General News

Sorting Salvinia

An aquatic fern native to southern Brazil, giant salvinia (*Salvinia molesta*) is considered one of the most invasive plants in the world. Its rapid rate of spread is facilitated by environmental adaptability coupled with an ability to propagate vegetatively from plant fragments.

It has been the target of classical biological control programmes since the 1960s in Africa, Asia, and Australia. However, the first attempts were unsuccessful in Africa, India, Fiji, and Sri Lanka because of the misidentification of the plant as *Salvinia auriculata*. Researchers surveyed *S. auriculata* in Guyana and Trinidad and found a small weevil identified as *Cyrtobagous singularis*. Although *C. singularis* did establish in several areas, it had no effect on the infestations. *Salvinia molesta* was separated from *S. auriculata* in 1972 and its native range in Brazil was discovered in 1978. In 1980, what was thought to be a biotype of *C. singularis* from *S. molesta* was introduced at Lake Moondarra in Australia and proceeded to destroy more than 30,000 t of *S. molesta* in less than one year. Closer examination of the 'biotype' resulted in its elevation to species status, namely *C. salviniae*. This new species reversed earlier failures and successful programmes were conducted in Australia, Fiji, Ghana, Kenya, Malaysia, Papua New Guinea, South Africa, Zambia, Zimbabwe, India, Botswana, Namibia, and Sri Lanka, where control has been dramatic and rapid: in many cases *S. molesta* was reduced by more than 90% in less than a year following release of *C. salviniae**.

Here we look at progress in two programmes to combat recent invasions. The first, in the USA, underlines how taxonomic uncertainties and confusion can still confound biocontrol. The second, in the Senegal River in Senegal and Mauritania, deals with management of invasive species to mitigate threats to both the environment and economic development.

*Tipping, P. (2000) Biological control programmes for giant salvinia: history and update on US efforts. *Water Hyacinth News* No. 2, p. 6.

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Salvinia: USA Begins Round Two

Cyrtobagous salviniae was released for the second time against giant salvinia (*Salvinia molesta*) in Texas and Louisiana in October 2001. Weevils for this release were obtained from cooperators in Australia where they have been used successfully to control *Salvinia molesta*. Following the second release in the USA, numerous adults and significant damage were found at most of the sites 2 months later in December. The winter season is expected to inhibit any further activity by the weevils but we hope to learn if they can overwinter at locations in east Texas and western Louisiana. Additional releases of *C. salviniae* will be conducted if necessary during the spring and summer of 2002.

Salvinia molesta has been established in the wild in the USA since at least 1998, but it is possible that it has been living free in the USA for rather longer, as it has been widely distributed as an ornamental plant and is easily obtained via the Internet. First discovered in eastern Texas, it now extends into western Louisiana.

The first release of *C. salviniae* was conducted in June 1999 using weevils collected from common salvinia, *S. minima*, in Florida rather than the tried-and-tested stock from Australia, as this obviated the risk of introducing new pathogens or parasites into the USA. *Cyrtobagous salviniae* had been introduced accidentally into Florida prior to 1960 and is now found throughout the state feeding on *S. minima*, and has also been found attacking *S. molesta* at one site in southwestern Florida. Unfortunately, the results of the first biocontrol attempt were unclear as many of the original Texas and Louisiana release sites were corrupted or destroyed by floods, droughts, saltwater intrusion, or landowner actions. Significant damage of the salvinia was noted at one release site, though, before it was destroyed by the landowner (despite a previous agreement not to do so).

Gene sequence studies in early 2000 found minor differences between 'Australia' and 'Florida' weevils in the number of base pairs in the D2 gene. Further releases of the 'Florida' weevils were suspended because of the taxonomic uncertainty this created, and instead efforts were redirected to populations of 'Australian' *C. salviniae*, collected originally from Brazil and used in successful biological control programmes in Australia, Papua New Guinea, South Africa, and other countries.

However, the release permit for the 'Florida' *C. salviniae* was not extended to cover the 'Australia' *C. salviniae*. Regulatory officials in the USDA-APHIS (Animal Plant Health Inspection Service) required that a new permit be issued, which involved a lengthy process made more lengthy when a petition written by another lab was rejected because of substandard research and reporting, thereby causing further delays in obtaining a general release permit. In cooperation with Wendy Forno of Australia (formerly of the Commonwealth Scientific Industrial Research Organisation, CSIRO) and Sharon Docherty and Martin Hill from South Africa (formerly of the Plant Protection Research Institute, PPRI), we wrote a new petition, which was approved and the permit was finally issued, thus facilitating the second releases.

Studies designed to sort out the differences between the populations of *C. salviniae* are continuing. Preliminary data shows that 'Florida' weevils are equally attracted to both *S. molesta* and *S. minima*, can reproduce on *S. molesta*, and live longer and lay more eggs on *S. molesta* than on *S. minima*. In addition, the 'Australia' weevil has demonstrated the ability to suppress *S. minima* in tank studies.

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Salvinia: West Africa Battles Invasives

The freshwater wetland systems of Mauritania and Senegal are crucial habitats for Palaearctic migrant birds crossing 200 km of the arid western Sahara Desert, and as such they are the focus of national and international conservation efforts. A series of national parks has been set up by the governments of Senegal and Mauritania in recognition of the importance of the ecosystems, many of which are designated World Heritage Sites and/or recognized as Wetlands of International Importance by Ramsar. The wetlands and the rivers that feed them, though, are also fundamental to maintaining local livelihoods and regional economies, providing fishing, irrigation for agriculture and potable water supplies for both rural and urban areas. Traditionally maintained by varying seasonal rainfall, advances in hydrology now create opportunities for water flow to be regulated to meet needs throughout the year. Such changes inevitably lead to disruption of the ecosystem, and restoring a balance that is sustainable in the long term is proving a challenge, and is having to overcome some unexpected obstacles including invasion by alien water weeds, with *Salvinia molesta* (giant salvinia) causing alarm most recently. Concerted efforts involving local, national, regional and international co-operation have been made to mitigate the *Salvinia* threat. Mechanical clearance provided limited and costly short-term relief, but improved water management and biological control through introduction of the weevil *Cyrtobagous salviniae* is providing a permanent solution. In a wider context, however, this programme provides a blueprint for both preventing the introduction of other invasive species, and implementing good management of those already present.

Damming a Problem

Historically, the wetlands were sustained by natural flooding, but this was variable and in some years of diminished rainfall (particularly since the 1960s) it failed to restore water levels. The erection of dykes, sluices, temporary dams and, more recently, permanent dams on the Senegal River by OMVS (Organisation pour la Mise en Valeur du fleuve Sénégal, a trilateral organisation grouping Mali, Senegal and Mauritania) formed the basis of a management plan for the Senegal River basin, intended to allow river navigation, and provide reliable irrigation for agriculture on hundreds of thousands of hectares as well as water and electricity supply for rural and urban areas in Senegal and Mauritania. The Diama Dam, built near the mouth of the Senegal River and 25 km upstream from the city of St Louis, prevents seawater incursion into agricultural land in the delta during the dry season. Since it became operational in 1988 it has wrought significant ecological changes in the lower Senegal River basin. Upstream, the formerly estuarine, seasonally dry conditions of the lower river have given way to permanent freshwater, and this has led to luxurious development of aquatic vegetation, and notably dense stands of *Typha australis* (reed mace) in shallow water, and mats of floating weeds, initially *Pistia stratoites* (water lettuce) and now *Salvinia*. Besides visible impacts on the riparian human and wildlife populations there have been less-evident effects, including a substantial increase in malaria, for example, owing to an increase in year-round standing water for breeding. Downstream, in contrast, conditions became more saline and water supply virtually ceased during the dry season. These changes were enhanced by embankments built to separate the river from the floodplain, which led to large parts of the floodplain and estuary becoming drier.

The emergence of an invasive weed threat is thus part of a wider issue: the impact of changing land-use patterns and hydrological management on the natural ecosystems along the lower Senegal river, where salinity traditionally varied from nearly fresh (during inundation) to brackish as water levels fell through the dry season. The ecological disturbances above and below the Diama Dam are reflected in the national parks that bound the river to the north and south.

Djoudj National Park (Parc National des Oiseaux du Djoudj) in Senegal was created in 1971. It was designated a Wetland of International Importance under the Ramsar Convention in 1980 and inscribed on the UNESCO World Heritage List in 1981. This seasonally inundated wetland system covers some of 16,000 ha of brackish lakes and pools, linked by a network of channels stemming from the Senegal River. Djoudj forms a permanent sanctuary for some 1.5 million birds, and even more migrants: an estimated three million pass through between September and April, and more than 70 species of migrant birds were identified during an expedition to catch and ring Palaearctic birds in 1990. The sanctuary now lies upstream of the dam. Changes in vegetation since it was completed included an initial explosive growth of *Pistia* during the first half of each dry season, accompanied by a more insidious but no less damaging spread of the emergent weed *Typha*.

The Diawling National Park (Parc National du Diawling) lies on the Mauritanian side of the Senegal River delta, downstream of the Diama Dam in the former estuary. The area became completely cut off from fresh water after the Dam's construction, and for several years it was flooded only with seawater. Owing to the high evaporation rate, the area quickly became a salt desert, with high pyrite concentrations in the soil, which also made it unsuitable for cultivation. OMVS constructed four sluices to re-flood the area and restore the pre-dam hydrological scheme and to preserve the rich biodiversity. Since then IUCN (World Conservation Union) has built two more dykes and sluices to optimize water management, and sponsored artificial flooding by the park management. In consequence, 16,000 ha of salt desert are restored and the ecosystem is reviving, a unique example of the reconstruction of a natural environment. Diawling was made a National Park in 1991 with a mandate to integrate conservation and development (including fishing and pastoralism within its boundaries), and was designated a Ramsar site in 1994. It, too, has been invaded by *Typha*, and more recently by *Salvinia.*

Waves of Invasives

The invasive weed problem surfaced in the Djoudj Park soon after the Diama Dam became operational in 1988. Reports of *Pistia* were first received in 1989. The weed's encroachment over the next 5 years was relentless, covering part of the Djoudj River water surfaces within the Park in the early dry season, making navigation difficult and threatening the habitat of permanent and visiting birds. The fall in salinity following the completion of the dam and inadequate control of flooding (leading to an insufficient drying-out period) were cited as being responsible for this and other changes in vegetation in the Park, and similar changes in the nearby Senegal River and other water bodies including Lac de Guiers. This lake, some 50 km upstream of the Diama Dam, is the city of Dakar's major drinking water supply and also provides irrigation water for vast agricultural areas.

