above, at any one time only a proportion of the ants will be actively foraging, and those foragers are mostly sterile workers, so killing them has limited impact on future population growth. Their wide and active foraging behaviour, however, means they pick up insecticide from baits distributed at low densities, and concentrate it in their nests. By penetrating the nest in this way, it is possible to destroy the entire ant population of an area.

Further investigations are underway, both in the laboratory and in the field, to study the effect of other biopesticides in the management of leaf-cutting ants in Guyana. We also intend to look at the bait matrix and investigate whether the quality, acceptability and shelf life of the bait could be further improved and its cost reduced in order to enhance the sustainability of this technology. Currently the bait is made using wheat flour and wheat bran, products that are imported into Guyana, and as such the cost is heavily subsidized.

The authors wish to thank everyone who contributed in any way to this study. We are grateful to the Management of NARI, and in particular to the Director of the Institute, Dr D. Homenauth, whose management made these studies possible, and to the Head of Plant Technology Department, Dr P. Chesney, for technical guidance and support. We also pay special thanks to Dr L. Monroe whom we regard as an authority in this area and whom we consulted extensively before and during the conduct of these studies.

Finally we give our heartfelt and sincere thanks to the farming community of St Cuthbert's who warmly welcomed us in their area and shared their invaluable experiences on acoushi ant management practices. We similarly express our sincere gratitude to the Managing Director of Pyrethrum Board of Kenya, Nakuru, for donating and sending samples of natural pyrethrum for use in these experiments. Last, but by no means the least, thanks to the Voluntary Service Overseas (VSO) in Guyana for their administrative and moral support.

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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.

Not the Same Old Song and Dance: Extension Steals the Show in Bangladesh

Picture songs are a novel extension method created by the NGO Shushilan in southwest Bangladesh to teach good rice farming to smallholders, particularly women. The songs build on a traditional Bangladeshi family entertainment, *jari gan*, a song and dance show, illustrated with paintings on a large scroll of cloth, formerly put on for villagers by travelling troupes of actors.[1]

Shushilan was basically a human rights movement, which started working with agriculture with the PETRRA project[2] to help poor people harvest more food, along with the Department of Agricultural Extension (DAE) and the Bangladesh Rice Research Institute (BRRI). Shushilan weaves with three threads: reaching women farmers, working through village clubs (which grew out of football teams), and using culturally appropriate extension.

Shushilan writes and choreographs its own numbers (many of which are still on issues like non-violent conflict resolution). Once written and rehearsed, they are pre-tested in front of colleagues and collaborators, then revised and performed for farmers. The picture songs get the messages right with a balance between education and entertainment, and a message to go with each step of the dance.

Shushilan sings and dances outdoors or in large meeting rooms. The catchy tunes, striking costumes, lively dancing, and bright pictures larger than a giant TV screen draw people in. They may well have heard the messages before, but this is entertaining and that holds their attention. The picture song lasts for 45 minutes, enough time to convey a lot of information. Through singing, dancing and pictures, the actors tell people about the high yielding varieties developed by BRRI and promoted by DAE, but also urge them to use organic fertilizers such as cow dung and balanced chemical fertilizers (a picture reinforces the message about the number of applications). They tell them not to abuse insecticides, and that insect pests have natural enemies (illustrated with paintings of toads, ladybirds and spiders). They also teach new ways of saving seed in a pot (another easy message to illustrate). The picture song ends with the actors inviting farmers to come to Shushilan with samples of crop pests, diseases, soil and water. Shushilan staff analyse the samples and provide recommendations for the farmers, while also keeping a database of results. (The lab now receives support from CABI Bioscience's Global Plant Clinic.)