Fortunately, there was a good history of successful biocontrol of *Pistia* with the Neotropical weevil *Neohydronomus affinis,* beginning in Australia and subsequently elsewhere including Africa. Introductions in Senegal began in Lac de Guiers in 1994, with the support of IITA (International Institute of Tropical Agriculture) and GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). Introduction of weevils from Lac de Guiers into the Djoudj Park took place in 1998 and subsequent years within the framework of an EU (European Union) funded research project (coordinated by (Koninklijk Instituut voor de Tropen/Royal Tropical Institute, Netherlands (KIT/RTI) in collaboration with the Finnish Environmental Institute, the University of Vienna in Austria and the Senegalese Ministry of the Environment). The *Pistia* vegetation became markedly stressed, but as the plants die off in the course of the dry season owing to the increased salt content of the water, the natural enemy populations collapse. However, *Pistia* proved to be a prolific seed producer (because of – some or all of – increased salinity, crowding and nutrient-rich water owing to bird colonies) and strong seedling regrowth each season meant the biocontrol agents needed to be reintroduced annually. Releases made immediately after inundation at the beginning of the dry season in September proved most effective. The introduction of the weevils was accompanied by improvements in water management, and together these measures have reduced *Pistia* populations to a level that does not impact adversely on the ecological function of the Park.

While the *Pistia* problem has been solved, though, *Typha* is still thriving within the national parks and outside. In less than 10 years, it has built an almost impassable wall between the river dykes and the open water on both sides of the river, clogged shallow waterways within the parks, invaded the economically important Lac de Guiers, and has caused particular problems by its spectacular take-over of a shallow freshwater reservoir just above the Diama Dam. *Typha* continues to have diverse negative impacts on drinking water, fishing, water-borne diseases and pests, which far outweigh any potential of the plant to combat erosion or be used in manufacturing.

A new threat, from *Salvinia*, was first observed in the Senegal River near the Djoudj Park in September 1999, the result of an accidental introduction from a nearby flooded field where it was under cultivation. By then, though, *Salvinia* had already invaded a stretch of more than 70 km of the river between the village of Rosso and the Diama Dam, approximately 20 km upstream from the city of St Louis*. It had formed thick mats along the *Typha* fields, which occur in shallow water along the southern shore in Senegal and the northern shore in Mauritania. Tributaries of the Senegal River as well as narrow channels through the *Typha*, which had been kept clear by the local population using laborious manual methods, were now entirely overgrown by *Salvinia*. Consequently, it had become very difficult for the people in the villages along the river to reach open water and even when they did fishing was impossible because their nets became clogged with *Salvinia* plants. Only the main flow of the river was still open. Dense plant masses also piled up against the Diama Dam, and these led to it being opened three times a week to flush down the *Salvinia* plants. Ironically, this unplanned release of water turned out to be very beneficial downstream of the dam. The remaining mangrove trees, craving freshwater during the dry season, staged a recovery. Other beneficiaries were the young marine fish that still try to use this former estuary as a nursery, and of course the local people.

As *Salvinia* spread through adjacent water bodies and basins, including the Lac de Guiers, it became increasingly apparent that this was a new threat, not just to the ecological equilibrium, but also to the economic stability and human health of the region. It provided a substrate for other weeds to encroach on water bodies, and there was a threat that it could spread into rice fields, as it has elsewhere in the world. The weed also impedes gas exchange, and as the plants decay they consume oxygen, which further disturbs the ecological balance and impacts negatively on aquatic fauna and potable water quality. Conversely, though, weed cover increases the available habitat for disease vectors such as snails and mosquitoes.

Weevils Win Again

The recognition of the threat from a new invasive floating waterweed precipitated prompt action in both Mauritania and Senegal, although fear of nontarget effects, even from the tried-and-tested *Salvinia* biocontrol agent, led to delays in funding and of biocontrol implementation in Senegal.

In Mauritania, *Salvinia* blocked water inlets to the Diawling Park completely, hampering the annual artificial flooding. Barriers built in the river in front of the sluices, intended to prevent *Salvinia* entering the Park, collapsed under the weight of plants as soon as the sluices were opened during the rainy season inundation in July-August 2000. Worse, the Park authorities could not now close the sluices because of the remaining plants. Thus water continued to leak into the former floodplain for 5 months before the sluices were repaired and closed. This extended period of freshwater in the Park also allowed *Typha* to establish itself in the areas around the sluices. *Salvinia* had serious impact on local people, as fishing had become impossible and some 40% of the fishermen left the area to work in the city or in the rice fields, thus jeopardizing the 7 years of ecosystem restoration efforts aimed at promoting re-migration back to the delta by re-establishing the natural resources to sustain riparine livelihoods.

The Minister of Rural Development and the Environment in Mauritania gave a green light to biological control in February 2000. Donors were slower to react, however. Instead, contributions from the Minister himself, the Senator of Rosso, national environmental NGOs, the fishermen of the Diawling Park, and some DGIS (Dutch Development Aid Agency) workers paid for a shipment of 300 *Cyrtobagous salviniae* weevils from PPRI (Plant Protection Research Institute), South Africa in April 2000. Charmed by this private initiative, PPRI charged only transportation costs: a mere US$300. The weevils were used to establish a starter colony in plastic containers (purchased by an Austrian and Dutch development workers) on the shores of the Senegal River. Continuing the spirit of 'do-it-yourself' biocontrol, local fishermen from the village of Zirét Takhredient became involved in rearing and maintaining the insect cultures, regularly refreshing the breeding culture with fresh *Salvinia* plants and removing dying ones. These people normally fish in the Park, migrating to the river as the Park dries up. Continuing support for Diawling Park staff and the fishermen was provided by a GTZ technical advisor working at the Ministry of Rural Development. First releases were made in June 2000 at various sites from the Diama Dam to Rosso, and 9 months later the impact was visible within the *Typha* stands: *Salvinia* had completely disappeared. More fishermen are now beginning to return.

The only international funding for this striking success was from China, which contributed to the state budget for mechanical removal of *Salvinia* in front of the main water inlets of the Park, just before the artificial flooding period in 2000. The speed with which control has been achieved is testament to the dedication of those involved, decisive action at every level, and the cooperation and generosity of all involved. Such qualities may not be enough to meet future invasive threats: *Salvinia* is acknowledged to be an 'easy' target for biocontrol, and the international donor community needs to be ready to help Mauritania in the future.

Across the river in Senegal, the Djoudj Park had remained free of the weed. Sluices were kept closed to prevent *Salvinia* incursion, but clearly this bought only limited time. The weed was, in any case, impacting seriously on the livelihoods and health of the population outside the Park. The Ministry of the Environment quickly mobilized initiatives. The scientific committee (Groupe de Réflexion et d'Appui Scientifique et Technique; GRAST) of the National Parks Directorate (Direction des Parcs Nationaux; DPN), comprising scientists, decision makers and local people was tasked with developing, directing and evaluating a *Salvinia* management strategy. This met first in February 2000 with Dr Arnold Pieterse (KIT/RTI). Recognizing the need for regional coordination, the management strategies of Senegal and Mauritania were developed during and following further inter-country meetings held in April 2000 and June 2001.

Participants at the February 2000 meeting agreed that biological control would be the lasting lynchpin of *Salvinia* management in Senegal too, with mechanical control being used to provide rapid and short-term alleviation. While the biological control effort was being set in motion, mechanical removal began to clear important waterways and in particular keep backwaters and tributaries near the sluices for the Djoudj Park clean of *Salvinia*.

A joint civilian and military committee for mechanical eradication (Comité Civilo-Militaire d'Appui au Développement; CCMAD) was coordinated by the Société d'Aménagement et d'Exploitation du Delta de la Fleuve du Sénégal (SAED). CCMAD comprises representatives of local people, military personnel, Djoudj Park staff, regional water and forests inspection services, the tourist office and DPN. Funding for mechanical control came from both state and private sources and from the UN Development Programme (UNDP) Global Environment Facility (GEF). During 6 weeks in May-June 2000, 200 civilians and military personnel put in 6000 h to remove as much weed as possible (and particularly to clear infestations upstream of sluices), and to erect barriers to prevent further spread into backwaters feeding the Park. More than 20,000 m^3 of weed was removed, which provided short-term alleviation of the weed problem and contributed to containment of its spread. Cost, however, was prohibitively high in terms of manpower and fuel costs (5000 litres of diesel fuel, for example, was used), and mechanical measures could delay but not indefinitely prevent *Salvinia*'s invasion of the Park and were not practical on the larger scale needed for widespread control.

The biological control component of the *Salvinia* management strategy was placed under the management of DPV (Direction de la Protection des Végétaux), which was tasked with coordinating efforts by national and international bodies. The first batch of 300 weevils was imported from PPRI (shortly after weevils were introduced into Mauritania), financed by the Dutch government via IUCN. The release of these first weevils in Senegal ended in failure, as a so-called 'starter' population was not cultivated at a protected site. Instead, all the insects were released at unmarked sites in the river where the infested plants could not be kept together. Subsequent surveys failed to recover any weevils and it may be assumed that the small number of insects became too dispersed to build up a population. With the support of the Dutch government, IUCN imported 1200 more weevils from South Africa in March 2001, a year later. A rearing operation was started at the Biological Station (Station Biologique) in Djoudj Park in the framework of a new policy project of the EU, which is coordinated by RTI. In this context, two Senegalese students at the University of St Louis were trained in rearing techniques by PPRI, and subsequently insects from their rearing programme were released in the Senegal River in the vicinity of the Park and in the Lac de Guiers. A UNESCO (UN Educational, Scientific and Cultural Organization) funded mission to Senegal in April 2001 found that the rearing operations were being hampered by a severe lack of resources at the Biological Station of DPN, however. The mission concluded that the operational capacity in terms of logistics, materials and staff, could be improved.

Despite these misgivings, it soon became apparent that the weevils were doing a magnificent job. Within 6 months of this visit, *Salvinia* plants were dying throughout the Senegal River, and their colour was turning from green to dark-brown or black. Evidence for the weevils' wide dispersal was seen both in Senegal and in Mauritania. In Senegal, *Salvinia* plants were infested at distances far from the release sites near the Djoudj Park, and it may be assumed that the weevils had flown across from Mauritania, where they had been successfully released almost a year earlier. A workshop held in St Louis in October 2001 on the problem of invasive plant species made it possible for the participants, who came from all over Africa, to see the *Salvinia* die off in the Senegal River with their own eyes.

Battle Won, War Continues

The rapid and spectacular invasion of the Senegal River delta by *Salvinia* captured the attention and stimulated action by local, regional, national and international stakeholders. However, the *Salvinia* explosion in the River happened in the wake of the largely unchallenged invasion by the equally damaging but less conspicuous species, *Typha*, along the river, in reservoirs and inside the parks.

Even worse could follow: water hyacinth (*Eichhornia crassipes*) is not far away and threatens the ecosystem. During the St Louis workshop, participants learned that water hyacinth plants are being sold as ornamentals at a plant nursery in the city. This does not pose an immediate threat to St Louis, as the water in the Senegal River downstream of the Diama Dam is too brackish for water hyacinth to survive. However, if plants were somehow to be transferred to the river upstream of the Diama Dam, which is only 20 km away, a new ecological disaster would emerge. Water hyacinth is even more aggressive than *Salvinia* and the available biological control agents are less efficient than *Cyrtobagous*. The authorities announced that the plants would be destroyed. However, as large numbers of water hyacinth plants are present in the markets of Dakar, extreme watchfulness remains a priority.

Thus, although first *Pistia* and now *Salvinia* have been brought under control, invasive weeds continue to threaten the region. In this sense, what is happening in the Senegal River basin is an example of a problem facing the whole continent: land-use change owing to population pressure and agricultural development is allowing invasive species to threaten Africa's biodiversity, economy and health. The agriculture, river traffic, hydroelectric and other developments that the dams on the Senegal River were built to help are under threat from invasive weeds. The actions of the parties involved in the threat to the Senegal River basin, and in particular the concerted and cooperative actions of the countries in recognizing the need to include invasive species issues in management and development plans for the delta, provide a good model for other parts of the continent.

*Pieterse, A. (2000) Aquatic weed management. *In*: Rijn, P.J. van (*ed*) Weed management in the humid and semi-humid tropics. Amsterdam, The Netherlands; Royal Tropical Institute, pp. 169-176.

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Black Wattle Problem Emerges in Indian Forests

Black wattle (*Acacia mearnsii*) is a fast growing leguminous tree native to Australia. It is widely used as a source of tannin, fuel wood, charcoal, poles, green manure and windbreak. Suited to cooler tropics, this tree grows well in tropical areas where the annual rainfall is more than 1000 mm.

Extensive areas of black wattle plantations have been established in South Africa, South America, southern Europe and Southeast Asia. The main purpose of introduction was for the commercial production of tannins, which is used for leather tanning and in products such as wood adhesive.

In Kerala State in southern India, *A. mearnsii* was introduced in the 1980s and mainly grown in the high altitude areas (over 1000 m above sea level; masl). It was preferred over other candidate forestry species because of its fast growth rate and the minimum post-planting care required. However, attempts to grow *A. mearnsii* on a plantation scale were not successful in most places in Kerala owing to high seedling mortality, eco-climatic stress and other factors. Hence, it now occupies only a very small area in the State, and fresh planting is not undertaken because of recurrent failure in establishment.

The experiment with black wattle plantations has left an ominous legacy, however, for *A. mearnsii* has not simply gone away. Recent surveys conducted by the Kerala Forest Research Institute (KFRI) indicate that in certain isolated pockets in the high altitude areas, some trees of *A. mearnsii* survived against the odds and are now growing luxuriantly, forming small scrub jungles. At Vattavada (1800 masl) in Idukki District, it was noticed that, within a period of 3 years, *A. mearnsii* has penetrated and spread over a 1 km^2 area in the dense subtropical montane (shola) forests, suppressing the native vegetation. Spread of the trees into the core areas of the highly diverse shola forests at Kolukkumalai (2480 masl) in the same district was also observed. The high competitive ability and seed production, prolonged seed dormancy and high rate of seed viability of the species probably helped the tree to spread like a wildfire into these forests. Collection of branches and logs of *A. mearnsii* by the local people for firewood purposes will also have helped spread of the tree species. Wild animals such as bison and deer also aid in seed dispersal. The allelopathic properties of leaves and branches are other possible factors favouring the gregarious growth of the species.

Needless to say, the biodiversity of the subtropical montane forests in Kerala is now under great threat owing to this unchallenged invasion by *A. mearnsii*. Control methods need to be considered urgently, and in this context it should be noted that this species is a serious weed in South Africa, where it was introduced much earlier than in Kerala.

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Black Wattle: South Africa Manages Conflict of Interest

Australian *Acacia* (wattle trees) have been utilized in South Africa since the 1820s for sand stabilization, garden ornamentals, timber and pulp production and tannin extraction. Their use has been widespread and most of the 13 naturalized species form an integral, although not always welcome, part of South African socio-economic culture. Black wattle (*Acacia mearnsii*) is the most economically important Australian *Acacia* present in South Africa, both as a silvicultural crop plant and as an invasive weed.

Black wattle is indigenous to southeast Australia where it forms a common component of *Eucalyptus* forests. The species was utilized initially in South Africa as an ornamental as it appeared in the 1858 catalogue of the Cape Town Botanical Gardens. However, the commercial potential of black wattle was soon realized by John van der Plank who commenced the development of plantations in KwaZulu-Natal in 1864, primarily for the production of tannins, which are extracted from the bark. Black wattle bark is a rich source (31-51% dry weight of bark) of water-soluble tannins, primarily 3,7,3',4,'5'-pentahydroxy-2-phenyl chrom, which is used for tanning leather and the manufacture of water resistant resins or adhesives for reconstituted wood products. Black wattle wood is also an important export product of South Africa with the majority being processed as pulpwood for the production of paper and paperboard products. In 2001, South Africa exported 1.2 million tonnes of black wattle wood product worth around R360 million (US$31.5 million) from 130,000 ha of managed plantations centred in the provinces of Mpumalanga and KwaZulu-Natal in northeast South Africa, and from black wattle control programmes. In 1998, the industry directly employed between 10,800 and 13,000 people, mostly unskilled labourers. In addition to this, black wattle is a source of firewood utilized for cooking and heating in lower income rural communities where it is also used for informal housing and building construction.

Environmental Impact

Despite the economic virtues of black wattle in South Africa, the tree has serious environmental impacts, which are reflected in its status as a weed of national importance. Black wattle occurs on 2.5 million hectares in South Africa mostly in the southern and eastern sectors of the country where mean annual rainfall exceeds 500 mm. The invaded area is the equivalent of 131,000 ha of condensed infestation and this is expected to increase at 5-10% per annum without proactive intervention. The main negative impacts associated with black wattle are the reduction in surface stream flow with a net present value cost of R16,285 million (US$1425 million) (based on an annual water consumption of 577 million m^3), loss of biodiversity, and increased soil erosion and destabilization of river banks. Black wattle has invaded grassland, fynbos, savanna and forest biomes in South Africa and is considered a threat to the species-rich Cape Floral Kingdom and many of the biodiversity 'hot spots' of southern Africa. The potential for species' reduction and loss is therefore substantial. The key ecological traits that contribute to the success of black wattle are its ability to develop large soil-stored banks of long-lived seeds that are triggered to germinate *en masse* by fire (a characteristic that is shared by many other Australian acacias) and the development of a large, structurally-dominating crown.

Biological Control

The vast scale of black wattle invasion in South Africa, coupled with the species negative impacts, led in 1973 to the initiation of a biological control programme that targeted the seeds of black wattle. Organisms that could develop or feed on vegetative parts of the plant were not considered because of the direct negative impact these may have on the black wattle industry. However, resistance to research on seed-reducing agents for black wattle mounted over the subsequent years. The industry challenged the validity of the research programme by questioning the status of black wattle as a serious invader, which had not been adequately documented at the time. In addition, growers were concerned about the possible depletion of seeds within plantations that are required for natural regeneration of crops, and the protection of seed orchards used for mass production of seed from selected tree stock. The research effort shifted as a result of this conflict and focussed on the biological control of other invasive, mostly non-commercial Australian acacias, particularly *A. longifolia*, *A. melanoxylon*, *A. cyclops*, *A. saligna* and the related *Paraserianthes lophantha* (Mimosaceae). As a result of this research, all these species are now considered to be under satisfactory, or partial, biological control in South Africa using seed-reducing insects and a host-specific gall-forming rust fungus. However, in 1987 the research programme found itself again in conflict with the black wattle industry when a seed-feeding curculionid, *Melanterius servulus,* proposed for the biological control of *P. lophantha*, was found to feed on seeds of black wattle in laboratory tests. The black wattle industry opposed the release of this insect from quarantine due to concerns of potential damage the insect may cause to black wattle seed supplies. The research programme was suspended, but then recommenced following pressure by environmentalist and farmers affected by *P. lophantha.* A negotiated agreement was achieved stipulating that releases of *M. servulus* could be made on *P. lophantha* providing it could be demonstrated that black wattle seed orchards could be protected with insecticides. Synthetic pyrethroids registered for use in wattle plantations were found to cause high mortality in the field on the analogous *M. ventralis*, which develops in seeds of *A. longifolia.* As *in vitro* tests showed *M. ventralis* and *M. servulus* had similar mortality responses to these insecticides, the wattle industry accepted that seed orchards could be protected, should the need arise. The beetle was formally approved for release in 1989 on the condition that releases were confined to the Cape Peninsula in the extreme southwest of the country, until it could be confirmed that *M. servulus* would not attack black wattle under field conditions. Subsequent field surveys showed that *M. servulus* does not use black wattle as a host and that feeding on this plant in laboratory tests was an artefact of confined, non-choice test conditions.

Conflict Resolution

Resolution of the potential conflict by a negotiated agreement, in retrospect, was the most pragmatic approach that could have been taken on this issue. Negotiations were founded on basic trust and the ability of both sides to acknowledge and understand each other's concerns. The eventual outcome was satisfactory to both sides of the conflict, but the fact that it took about 25 years to resolve the issue using an adequately represented industry and biological control research has been rightly criticized. In South Africa today, biological control research is governed by a process of public consultation and liaison with affected parties. In the case of black wattle biological control, a steering committee with industry representatives, researchers and other relevant organizations or individuals, share in information transfer. Potential conflicts of interest are identified in the early stages. This process has now been formalized as a mandatory procedure under the National Environmental Management Act 1998 (No. 107). Although at times the legislative process is administratively clumsy and inefficient, it enacts the principle of freedom of information and equitable consultation and is therefore a progressive move.