The picture song is not Shushilan's only extension method, but it draws in a large audience. It may motivate the farmer to attend a training course, visit a demonstration plot, or visit the Shushilan's agricultural service centre for advice. When asked how they learned, farmers tended to mention first training in the village by extension agents, with picture songs coming in second or third place. Picture songs do not replace conventional extension, but they capture attention and reinforce messages and open minds so people then learn better through field days, demonstration farms, and courses. Picture songs have also encouraged women to work in their own rice fields, thus saving money on labour. Picture songs have now been seen by some 25,000 people, and Shushilan planted 501 demo farms with local people, including 347 women.

Farmers say that Shushilan taught them to space rice systematically in lines (which saves the seed), to analyse soil to apply the right amount of fertilizer (and harvest more rice with fewer chemicals); to plant higher yielding varieties; and to use less insecticide. One farmer group said rice yields had risen from 2.2–2.9 t/ha before the project to 5.2–5.7 t/ha.

Picture songs show that successful extension should be entertaining, have something to say, blend the old and the new, and use realistic naturalistic drawings. It also combines the first rule of extension, 'thou shall not be boring', with a new one: if you want people to remember something all their lives, teach them to sing it.

[1]Bentley, J.W., Nuruzzaman, M., Nawaz, Q.W. & Haque, M.R. (2005) Picture songs. Chapter 10 in: Van Mele, P., Salahuddin, A. & Magor, N.P. (Eds.) *Innovations in rural extension: case studies from Bangladesh*. CABI & IRRI, Wallingford, UK, pp. 115–123.

[2]The PETRRA (Poverty Elimination through Rice Research Assistance) project was funded by DFID (the UK Department for International Development) and managed by IRRI (the International Rice Research Institute), in partnership with BRRI (the Bangladesh Rice Research Institute), the Bangladesh Ministry of Agriculture and the resource-poor rice farmers of Bangladesh.

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.

Arthropod Record

The Second International Symposium on the Biological Control of Arthropods (ISBCA II) was held in September in Davos, Switzerland (for a full conference report, see Conference Report section, this issue).

The conference produced a paperback 2-volume 734-pp. proceedings with developed articles and coloured plates from the invited speakers. The CD Rom with PDF files contains these papers as well as abstracts from the 116 posters presented at the conference. Copies of the proceedings and CD are available free of charge. (There are also limited numbers of the conference proceedings from ISBCA I available.)

Contact: Dr Richard Reardon, USDA Forest Service.
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Looking Ahead

ISBCA III will be held in New Zealand in February–March 2009. The main organizer, Steve Wratten (Wrattens@lincoln.ac.nz) is seeking volunteers for the Scientific Committee and as Regional coordinators. See the full report for more details.

EMAPi9 in Australia

The 9th International Conference on the Ecology and Management of Alien Plant Invasions (EMAPi9) will be held on 17–21 September 2007 in Perth, Western Australia.

The 2nd International Workshop on Weed Risk will be held in conjunction with this conference.

For details and to register interest, see:
www.congresswest.com.au/emapi9/

Or contact: Liz Bradley, Conference Manager, Congress West Pty Ltd, Suite 3/12 Thelma Street, West Perth, WA 6005, Australia.
Email: emapi9@congresswest.com.au
Fax: +61 8 9322 1734

South Africa's PPRI Newsletter Online

The Plant Protection Research Institute (PPRI) newsletter has gone electronic. The latest issue, No. 64, is available in pdf format and can be downloaded from:
www.arc.agric.za/institutes/ppri/main/news/pprinews.htm

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Conference Report

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.

The Second International Symposium on the Biological Control of Arthropods

The Second International Symposium on the Biological Control of Arthropods (ISBCA II) was held in Davos, Switzerland on 12–16 September 2005. The meeting was attended by 220 participants from 52 countries. ISBCA II built on ISBCA I, which was held in Hawaii in January 2002 and was attended by 150 participants from 25 countries. ISBCA is held every 4 years and its purpose is to create a meeting for biological control practitioners, a forum for information exchange and an event to build cohesion among the research community, and to foster discussions of issues affecting biological control work, particularly pertaining to the use of parasitoids and predators as biological control agents.