***Melanterius* Seed Weevil**

The resolution of the conflict of interest associated with the release of *M. servulus* in South Africa opened the opportunity to recommence the search for seed-reducing agents for black wattle. A small, univoltine beetle, *M. maculatus,* that feeds on developing seeds can be locally common on black wattle and closely related *Acacia* spp. (section Botrycephalae) in Australia. The beetle was approved for release in 1993 after it was proven that non-target species, particularly indigenous African acacias, were not accepted as hosts. Mounting public concerns over the environmental impact and continued spread of black wattle in South Africa, coupled with the knowledge that *Melanterius* could be controlled in seed orchards facilitated the process of approval for release. Once again, release approval was conditional, in that beetles would only be distributed in the Western Cape, to allow the wattle industry time to prepare for future incursions of the beetle into plantation areas. The insects have become abundant in the vicinity of their original release sites, but their natural dispersal has been slow. The beetle has not been detected anywhere near the commercial wattle growing regions of South Africa.

Gall-Forming Fly

Black wattle is a difficult target for biological control. The species inhabits a broad eco-climatic range in South Africa, has a high fecundity, sometimes aseasonal flowering and fruiting, and an early sexual maturation period. These attributes make it unlikely that satisfactory control will be achieved by any single seed-reducing species. Although *M. maculatus* is causing increasing levels of seed damage, sufficient seed reduction across the full range of black wattle in South Africa will probably only be achieved by the additive effect of compatible seed-reducing insects. We are examining the potential role of a gall-forming cecidomyiid midge as an additional seed-reducing agent for black wattle. Gall-forming insects have been spectacularly successful in reducing seed loads on *A. longifolia* and *A. pycnantha* in South Africa by committing the plants to allocate host resources to gall formation at the expense of fruits. This 'forced commitment' acts as a resource sink and vegetative performance of infected trees is reduced in the process. Clearly, this indirect impact would not be accepted on black wattle in South Africa, and indeed other countries where the species is economically important. However, an undescribed cecidomyiid, *Dasineura* sp. has been discovered that forms flower galls (2-3 mm) by causing the ovary to swell soon after oviposition and form small, multi-chambered galls. Fruit production is then prevented. A low biomass of galls, despite high infection levels, together with a shorter activity period compared to fruit development, releases the host tree from resource commitment and could have beneficial consequences on vegetative growth. The cecidomyiid appears to have sensitive host-finding abilities and as adults are readily dispersed by wind, offers the potential for effective seed-reduction of black wattle in South Africa. As with most gall-forming cecidomyiids, the insect has a narrow host range and presents no threat to African *Acacia*, which belong to different subgenera from Australian *Acacia.*

Protecting Seed Orchards

The issue of protecting black wattle seed orchards from attack by the cecidomyiid is paramount to the debate on whether this insect could be approved for release in South Africa. Trials utilizing a range of insecticide formulations on trees in Australia will be undertaken to resolve this problem. Insecticide spraying for the suppression of *M. maculatus* or *Dasineura* sp. in black wattle seed orchards will involve an additional cost to the industry. Indigenous pests such as foliage-feeding

Lepidoptera can warrant pesticide application in plantations, but outbreaks are sporadic and annual applications are mostly not necessary. Most wattle growers in South Africa (75%) regenerate trees following harvesting using line-seeding, where treated seeds are drilled into the soil, especially in colder areas, or use nursery-raised seedlings from improved tree lines. About 1000 ha of seed orchard services this market in South Africa and would require annual protection from seed-reducing biological control agents should these establish within seed production areas. All but 18 ha of this area is dedicated to the collection of seed for line-seeding that yields around 3 t of seed per annum. *Melanterius maculatus* and *Dasineura* sp. have a period of overlapping adult activity between September and October and insecticides applied to the tree canopy during this time should limit the impact of both insects. A single application of insecticide is likely to be sufficient for control of *Melanterius*, but several may be necessary for the *Dasineura,* if the total potential seed crop is to be protected, as adults emerge from the soil during the entire flowering period of black wattle. Systemic organophosphate insecticides may have a greater role in the protection of trees from *Dasineura* than foliar-applied synthetic pyrethroids. The projected cost to the wattle industry for the protection of 1000 ha of seed producing plantations from both *Melanterius* and *Dasineura* sp. is between R115,000-R300,000 (US$10,000-26,000) per annum, based on the aerial application of cypermethrin at R110/ha. This cost could be reduced with improved line-seeding techniques, which are considered wasteful of seed, or the phasing out of line-seeding in favour of replanting with nursery-raised seedlings. This has been the trend in many areas of South Africa, and the implementation of biological control in wattle growing areas could accelerate this rate of change.

Natural Regeneration of Wattle Crops

Wattle growers that rely on natural seedling regeneration as a method of crop re-establishment (25%) are unlikely to require protective insecticide sprays. Even in the presence of biological control agents, low numbers of seed will be produced that will accumulate in the soil over the 10-year crop rotation period. A single application of synthetic pyrethroid during a prolific flowering season would certainly guarantee seed supply for the next crop. Also, several silvicultural practices will reduce the impact of biological control agents. After clear-felling, there is a 2- to 3-year sexual maturation period for flower production and a 3- to 4-year period for fruit production. During this time, populations of *Melanterius* and *Dasineura* will become locally extinct, and recolonization must occur from neighbouring sources at the onset of flowering or fruiting. The rate of re-establishment of seed-reducing insects will depend on the size of founder populations and their intrinsic rate of increase. Very little is known about the latter for both *Melanterius* and *Dasineura*. Geographic and weather variables will influence the size of founder populations with distance from the neighbouring source, the nature of barriers between sites, and the direction of the prevailing wind being most important. Plantations that are isolated are likely to experience slow colonization by *Melanterius* and *Dasineura* and seed production in the first few years of the establishing crop should be close to normal. Alternatively, grouping two or three consecutive seasons' plantings together within a mosaic of non-*Acacia* plantation species could reduce migration rates and lower the impact of the insects on subsequent seed crops. As black wattle is often grown amongst blocks of *Eucalyptus* and *Pinus*, only minor changes to farm planning would be required to implement this model.

The 'Sterile Tree'

Emerging technology is very likely to have an important impact on the way biological control of black wattle seed is managed in South Africa. In an innovative initiative sponsored by the wattle industry, a breeding programme has commenced to produce a 'sterile tree' through manipulation of the tree's genetic composition using gamma irradiation, and the formation of triploid trees. If successful, the sterile tree will produce no flowers or seeds, and if adopted by the wattle industry, biological control could be practised in South Africa with minimal conflict of interest. In this situation, the benefits of the industry could be preserved while allowing wild black wattle trees to be freely suppressed using biological control. It is this situation that is expected to positively change the cost:benefit ratio of black wattle in South Africa from a current undesirable 0.4 to 4.3. If this were achieved, the divided perceptions of black wattle in South Africa would change to that of a generally welcomed 'guest' with great utilitarian value. Also, effective implementation of biological control of black wattle seed in South Africa may greatly enhance the industry's success in seeking approval to expand plantation areas to meet market demand for its products.

Black wattle is grown commercially in many other countries and is reported to have escaped cultivation in Tanzania, Zimbabwe, Swaziland, India, Madagascar, Hawaii, La Réunion, Brazil and New Zealand. The impact of naturalized black wattle in these areas is largely unknown, but given the experience in South Africa, it is likely to be considerable or has the potential to become so. Introduction of seed-reducing biological control agents of black wattle to these countries, particularly in the early stages of invasion, is likely to result in massive long-term cost savings.

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Harmonizing Weed Biocontrol in Australia

Over the coming issues of *BNI* you will be reading about a range of biological control of weeds projects that are underway in Australia with CSIRO (the Commonwealth Scientific and Industrial Research Organisation). [See the next two articles, and also Training News, this issue.] Here we give some background to these initiatives, and outline the development of the strategy of cooperative action that lies behind them.

Weed control is a problem that is faced by most farmers no matter what agricultural production regime they belong to. There would be few farmers in Australia, or indeed around the world, who could claim to be running weed free properties, whether they are raising ostriches or growing trees.

In Australia weeds are the most widespread problem faced by growers, much more so than salinity, for example. Weeds do not discriminate between natural environments or manipulated production systems, nor do they stop at the farm fence or any border. Realizing this is an important step in weed control, as is the realization that weed issues cannot be addressed one species at a time using only one technique. A holistic approach to weed management is required.

One of the initiatives that is helping to bring together a range of weed control options in Australia is the National Weed Strategy and the relevant strategic plans associated with the 20 Weeds of National Significance (WONS).

As well as thinking about weeds in a holistic manner, organizations involved in weed management need to work together. A major step towards greater collaboration was taken in 1995 when the Cooperative Research Centre (CRC) for Weed Management Systems was established and this has continued with the commencement of the new CRC for Australian Weed Management in July 2001. The original Weeds CRC formally brought together leading organizations involved in weed control and was a catalyst in the integration of various weed management practices. The new Weeds CRC takes this collaboration one step further and incorporates northern Australia, allowing a truly national approach to weed management.

One of the options in weed management is biological control, the use of naturally occurring invertebrates (such as insects) or pathogens (fungi) to control plants that have become weeds. Biological control does not eradicate a weed, but if successful it can restore Nature's balance to a point where the weed is no longer of economic importance. Currently it is estimated that agricultural weeds in Australia cost more than Au$3.3 billion per annum, so reducing that economic impact by even a small fraction would be a major achievement. For many years, CSIRO Entomology has been involved in the biological control of a range of agricultural and environmental weeds. Some of these weeds are on the WONS list as part of the National Weed Strategy.

There are currently a number of agricultural weeds that are targets for biological control by CSIRO. For temperate Australia, projects exist for Paterson's curse (*Echium plantagineum*), *Onopordum* thistles, nodding thistle (*Carduus nutans*), Scotch broom (*Cytisus scoparius*), *Emex* and blue heliotrope (*Heliotropium amplexicaule*). New projects have recently commenced on wild radish (*Raphanus raphanistrum*) and serrated tussock (*Nasella trichotoma*), although it will be some years before agents are released and established on these latter weeds. For environmental weeds, agents have been released on bridal creeper (*Asparagus asparagoides*), bitou bush and boneseed (*Chrysanthemoides monilifera* spp.), horehound (*Marrubium vulgare*), blackberry (*Rubus fruticosus*), St John's wort (*Hypericum perforatum*) and Scotch broom with work commencing on Montpellier broom (*Genista monspessulana*).