To this end, a 14-session conference, with five invited speakers per session, was arranged in Davos, Switzerland. Sessions were designed to address the most interesting and relevant research topics in biological control of arthropods that have current and broad international application. The oral sessions were complimented with poster presentations prepared by over 116 scientists from around the world. Topics covered at ISBCA II were diverse and included invasion biology and application to biological control, biological control of arthropod pests of conservation importance, the role of biological control for pest management in developing nations, the compatibility of transgenic crop plants and natural enemies, and emerging experimental protocols and legislation for assessing natural enemy specificity and safety.

ISBCA II kicked off on Monday 12 September 2005. Sandy Smith (University of Toronto, Canada) and Heikki Hokkanen (University of Helsinki, Finland) developed Session 1 which looked at Invasion Biology and Lessons for Biological Control. Topics covered included the role of intraguild predation facilitating invasion by coccinellids, identifying the pest donor region within the area of origin of an invasive species, and the invasion dynamics of exotic beetles in Japan and Europe. Session 2 focused on Biological Control of Arthropods of Conservation Importance and was organized by Mark Hoddle (University of California, Riverside, USA) and Matthew Cock (CABI Bioscience, Delémont, Switzerland). An interesting topic in this session covered an emerging area in classical biological control: assessment of natural enemies for control of pestiferous marine arthropods, in particular, the potential role of castrating barnacles for green crab control. The biological control of cottony cushion scale (*Icerya purchasi*) with *Rodolia cardinalis* on the Galapagos Islands provided a non-agricultural application of this very successful natural enemy. Programmes targeting scales, leaf miners, and weevils attacking endangered native plants were covered. Nick Mills (University of California, Berkeley, USA) and Jacques Brodeur (University of Montreal, Quebec, Canada) organized Session 3 which focused on Recent Successes of Classical Biological Control: An Impact Analysis. Presenters from South Africa, Canada, and the USA covered a diverse range of projects including codling moth (*Cydia pomonella*), diamondback moth (*Plutella xylostella*), and lily leaf beetle (*Lilioceris lilii*) control.

Session 4 was organized by Steve Wratten (Lincoln University, Canterbury, New Zealand) and Geoff Gurr (University of Sydney, Orange, New South Wales, Australia) and investigated emerging research relating to Cultural Manipulations to Enhance Biological Control. Topics covered included habitat management in sub-Saharan Africa, evaluation of native plants to conserve natural enemies in perennial crops, and the use of synthetic herbivore-induced volatiles to recruit natural enemies into cropping systems. Session 5 investigated the Contribution of Biological Control to the Global Development Agenda and was organized by Juan Manuel Alvarez (University of Idaho, Aberdeen, USA) and Liu Shu-Sheng (Zhejiang University, Hangzhou, China). Presenters provided overviews on the role of biological control for pest suppression of citrus pests in the Caribbean, control of cassava pests in Africa and South America, and of fruit-piercing moths in the South Pacific Islands, and the diminishing support for biological control for pest management as a tool for poverty alleviation in developing nations.

Janny Vos, (CABI Bioscience, Leusden, The Netherlands) and Peter Ooi (UN Food and Agriculture Organization [FAO], Bangkok, Thailand) arranged Session 6 which looked at the Implementation of Biological Control through Farmer Participatory Training and Research. The papers in this session highlighted the need for in-the-field training of farmers in developing nations to demonstrate the principles of biological control, the role of natural enemies in pest suppression, and the disruptive effect pesticides can have on resident natural enemy populations. Session 7 was on the Compatibility of Insect-Resistant Transgenic Plants with Biological Control and was arranged by Joerg Romeis (Agroscope-FAL, Zurich, Switzerland) and Tony Shelton (Cornell University, Geneva, New York, USA). The overwhelming message from this section indicated that transgenic corn and cotton crops probably pose no substantial threat to natural enemies, and significant reductions in broad-spectrum pesticide use most likely enhance naturally-occurring control by resident natural enemies.

Session 8 was organized by Felix Wäckers (NL Royal Academy of Sciences, Harlem, The Netherlands) and Henry Fadamiro (Auburn University, Alabama, USA) and looked at the Role of Food Supplements in Biological Control. Papers in this session indicated that not all resource subsidies for natural enemies are equal and expected pest suppression can be significantly influenced when alternative foods are available. Bob Pfannenstiel (US Department of Agriculture – Agricultural Research Service [USDA-ARS], Weslaco, Texas, USA) and Matthew Greenstone (USDA-ARS, Beltsville, Maryland, USA) collected together a very interesting set of speakers who addressed the Role of Generalist Predators in Biological Control. Data were presented on the important role landscape effects can have on predator guilds, to show that specific predator guilds forage only at night, and on how alternative prey and intraguild predation can affect predator diversity and impact.

Session 10 on Augmentative Biological Control in Outdoor Annual Crops was arranged by Steve Naranjo (USDA-ARS, Phoenix, Arizona, USA) and Patrick de Clercq (Ghent University, Belgium). Talks covered the mass rearing, field releases, and dispersal of *Trichogramma*. Work in Israeli strawberries provided an example of how the removal of predatory bugs actually enhanced augmentative biological control of primary pests. Dave Gillespie (Agriculture and Agri-Food, Agassiz, British Columbia, Canada) and Karel Bolckmans (Koppert, Amsterdam, The Netherlands) gathered speakers to address issues pertaining to Augmentative Biological Control in Greenhouses in Session 11. Talks covered the development of greenhouse biological control in China and Latin America, the compatibility of insecticides with natural enemies, and the role of predators for pest suppression and the importance of intraguild predation in greenhouse crops.

The last three sessions of ISBCA II were extremely topical and looked at new areas related to risk assessment, host specificity testing and regulation of natural enemies for biological control. Session 12 organized by Franz Bigler (Agroscope-FAL, Zurich, Switzerland) and Thomas Hoffmeister (University of Bremen, Germany) on Environment Risk Assessment of Invertebrate Biological Control Agents covered subjects pertaining to selection of nontarget species for testing and the role of environmental conditions in the establishment of exotic natural enemies. Roy Van Driesche (University of Massachusetts, Amherst, USA) and Peter Mason (Agriculture and Agri-Food, Ottawa, Ontario, Canada) organized Session 13 on Predicting Natural Enemy Host Ranges: Strengths and Limitations of Lab Assays. Speakers addressed issues related to experimental design, the power and appropriateness of statistical tests, and extrapolation of lab assays to field situations. Legislation and Biological Control of Arthropods: Challenges and Opportunities was the theme for Session 14 organized by Barbara Barratt (AgResearch, Mosgiel, New Zealand) and Ulli Kuhlmann (CABI Bioscience, Delémont, Switzerland). Regulatory issues on export, shipment, and importation were discussed along with legislative needs to harmonize natural enemy use in Europe and the USA. It was suggested that aspects of the Hawaiian biological control model may serve as a template for the development of biological control legislation for the entire USA. The regulation of natural enemy releases in Australia and New Zealand was contrasted; the New Zealand model included extensive involvement and consultation with the indigenous Maori population.

The memory of the meeting has been captured in the ISBCA II conference proceedings. The printed ISBCA II proceedings are large, two volumes totalling 734 pages, representing the wealth of information presented at this meeting. The two-volume proceedings include only the articles prepared by invited speakers. The accompanying CD is an electronic version of the conference proceedings and the abstracts of approximately 116 posters that were presented at the meeting which were perused by over 200 meeting attendees representing the international biological control community. The conference proceedings and CD are available free of charge by contacting Dr Richard Reardon at the USDA Forest Service (rreardon@fs.fed.us).