In tropical Australia agents have been released on mimosa (*Mimosa pigra*), parkinsonia *(Parkinsonia aculeata)*, mesquite (*Prosopis* spp.) and sida (*Sida acuta*) and research is being conducted into control for Mexican poppy (*Argemone mexicana*), *Hyptis* and bellyache bush (*Jatropha gossypiifolia*).

The impact from some of these agents is only just starting to be felt because biological control is a long-term option. Some of the target weeds have been in Australia for over 100 years, and it would be blithely optimistic to expect the agents to reverse a century of damage in the space of a year or two. For instance, for most weeds there is a huge build up of long-lived seed in the soil and this stock of seeds must be depleted before any kind of control can be affected. In some cases this amounts to hundreds of thousands of seeds per square metre of soil, all waiting to germinate and all capable of surviving for up to 10 years or more.

As organizations work more closely together, biological control is increasingly being looked at as an important component in overall weed management, rather than as a last resort when all else has failed. Research into the integration of biocontrol agents with other management practices is allowing Weeds CRC researchers to develop best practice management guides that will ultimately provide landowners with a package of information that they can implement on their properties.

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Rollers Released on Australian Coastal Weed

Bitou bush (*Chrysanthemoides monilifera rotundata*) is a major conservation weed of coastal southeastern Australia and through the National Weeds Strategy is listed as one of Australia's 20 Weeds of National Significance. [See also *BNI* **20(4)**, 108N (December 1999) 'Speedy seed fly'.]

One more biological weapon has now been added to the assault on this South African conservation menace and it comes in the form of a moth. The leaf-rolling moth (*Tortrix* sp.) is the most damaging insect feeding on bitou bush in its homeland, South Africa, and is the sixth biological control agent to be released on this weed along the New South Wales (NSW) coast.

Bitou bush was first recorded in NSW in the early 1900s and from 1946 through until 1968 it was deliberately planted along the NSW coast to aid control of erosion and post-mining rehabilitation. It was so successful in this role that it continued to invade coastal habitats in southeastern Queensland, NSW and Lord Howe Island. Bitou bush is particularly prevalent on the central and north coasts of NSW and the total area infested in Australia is now estimated to be over 70,000 ha.

CSIRO Entomology, in collaboration with the Cooperative Research Centre for Australian Weed Management and NSW Agriculture, has attracted funding through the National Heritage Trust to allow the rearing, release and evaluation of the leaf-rolling moth. The moth was first released near Grafton NSW in 2001 and subsequent releases have been made along the NSW coast from Moruya in the south to the Queensland border.

The life cycle of the leaf-rolling moth takes about 8 weeks from egg to adult, depending on the season. Eggs hatch after about 8 days and the larvae move to the shoot tips where they begin to feed. The larval stage lasts about 30 days and during this time the larvae feed on leaves, stems and surfaces of young shoots resulting in death of shoot tips. High larval populations in summer, when the insect is most active, may severely defoliate, weaken or kill plants. The larvae then pupate for around 10 days and then live as adults for about 14 days during which time they mate, lay eggs and the cycle begins again.

Biological control agents, like the previously released tip moth and seed fly, as well as the leaf-rolling moth, complement each other and increase pressure on bitou bush, making it less competitive. Biological control is a long-term strategy for control and is most often best used with a combination of other control methods. The best combination to achieve control is often site specific, but may include herbicide, manual removal or fire.

Once the weed has been removed from an area it is important to ensure that another weed does not take its place. Revegetation of heavily infested areas has a major role to play in the prevention of further problems.

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Australia's Two-Step Strategy for Blue Heliotrope

The mauve coloured flowers of the deadly South American blue heliotrope (*Heliotropium amplexicaule*) infest thousands of hectares in eastern Australia. Originally introduced in the 19th century as an ornamental garden flower, blue heliotrope has now spread from southern Queensland as far south as the Victorian border and into South Australia. It is poisonous to stock, causing liver damage that can result in loss of condition and often death.

The first biological control agent, the leaf-feeding beetle *Deuterocampta quadrijuga*, was released on 21 November 2001. The release of this beetle is due to the efforts of the Blue Heliotrope Action Committee of northern NSW, who continued to seek support for biological control and were successful in gaining funding through the Rural Industry Research and Development Corporation (RIRDC).

In the early 1990s CSIRO conducted surveys in South America that identified some insect species as potential biological control agents. However, at the time blue heliotrope did not attract sufficient industry funding, so no further work was done and the plant continued to spread. After a long delay CSIRO was able to begin in earnest in 1998. Professor Miguel Zapater of the University of Buenos Aires, Argentina came on board to study the biology of a number of the potential agents that were identified in the earlier study. As a result, *D. quadrijuga* and *Longitarsus* sp., a flea-beetle whose larvae feed on the roots, were prioritized for the biological control of blue heliotrope.

In March 2000, CSIRO received the first batch of *D. quadrijuga* eggs. The larvae and adults of the beetle feed on leaf tissue and can cause complete defoliation of the weed. They were reared in quarantine and spent a year and a half being tested to ensure that they would be safe to release into the Australian environment. Tests showed that the beetles only attacked the South American blue heliotrope and did not pose a risk to non-target plant species, including native Australian *Heliotropium* species.

Based on these results, in July 2001 Australian Plant Biosecurity authorities approved the release of the beetle for the biological control of blue heliotrope. Efforts are currently underway to obtain funding for host-specificity testing of the flea-beetle and eventual redistribution of these agents throughout the infested areas of southeastern Australia.

It is hoped that the planning and evaluation carried out thus far will bring the desired results of curtailing the unchecked spread of blue heliotrope and limiting its impact in the areas in which it has gained a presence.

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Cocktail for a Sharpshooter

The vineyards of California are under threat from an old enemy given a new lease of life by a new ally, the glassy-winged sharpshooter (GWSS), *Homalodisca coagulata*. Pierce's disease, a serious malady of grapes (caused by the xylem inhabiting bacterium *Xylella fastidiosa*) was first identified in California over a century ago. The bacterium produces xanthan gum, which blocks the xylem vessels. The leaves of diseased plants typically develop drying or scorching symptoms, and the vines become unproductive and usually die within 1-2 years of infection. GWSS is a xylem-feeding insect that readily acquires and transmits *X. fastidiosa*. Currently, there is no known cure for eliminating the disease from infected vines.

In rapid response to this deadly alliance, an inter-disciplinary collaborative effort involving the US Department of Agriculture – Agricultural Research Service (USDA-ARS) and Animal and Plant Health Inspection Service (USDA-APHIS), the California Department of Food and Agriculture (CDFA), County-based Co-operative Extension Personnel, the University of California (UC) and industry and private organizations planned and launched a multi-pronged attack to simultaneously manage the threat posed by the GWSS-*Xylella* combination. Its goals are to contain the sharpshooter's spread, and at the same time develop a cocktail of control and curative measures to protect the wine industry in the south of the state from further devastation. A meeting held in San Diego, California in December 2001 provided an opportunity to review progress.

Until recently, Pierce's disease was spread by native sharpshooters, principally the blue-green sharpshooter (*Graphocephala atropunctata*). These are poor fliers and prefer other plants in preference to grapes for feeding. However, even *G. atropunctata* was able to bring about the destruction of the Orange County wine industry in the late 19th century. During the 1880s Pierce's disease decimated more than 16,000 ha of grapes in the Anaheim area. The incurable disease has appeared on and off ever since, but its spread was limited. Farmers in most parts of the state were able to control it by pruning infested branches, grubbing out infected vines, and replanting.

The status quo was shaken by the arrival in California of *H. coagulata*, a cicadellid native to the southeastern USA. First identified in the state in Ventura County in 1990, it began wreaking havoc in 1999 when the first disease outbreak occurred in the vineyards of Riverside County's Temecula region. Much larger, vagile, and more robust than native sharpshooters, it spreads the disease much more efficiently. Moreover, it has a recorded host range of over 70 species, and thrives in urban and rural environments. As well as Pierce's disease, it can transmit diseases such as oleander leaf scorch (in California), phoney peach disease (in the southern USA), almond leaf scorch and alfalfa dwarf. In California, GWSS has two generations per year and overwinters as adults. It can fly distances over 400 m and up to heights of 8 m, frequently appears in high numbers, and survives winter temperatures dipping to –6.5°C in citrus orchards. It spread throughout the wine producing areas of southern California, and into the south of the San Joaquin Valley threatening the table grape industry there. Current losses have been estimated at US$14 million dollars-worth of damage to the wine industry in just a few years. GWSS has now established in San José and threatens California’s premier wine producing areas of Napa, Sonoma, and Mendocino counties.

A state-wide management programme includes survey activities to determine the distribution of GWSS in California and detect new infestations, and regulatory activities to prevent artificial spread to uninfested at-risk areas. In this context, UC Cooperative Extension (UCCE) has launched an information campaign to alert growers and enlist their assistance in monitoring for the disease.

Biological control is seen as the key ingredient in an IPM solution. One native egg parasitoid, *Gonatocerus ashmeadi*, is already abundant in California, but is primarily effective during the summer. Researchers at UC Riverside are evaluating another species from the same genus, *G. triguttatus*, which attacks earlier in the season, and could potentially depress numbers of first generation sharpshooters.

In cooperation with CDFA, they have released *G. triguttatus* reared from stock imported from Texas and Mexico in vineyards and citrus groves in Riverside, Ventura, and Tulare counties, and are now waiting to see whether this species can survive the Californian winter. Additionally, UC Riverside researchers are looking at the preferences of parasitoids for GWSS of different ages to assist with mass rearing efforts of these natural enemies. The outcomes of competition between different species of egg parasitoids for GWSS egg masses of different ages are being studied to determine if new natural enemy additions to California will be complimentary or antagonistic to GWSS control. One other area that is being investigated is the importance of flowers and other sugar sources for helping increase the longevity and fecundity of GWSS parasitoids in citrus orchards and vineyards. This strategy may be particularly important for helping parasitoids survive through the winter to attack the spring generation of GWSS eggs. The spring GWSS egg population currently suffers from low levels of parasitism (around 30-60%) by *G. ashmeadi*. Summer levels of GWSS egg parasitism by *G. ashmeadi* are much higher, often exceeding 95%.