ISBCA II is extremely grateful to the sponsors who contributed generously to this meeting. Without their gracious support ISBCA II would not have been as successful or memorable as it was. ISBCA II acknowledges the support of the USDA Forest Service for supporting the publication and distribution of the conference proceedings. The USDA-ARS National Program on Tropical Agriculture and National Beneficial Insects Program supported travel and accommodation for selected invited speakers and scientists from developing nations. The Swiss Agency for Development and Cooperation Natural Resources and Environment Division and Asia II Division provided financial support for attendees from developing nations. The Swiss National Science Foundation International Relations Division supported attendance by scientists from East European countries. CABI Bioscience and the University of California, Riverside provided substantial technical assistance and manpower to make ISBCA II a reality.

ISBCA III will be held in Christchurch, New Zealand in February–March, 2009. The key organizer of ISBCA III is Steve Wratten (Wrattens@lincoln.ac.nz) at Lincoln University. Dr Wratten will be searching for volunteers to form the Scientific Committee which will assist with the development of the programme for ISBCA III and also volunteers to act as Regional Coordinators to help advertize ISBCA III globally and answer local inquiries about ISBCA III and biological control in general. We intend building on the success of ISBCA I and II. With gathering momentum and increasing need for biological control of invasive arthropod pests of agricultural and conservation importance we anticipate ISBCA III in 2009 to be a 'must attend' event for practitioners of arthropod biological control. Mark your calendars now, start planning, and we will see you all at ISBCA III in New Zealand!

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New Books

Queensland's Biocontrol History

This book is a must for anyone involved, however remotely, in biological control, be it at the cutting edge of research, or at the undergraduate level, or, the most demanding and pragmatic of all, as a farmer. The author and the Queensland Department of Natural Resources and Mines are to be congratulated on reproducing such an informative, beautifully presented and lavishly illustrated publication. Unlike many similar works, the high quality of the cover and text pages more than do justice to the numerous historical black and white prints as well as the latest digital images.

The four parts to the book are well thought out, beginning with a brief introduction to the history and science of biological control, and then in Part 2 – which comprises by far the largest component – describing past weed biological control programmes in Queensland (intriguingly, for me at least, American spelling is used). Eight major weed targets are profiled, and 14 pages alone are devoted to the pioneering prickly pear "program", which charts the history and impacts of the weed, the early control efforts employed, and the hunt for biocontrol agents. In addition, as an added bonus, a boxed case study of an important phase or aspect of the programme is included. Finally, the current status of the weed is assessed and all the data are encapsulated in a neat and informative summary which, crucially, includes a cost–benefit analysis. Much of this information, and possibly most of the prints, have probably never before 'seen the light of day'. Each weed is treated thus.

Part 3 describes and illustrates the places and people involved, and case studies of selected personalities provide unexpected insights and highlights, including a rare picture of Rachel Crutwell McFadyen in her former CIBC life. Part 4 discusses the current and future weed targets and trends, followed by a useful appendix detailing all the agents released so far, as well as those still being screened.

The inside cover advises that: "For copies of this book contact Land Protection, Department of Natural Resources and Mines, P. O. Box 2454, Brisbane, QLD 4001" [Australia].

I hope that sufficient copies of the book are in stock to meet the demand that this delightful publication merits.

Walton, C. (2005) *Reclaiming lost provinces: a century of weed biological control.* Queensland Department of Natural Resources and Mines, 104 pp. Pbk. ISBN: 1 920920 94 3