Scientists at the USDA-ARS Beneficial Insects Research Unit in Weslaco, Texas are looking at egg parasitoids found in south Texas, Louisiana and northeastern Mexico. Surveys in south Texas during 2001 showed that 86% of GWSS egg masses were attacked by the parasitic wasp, *G. triguttatus*. This species will continue to be released in California during 2002. *Gonatocerus fasciatus* is one species being targeted for importation into California from Louisiana this year. Natural enemies in the home range of GWSS are thought to be at least partly responsible for the low densities of sharpshooters in these regions. At the same time USDA is conducting DNA analysis on the Californian sharpshooters, and comparing results with populations from elsewhere to try and determine the source of origin of the invasion. The results may help delineate where the most effective biocontrol agents might be found.

Exploration for sharpshooters and more natural enemies, though, is already being conducted in South and Central America. At the USDA-ARS South American Biological Control Laboratory in Argentina, scientists are surveying and collecting parasitoids from the eggs of the South American sharpshooter, *Tapajosa rubrimarginata*, collected from areas of Argentina with subclimates similar to those found in the grape-growing regions of California. Over a dozen species of egg parasitoids have been collected. Shipments to US quarantine for evaluation against GWSS are expected to begin in 2002. Parasitoids or other sharpshooter natural enemies from similar subclimates might outperform natural enemies imported from different climates. Chile, also, has some good climate matches and is being included in new explorations for new biological control agents.

Even good biological control will not provide a complete answer to the GWSS problem, as small numbers of insects can still transmit disease and wreak havoc. (Consequently, there is not a viable grape industry in areas of the USA where GWSS is native.) Biocontrol will therefore be just one part of the GWSS management strategy, and other possibilities including chemicals (insecticides and bactericides), cultural control (barriers), breeding programmes (traditional and transgenic), and monitoring strategies (for GWSS and *Xylella*) are being investigated.

Plant resistance is a good complementary tool for biocontrol, but currently there are no commercial vines resistant to Pierce's disease. Research is focused on investigating the molecular mechanisms of susceptibility to *X. fastidiosa*, and also on investigating mechanisms of resistance in wild grapevine relatives that do not develop the disease. With this information, classical breeding or biotechnology could be employed to create a vine more resistant to *Xylella*.

Making vines physically unattractive to the sharpshooter is another approach. USDA-ARS scientists in West Virginia have found that a coating of white kaolin particles makes them inhospitable. Field trials coordinated by USDA-APHIS in vineyards, some bordering citrus orchards, in Kern County, California gave encouraging results. Three treatments applied from mid-March to mid-April resulted in sharpshooter numbers lower than those found on insecticide-treated vines. In addition, the kaolin treatments were cheaper than six insecticide treatments. It could provide a promising non-toxic early-season alternative to insecticides. It may not be suitable for use once the vines have bloomed, as visible white kaolin residues on grapes, although harmless, do affect wine quality and would probably be unacceptable to consumers.

Innovative biotechnology may allow the causal agent of Pierce's disease to be targeted. Armed with the full genome sequence of *X. fastidiosa*, scientists at UC Riverside are studying some 100 genes that, if removed, could render the bacterium harmless by preventing transmission or infection. To be successful, the modified bacterium would need to be able to outcompete the wild-type disease-causing form. An alternative strategy is to use another a bacterium or virus to kill *Xylella*. This would entail using bioengineering techniques to modify an antagonist from the gut of the sharpshooter to produce enzymes lethal to *X. fastidiosa*. Infected sharpshooter populations could potentially pass this on from generation to generation. A candidate bacterium has been shown to reproduce in the sharpshooter gut. Now a suitable lethal gene is being sought, which would need to be inserted into the bacterium, and then application technology would have to be developed, and of course rigorous safety standards would have to be met before any genetically modified organism could be released. Another potential method for disarming *X. fastidiosa* is to prevent it producing the xanthan gum, the substance that damages and eventually kills the plant. Some bacteria are known to break down xanthan, and the search is on for one that does this inside diseased grapevines. Although these tools are at an early stage of development, they could be a powerful boost for control options.

The wide host range of GWSS causes particular problems. A variety of common weeds can carry *X. fastidiosa*, and this reinforces the importance of good weed control to prevent disease spread. In addition, fava bean, a common cover crop in vineyards in northern California, can also host the bacterium, and legume crops are now contra-indicated as crops in vineyards.

The sharpshooter is especially problematic where citrus and vines are cultivated in close proximity. Although GWSS can transmit disease in citrus, these pathogens are not found in California, and the sharpshooters feed and reproduce in citrus without causing significant damage. They tend to overwinter in the citrus trees' protective foliage and move out to colonize vineyards in spring. Trials coordinated by UC Davis Extension Service staff in Kern County demonstrated that contact insecticide applied to citrus in winter reduces adult numbers, while a follow-up systemic treatment in spring targets the wingless nymphs, which are confined to the plant they hatch on. Thus fewer survive to move onto the vines when they mature. In separate trials conducted by the USDA-ARS Western Cotton Research Laboratory in Arizona and UC Riverside researchers, pyrethroids and neonicotinoids gave fastest knock-down of the pest, with one pyrethroid compound giving 100% kill in 6 hours. Compound residues from both classes also continued to give good knockdown beyond 28 days. However, resistance development is a major concern with sole reliance on insecticides for GWSS management.

An additional problem with this approach, however, is that significant areas of citrus are under IPM for primary pests or under organic production. Therefore, considerable grower resistance to paying for and using insecticides for a pest that is not a problem in citrus is being experienced and disruption of stable IPM programmes caused by broad spectrum pesticide use is resulting. GWSS control where organic or IPM citrus borders grapevines is thus particularly difficult and controversial. Although biocontrol by egg parasitoids and other compatible measures are expected to alleviate the problem to some extent, the introduced parasitoids will take time to have an impact in citrus, wilderness and residential areas. In the meantime, cage trials to test the efficacy of augmentative releases of commercially produced green lacewing larvae (*Crysoperla rufilabris*) conducted by CDFA scientists in the southern San Joaquin Valley gave promising results. Further trials are planned with other commercially available predators. Results of trials in organic lemons have reduced sharpshooter numbers, although not as much as in conventionally treated citrus.

USDA is also researching alternatives to chemical pesticides for killing the eggs without affecting natural enemies.

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New Legislation Benefits Weed Biocontrol in South Africa

Biological control, by definition, does not result in the complete eradication of the target weed. The continuous presence of remnant populations of the target weed is a prerequisite of sustainable biocontrol; yet it is this aspect that often brings biocontrol into conflict with weeds legislation, because legislation usually requires the total and immediate eradication of declared or noxious weeds.

Until recently, this has also been the situation in South Africa, where biological control has not always been recognized by law as a viable, long-term control measure for alien invasive plants. Several potentially successful biocontrol projects have been impeded by the insistence of the relevant authorities that herbicides or mechanical control, often in an attempted 'eradication', be applied as soon as the populations of biocontrol agents go through a temporary depression that is part of their natural population cycle. Other biocontrol projects never got off the ground because the authorities were not prepared to risk the phasing out of the herbicidal regime in favour of biological control. Stands of declared weeds under complete biological control have frequently been cleared chemically or mechanically by order of the authorities or out of ignorance, resulting in the loss of valuable biocontrol material.

The recent amendment of the relevant legislation in South Africa has gone a long way to rectify this situation. During March 2001, regulations 15 and 16 of the Conservation of Agricultural Resources Act (CARA) were drastically revised. Despite a much tougher stand on weeds, as reflected by the substantial increase in the number of plant species that are now either prohibited or regulated, some imaginative changes in the regulations have significantly improved the prospects for biological control.

In the original 1983 version of CARA, harmful plants were divided into 46 species of declared weeds (which had to be eradicated) and 35 species of invader plants (which needed to be controlled in rural areas only, if they were threatening any agricultural resource). Of these invader plants, ten species were alien plants, while the other 25 were indigenous species. By making no distinction between alien invaders and indigenous species that became unnaturally abundant only as a result of inappropriate management practices, several valuable indigenous species were placed under unnecessary 'suspicion' in well-managed areas in which they were not causing problems. No provision was made for dealing with plant species that were clearly harmful in certain situations, yet were valuable to part of the population.

The amended CARA regulations separate alien problem plants (discussed under regulation 15) from indigenous ones (dealt with under regulation 16), differentiate between three categories of alien problem plants, and are unique in making special legal provision for biological control.

Classification of Problem Plants by the CARA Amendments

Bush encroachment indicators. The indigenous problem plants (44 species) are now called 'indicators of bush encroachment'. The amended regulations display an understanding of the ecology of bush encroachment by advising land users to take extra care in areas characterized by the listed species. In addition, they prescribe ecologically sound management practices aimed at preventing bush encroachment and at combating it where it already occurs.

Declared weeds and invader plants. Alien problem species are subdivided into three categories, based on their current utilization (or lack thereof) in South Africa.

1. The greatest proportion of alien problem plants (124 species) are those that have no function to fulfil in South Africa or whose harmfulness outweighs any useful properties they might have. These were placed into Category 1, and are called 'declared weeds'. This denotes that they are prohibited and must be controlled wherever they occur. The only exception is that they may grow in biological control reserves (discussed later).
2. A much smaller group (35 species) consists of invasive plants that nevertheless have certain beneficial properties that warrant their continued presence in certain circumstances. These were placed into Category 2, and (together with Category 3 plants) are called 'invader plants'. They have commercial, structural or utility value as timber, fruit or medicinal plants, soil stabilizers, wind breaks or sources of fodder, fuel or building material. Land users will be allowed to cultivate or retain these species on condition that they take the necessary responsibility for the water use and seed pollution by these trees. Permission has to be obtained from the Executive Officer, who will demarcate a specific area for the growing of a particular Category 2 plant species. Category 2 plants growing anywhere except in such demarcated areas or in biological control reserves will be regarded as declared weeds, and will have to be controlled. Category 2 plants may be

sold only to, and purchased only by the users of areas demarcated for the particular species.

3. Another group of 'invader plants', placed into Category 3 (39 species), consists mainly of popular ornamental plants. It was considered unnecessarily harsh to prohibit them outright, and instead a ban was placed on all new plantings. The existing specimens of Category 3 plants, except those growing in or near watercourses or wetlands, may be retained until they die naturally. In cases where these plants threaten any agricultural resource, the Executive Officer has the authority to enforce additional measures. No further trade in Category 3 plants will be allowed, plants may no longer be propagated and all seedlings must be controlled.