By Harry C. Evans

Many Threads to a Plant Pathologist's Life

Having started off my professional career as a plant pathologist in the tropics working on a crop and disease – as well as in a habitat – totally alien to me, I sense a kindred spirit in Harry Marshall Ward (1854–1906). Indeed he has long been one of my heroes for his pioneering and still germane contribution to our knowledge of the life cycle of the coffee leaf rust. Not surprisingly, therefore, the author has chosen to devote the opening chapter of this evocatively titled book to this formative period of Ward's life. The relatively short time that he spent in Ceylon (Sri Lanka) investigating coffee leaf rust, which was then rampaging through the vast coffee estates, was his scientific making and the author sets the scene well, charting Ward's breakthroughs in plant disease aetiology and epidemiology. Hence I would question the author's somewhat sweeping statement that: "Harry was actually very lucky for it [the rust] has an extremely simple life cycle … just two spore stages [it has three, in fact] … and no secondary host" [still to be confirmed]. In common with many tropical rusts, especially those related genera with 'simple' microcyclic life cycles which are currently being exploited for the biological control of invasive alien weeds, the life cycle of *Hemileia vastatrix* is likely to be unconventional and far from simple, but this awaits a latter-day Ward armed with modern tools.

The book then returns to following, chronologically, the life (tragically short) and works (varied and pragmatic) of this Victorian scientist. Many of these works, I was blissfully unaware, or profoundly ignorant of, and thus the book serves an especially useful purpose to anyone with more than a passing interest in Harry Marshall Ward and particularly the birth and early years of plant pathology, and microbiology in general, in Europe. For example, the author makes a case for Ward as the founding father of physiological plant pathology and for being an early pioneer in setting water purity standards. He later established the Cambridge Botanical School as a major player on the world stage of plant science at the dawn of the 20th century, both physically – overseeing the construction of the new building – and mentally – through his publications and membership of august and influential scientific bodies. Ward was a founder member of the British Mycological Society and paved the way for his former 'lodgings' in Ceylon, the Royal Botanic Gardens at Peradeniya, to be transformed into a research station. More of my plant pathology heroes passed through this now legendary establishment, including Tom Petch, and some of the earliest biocontrol efforts were conducted here, including the application of *Verticillium* (*Lecanillium) lecanii* to control scale insects. Amongst Ward's other legacies to science was his son Frank Kingdon-Ward, who was to become one of the last great plant hunters.

These facts are unfolded in a readable, perhaps too technical in parts, well-researched and illustrated (42 historical black and white prints) text, which essentially and faithfully records the beginnings of plant pathology as a recognizable discipline. Such was the scientific standing of Ward that William Thiselton-Dyer (Director, Royal Botanic Gardens, Kew) described his genius as second only to Charles Darwin's. History has not reflected this, so it is appropriate that it is now addressed here.

The book is attractively presented and well edited, although there is a figure reference to the 1904 British Association meeting in Toronto which was, in fact, in 1897. Also, on occasion, the author does make sweeping statements, as previously noted, thus: "… evidence from a century of plant pathology is that pathogens [obligate] do not jump from one host species to another." There are examples of such pathogens extending their host range (or 'jumping') to new encounter crops – cocoa has at least two –and, to this reviewer's chagrin, supposedly coevolved fungal biocontrol agents have proven to be less than specific in host range tests, sometimes 'jumping' between genera, which may be a reflection of man's interference through breeding strategies rather than of natural events. Indeed, the author must be aware that the UK-introduced rust of *Senecio*, *Puccinia lagenophorae*, on which he has contributed much seminal research, will jump to other genera (such as *Bellis*) in high-inoculum situations.

Finally, to return to the kindred spirit theme, a comment by a contemporary of Ward following his death has especial resonance: "…he generally attempted to cover a great deal more ground, and to convey a great deal more information in his lectures, than was possible either physically and mentally."

In summary, I am minded to turn the title on its head and thereby – through information revealed in the book – reflect the (until now) invisible thread Harry Marshall Ward's life has woven into the lives of many botanists (*sensu lato*) over the last century.

The price is modest, by today's standards, and, therefore, this book is a sound investment for those interested in the history of plant pathology and applied mycology, which has its legacy in the modern field of biological control of weeds using fungal pathogens.

Ayres, P.G. (2005) *Harry Marshall Ward and the fungal thread of death*. APS Press, St Paul, MN, USA, 168 pp. Hbk. ISBN: 0 89054 333 X. Price: US$79.00 (ca. UK£44).

By Harry C. Evans