Another feature of the recent amendments to the CARA legislation is that certain sterile or less invasive forms of plants from Categories 1 to 3 may be grown and sold legally. Examples include the sterile double-flowered cultivars of *Nerium oleander*, the sterile form of *Lantana montevidensis*, all spineless cactus pear cultivars and selection of *Opuntia ficus-indica*, the sterile cultivar 'Rubrum' of *Pennisetum setaceum*, and all cultivars of *Pyracantha angustifolia*. Similarly, several plant species were placed into different categories in different provinces, based on the climate in which they are likely to become invasive. Examples are *Acacia dealbata*, which is a declared weed in the Western Cape Province and a Category 2 invader plant in the rest of the country; *Ardisia crenata*, which is a declared weed only in the Northern Province, KwaZulu-Natal and Mpumalanga, and *Schinus terebinthifolius*, which is a declared weed in KwaZulu-Natal and a Category 3 invader plant in the rest of the country. Most of these exemptions were negotiated in consultation with the nursery industry.

Implications for Biological Control

Control of weeds and invaders instead of eradication. The amended CARA regulations do not insist on the eradication of all declared weeds or invader plants that grow in areas where they are forbidden by law, but only on their control. CARA defines 'control' as: "the combating of plants by means of the prescribed methods" (including biological control), "to the extent necessary to prevent or to contain the occurrence, establishment, growth, multiplication, propagation, regeneration and spreading of such plants".

This formulation allows scope for biological control. Seed-destroying insects have the potential to prevent or contain the establishment and spreading of the target weeds, e.g. the snoutbeetles *Melanterius* spp. that destroy up to 100% of seeds produced by several Australian *Acacia* spp., aided in certain cases by inflorescence-galling wasps (*Trichilogaster* spp.); the flowerbud-feeder *Trichapion lativentre* together with the seed-feeder *Rhyssomatus marginatus* that almost obliterate seed production in *Sesbania punicea* and the combination of a fruit weevil, *Erytenna consputa* and a seed moth, *Carposina autologa*, which together destroy the vast majority of newly produced seeds of *Hakea sericea*, as well as seeds accumulated on the plant. Natural enemies that weaken their target plant by attacking its vegetative growth can be said to contain the plant's growth, propagation and regeneration. Examples are the 'nutrient sink' effect of the gall wasps (*Trichilogaster* spp.) mentioned above, and the leaf, bark and flower feeding beetles *Leptinotarsa texana* and *L. defecta* that reduce the photosynthetic surface and deplete the nutrient reserves in the rhizomes of *Solanum elaeagnifolium*, thus containing its growth and vegetative reproduction, and preventing fruit set by feeding on the flowers. In all the cases mentioned above, effective biological control complies with CARA's definition of control.

Recognition and safeguarding of biological control. The CARA regulations prescribe the following control methods, as long as they are appropriate for the particular species and ecosystem:

- uprooting, felling, cutting or burning
- treatment with registered herbicides
- biological control carried out in accordance with the stipulations of all the relevant Acts
- any other method recognized by the Executive Officer
- a combination of the above, except that biocontrol reserves and areas where biocontrol agents are effective, shall not be disturbed by other control methods to the extent that the agents are destroyed or become ineffective

Today this is probably the only weeds legislation that specifically mentions biological control as an acceptable control method.

CARA goes even a step further by protecting biological control from interference by other control measures. An example of such interference, which would now be regarded as illegal, was the enforced herbicidal treatment of *Opuntia aurantiaca* in areas where the cochineal *Dactylopius australis* was effectively controlling the cactus. This used to happen frequently in the Eastern Cape Province, especially while the cochineal populations were at the bottom of a natural curve, but still managed to keep the weed population below the economic damage threshold. A state subsidy on the registered herbicide, MSMA, encouraged land users even further to use herbicides instead of biological control. Nevertheless, the herbicide campaign against this weed was a failure, despite being the country's most expensive weed control project. Where biological control was given an opportunity to reach its full potential, *O. aurantiaca* is no longer a problem. The same applies to *Hypericum perforatum* in the Western Cape Province.

Biological control reserves. Biocontrol researchers need protected areas in which to monitor the establishment and performance of newly-released biocontrol agents, even though the agents cannot yet be expected to exercise effective control of their target weeds. Protected areas for biocontrol agents also serve the purpose of letting the agents build up their numbers to allow their collection and mass-release into new areas, or to enable the agents to colonize recently cleared surrounding areas as their target weed regenerates. Mindful of these requirements, CARA provides for the designation of biological control reserves.

Biocontrol reserves will be designated by the Executive Officer, on application in writing by a biocontrol researcher or practitioner ("biological control expert"). It will be illegal to destroy the biocontrol agents in such a reserve, or to do anything that will reduce their efficacy. This stipulation implies that a mechanism has to be created by which all persons involved in the control of alien invasive plants are informed of the whereabouts of biological control reserves.

Biocontrol as an Instrument for Resolving Conflicts of Interest

Biological control in the form of seed-destroying agents has the potential to restrict the invasive potential of a formerly invasive plant species without interfering with its utilization. This is illustrated by the use of the curculionid, *Melanterius acaciae* to destroy the seeds of the valuable Australian timber species, *Acacia melanoxylon*, without affecting the quality of the wood. Different *Melanterius* spp. have been released to reduce the invasive potential of several Australian *Acacia* spp.

in South Africa [see also 'Black wattle: South Africa manages conflict of interest, this issue]. Similarly, the bruchids, *Algarobius prosopis* and *Neltumius arizonensis*, which destroy the embryos in the seeds of *Prosopis* spp. without significantly reducing the nutritional value of the pods, allow the continued utilization of this valuable shade tree and source of stock feed. In this case, the efficacy of seed destruction depends on the measures that are taken to keep the pods away from the livestock until the beetles have had the opportunity to complete their life cycle in the seeds.

The availability of biological control as a conflict resolving tool was one of the factors that has made it feasible for CARA to allow persons to continue farming with invasive plant species, such as *Acacia mearnsii, Acacia melanoxylon, Prosopis* spp. and several *Pinus* species. Category 2 plants may be grown only in legally demarcated areas and under controlled conditions. One of the few practicable ways for the land user to comply with the requirement of preventing or restricting the spreading of the invader plant from the demarcated area is by releasing host-specific seed-destroying natural enemies. Without this option, the present Category 2 plants would probably have had to be included under Category 1 (declared weeds). This step would have caused such an outcry by the present users of these plant species that Government would most likely have withdrawn all the species concerned from legislation altogether, leaving them to invade the country unchecked.

Seed-destroying biocontrol agents also have a function to fulfil with regard to Category 3 invader plants (mainly ornamental trees). Despite the general ban on further planting of Category 3 plants, a clause was included whereby the Executive Officer may grant exemption from this stipulation, amongst others. Such an exemption will only be granted if the Executive Officer is satisfied that the risk of invasion was minimal, e.g. if the climate is unsuitable for seedlings to survive, or if seed production is negligible. The city planners of Pretoria and Johannesburg might invoke this exemption clause to obtain permission to continue planting jacaranda trees along their roads on condition that a host-specific seed-feeding insect be introduced and released against this popular street tree.

Conclusion

The amended CARA regulations might be unpopular because of the inclusion of such a large number of popular plant species: every farmer, forester, landscaper and nursery owner – in fact almost every landowner – is now at risk of transgressing the law, albeit inadvertently. With regard to biological control of alien invasive plants, however, the amendments create an awareness of this control method amongst the authorities, promote its use and its integration into management strategies, and safeguard the valuable agents that have been released into the field. The country is sure to reap the benefits of this forethought in the form of improved, cost-effective and sustainable control of invading alien plants.

Further Reading

These three key publications give background information on the weed programmes referred to in this article.

Hoffmann, J.R. (*ed*) (1991) Biological control of weeds in South Africa. *Agriculture, Ecosystems and Environment*, Special issue, **37(1-3)**, 255 pp.

Olckers, T. & Hill, M. P. (*eds*) (1999) African Entomology Memoir No. 1. Biological Control of Weeds in South Africa (1990-1999), 182 pp.

Olckers, T.; Zimmermann, H.G.; Hoffmann, J.H. (1998) Integrating biological control into the management of alien invasive weeds in South Africa. *Pesticide Outlook* **9(6)**, 9-16.

See also the two PPRI handbooks described in 'New Books', this issue.

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Portuguese Leave British Standing!

Which would you least like to have to work with: an invasive impenetrable thicket-forming, intensely prickly shrub, or a minute, almost immobile insect control agent? Spare a thought for scientists involved in gorse (*Ulex europaeus*) biocontrol in New Zealand, then, for they have both to contend with. The gorse thrips (*Sericothrips staphylinus*) imported from the UK and released in New Zealand some 10 years ago has the dubious honour of being named "slowest moving biocontrol agent of all time" by Landcare Research.

As this 1- to 2-mm-long, usually wingless insect had not dispersed far beyond its original release sites, it was clear to the scientists involved that it would need a fairly massive redistribution exercise if the control programme were to succeed. Not entirely surprisingly, they found the public reluctant to help – not just because of the gorse prickles, but also because the size and cryptic nature of the insect made people less than confident in dealing with it.

However, dialogue with colleagues working on gorse biocontrol in Hawaii suggested that the British thrips was a bit of a non-starter. Hawaii had imported both British and Portuguese strains of *S. staphylinus*, and while they had also found the British strain to be slow-moving or worse, the Portuguese insects dispersed with encouraging rapidity. For example, one 6000-ha area of gorse was completely infested within 6 years.

Portuguese thrips from Hawaii were imported into quarantine in New Zealand, and were being reared for releases planned for early 2002. No one is quite clear why the Portuguese insects move faster. It may be that more develop wings… or could it be that the Portuguese have more of an explorer's sense of adventure than their stay-at-home British relatives!

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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.

More US Apple IPM Success

As a follow up to 'Apple of their eye' in the last issue [*BNI* **22(4)**, 81N-83N (December 2001)], which described the achievements of the Areawide Program for Suppression of Codling Moth in the Western United States, there is news of more good apple IPM practice from the other side of the USA.

Fruit Notes Vol. 66 (2001) contains two interesting articles germane to the ongoing discussion of pesticides and the ability of apple growers to move away from high-risk organophosphates. *Fruit Notes* is a publication from the University of Massachusetts's Fruit Team, whose mission is to assist fruit growers with all aspects of horticultural and pest management. This is a cooperative programme of the research and extension efforts of the Departments of Plant & Soil Sciences, Microbiology, and Entomology, and is part of the University's Extension's Agroecology Program.

Ron Prokopy's article 'Twenty Years of Apple Production under an Ecological Approach to Pest Management', describes the efforts made on a small commercial farm to produce apples with largely ecological, prevention-based IPM methods. The orchard started in 1977. The article presents time-series data on a number of pests in the orchard, comparing levels to a nearby unmanaged orchard. The results are encouraging; pest damage was kept at or below levels experienced in commercial orchards. Pesticide use was much less frequent and generally involved softer materials, because of the emphasis (requirement, actually) to preserve beneficials. This is one of very few articles that presents a long-run view of ecological adaptation among pests and beneficials in a biointensive IPM orchard. Access the article in pdf at:
www.umass.edu/fruitadvisor/fruitnotes/twentyyearsof.pdf

A second article in the same issue compares the efficacy of insect control when the new reduced risk insecticide indoxacarb (Avaunt) replaces the old, high-risk material azinphos-methyl (Guthion). Again, the results are encouraging; comparable levels of control were achieved. The much less severe impact of indoxacarb on a range of beneficials also is likely to help restore a number of biocontrol processes in orchards where hot, broad spectrum organophosphates, carbamates and pyrethroids are used sparingly if at all. This article is at:
www.umass.edu/fruitadvisor/fruitnotes/comparisonofavaunt.pdf

The careful research behind these articles lends further support to two general conclusions that most pest management experts now embrace, some strongly, others begrudgingly:

- First, prevention-based, bioIPM systems can and are working. The technology and knowledge are there for those growers with the determination and support to make it work. The reason hard chemical-based systems still dominate agricultural production in the USA is that pesticides are relatively cheap to farmers and they are easy to use. It is not that farmers like to handle hot materials, or are anti-biology, it is basically pragmatic. As long as US policies remain as they are, pesticide-based systems will remain price-competitive and therefore the common choice of most farmers. Almost across the board, high-risk, older pesticides are the cheapest to use per acre/hectare – to the farmer – since so much of the indirect costs of pesticides are borne by people other than farmers.
- Second, the new generation of reduced-risk pesticides and biopesticides that have been coming on the market in the last few years are offering farmers viable alternatives, which can and are serving as stepping stones along the transition to bioIPM.

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Congratulations for some really nice, patient work to the apple IPM team at the University of Massachusetts!

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West African Recipe for Cocoa IPM

Regional collaboration and a participatory approach were the key ingredients of a meeting of cocoa scientists held in Benin in late 2001. It led to the formulation of an overall concept note for a regional cocoa IPM initiative in West Africa, which will encompass various sub-projects that can be submitted to various donors. This indication of regional commitment to support cocoa growers comes as cocoa prices, following years of decline, took an upswing owing to fears over production declines. Falling cocoa production is blamed on recent bad weather and disease, together with the impact of long years of poor returns on cocoa growers.

The West Africa Regional Cocoa IPM workshop held on 13-15 November in Cotonou was organized jointly by CABI *Bioscience* and IITA (the International Institute of Tropical Agriculture). It was sponsored by STCP (the Sustainable Tree Crops Program) and BCCCA (the Biscuit, Cake, Chocolate and Confectionery Alliance, UK), and provided scientists from the various West African cocoa-producing countries a platform to exchange ideas.

The BCCCA has a long tradition of support for cocoa research and currently funds a range of innovative projects together with key international resources which will benefit the world cocoa community. Its research programme aims to achieve sustainable production of good quality cocoa through the development of cost-effective and environmentally responsible ways of controlling the range of pests and diseases afflicting cocoa production.

The STCP, launched in Ghana in May 2000, is a joint public-private partnership between European and American chocolate manufacturers, bilateral donors (such as the US Agency for International Development; USAID), NARES (national agricultural research and extension systems) and IARCs (international agricultural research centres) in West and Central Africa. Coordinated by IITA, STCP uses a systems approach focused principally on the sustainable supply of cocoa, coffee, and cashew nuts through diversified multi-product agroforestry systems. Activities under four programme components (research and technology transfer, grower and business support services, market and information systems, and policy) have been endorsed by a broad coalition of stakeholders including farmer organizations, marketing agents, industry, research and extension.

West Africa produces some 60% of the world's cocoa, and by far the majority of this is produced by smallholders, who grow it with a number of different crops. At the moment, cocoa production in Africa is falling. Farmers find it increasingly difficult to make a living from the crop, in the face of pest and disease constraints and poor prices, and are abandoning their trees. The organizers of this workshop, however, described this bleak outlook as a window of opportunity to steer IPM towards a biologically based system for high quality cocoa production, in response also to ever-louder calls for environmentally friendly solutions to pest problems in these areas of high biodiversity where cocoa is grown. In order to stem abandonment of the crop, it has become imperative to rehabilitate cocoa groves and to find new ways to start new ones in areas where the rainforest has already been cut down, and to devise new IPM systems.

The workshop's participants included three cocoa IPM scientists from each STCP member country (Cameroon, Côte d'Ivoire, Ghana, Guinea-Conakry and Nigeria) together with others from the host country Benin, CABI *Bioscience*, CRIG (Cocoa Research Institute of Ghana), NRI (Natural Resources Institute, UK) and IITA. The workshop programme was developed in consultation with the participating countries, and provided a platform for scientists to exchange ideas on cocoa IPM research and implementation. Each country outlined its pest and disease problems, past and current control measures, and the status of its cocoa IPM research and implementation. Workshop sessions then focused on finding solutions to common key pest problems, and options for regional collaborative research and implementation by piloting new methods for cocoa extension.

The three key constraints to cocoa production in the region were agreed to be black pod disease caused by *Phytophthora* spp., the mirids *Distantiella theobroma* and *Sahlbergella singularis*, and the cossid moth stem borer *Eulophonotus myrmeleon*. Diseases currently devastating South American production (witches' broom, *Crinipellis perniciosa,* and frosty pod, *Moniliophthora roreri*) were also recognized as looming threats. Interestingly, swollen shoot virus (transmitted largely by mealybugs in the genera *Planococcus* and *Stictococcus*) was, along with mistletoes, termites and weeds, considered a threat, but was not accorded the priority it has sometimes been given.

Three regional groups, with one member from each STCP member country, focused on one prioritized pest problem. They considered its current status, available IPM options and options in development, identified experts in member countries, and came up with suggestions for regional collaboration to alleviate the problem. Following this, participants came together as national groups, and each evaluated cocoa IPM extension in their country, the experts they have and how current methodology could be improved to reach more farmers or improve impact.

By synthesizing this information, the workshop was able to come up with an inventory of on-going and potential regional cocoa IPM research and implementation, and a menu of possible solutions to the three key pest problems to achieve sustainable and cost-effective reduction in cocoa yield losses, while maintaining good cocoa quality. Core components of the menu are:

- biocontrol using indigenous micro-organisms
- rational pesticide use
- host plant resistance
- cultural controls including habitat management and tree pruning

Strengthening quarantine was added to this list, to address the need to prevent diseases from other regions of the world gaining access to the cocoa-growing areas of West Africa.

The next step is to formulate projects and secure funding to develop and evaluate different methods. The goal is to develop sustainable farming systems in the forest zone with cocoa as the main cash crop and farmers in the driving seat. The solutions have to be based on what is acceptable to farmers, and what is needed is a basket of options that alleviate cocoa farmers’ major pest problems. These should then be evaluated and implemented in 'best-bet' trials using farmer participatory methods.

This will make real the dream of farmers benefiting from more profitable production of cocoa using largely biologically-based IPM. Besides the economic benefits, this will be better for the health of the farming community. In addition, such an approach will sustain the forest environment, even providing habitat bridges between forest pockets.

Workshop proceedings will be produced and distributed in 2002.

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PAN Full of IPM Resources

Advice on cocoa IPM can be found in one of the latest briefings prepared by the Pesticides Action Network UK (PAN UK) under the 'Control of pesticides and IPM in Developing Countries Project', funded by the European Commission. One of the project's outputs, *Pest Management Notes* (*PMN*), is a series of four-page briefings for governments, development agencies, policy and technical advisers, researchers and others on policies and issues related to pesticides and IPM.

Number 12 in the series, 'Sustainable cocoa production systems' summarizes major pest and disease problems facing cocoa producers worldwide, and reviews current options for its sustainable management. Cocoa, it points out, is a crop of smallholder farmers, but low prices and high input costs have had a major impact on production and incomes. In the face of falling prices in this notoriously volatile sector, which have reduced farmers' profits in many cases to minimal at best, many farmers have virtually abandoned their cocoa trees. They have invested the bare minimum of time and inputs, and such neglect has in turn exacerbated many pest and disease problems. These are legion, but the conclusions of the workshop described in the article above mirror some of the conclusions in this Briefing. It identifies the most important pests in West Africa as: black pod disease (caused by *Phytophthora* spp.), which causes losses of a staggering 44% of global production each year; cocoa swollen shoot virus, transmitted largely by mealybugs (*Planococcus* and *Stictococcus* spp.) and leading to losses of some 25% and eventual death of the tree; capsids (*Distantiella theobroma* and *Sahlbergella singularis*), which cause up to 75% loss;

and parasitic mistletoes. The Briefing also warns that pests and diseases currently devastating cocoa in other parts of the world loom as threats on the horizon.

Conventional pesticide-based control has become uneconomic and increasingly ineffective. In addition lindane, which has been used to control capsids, is a highly persistent and toxic insecticide now banned by many countries. *PMN* No. 12 outlines current options for sustainable cocoa production, including maintaining crop hygiene, using resistant varieties, managing shade, biological control, rational pesticide use and maintaining fertile soils.

The briefing concludes:

- all stakeholders need to be involved in a partnership to develop effective sustainable systems for cocoa production
- apparent farmer reluctance to take up research results generally reflects inappropriate recommendations owing to the failure of research and extension services to appreciate farmers' constraints
- participatory approaches build the knowledge and confidence for farmers to make their own crop management decisions, and such approaches have already notched up successes in cocoa in Central and South America

PMN is just one output of the first phase of this project, which was designed to increase the speed of implementation of farmer participatory IPM and to improve awareness of essential steps in the sound management of pesticides. The project is implemented by PAN UK, part of PAN Europe, which is one of five regional centres coordinating a global network comprising over 600 participating non-governmental organizations, institutions and individuals in over 60 countries working to replace the use of hazardous pesticides with ecologically sound alternatives.

Pesticides continue to be used in developing countries, in spite of often inappropriate conditions facing women and men farmers and workers applying the products. Policy makers in governments and developing countries require accessible information on strategies for improving capacity to regulate pesticides, implement best practice, and develop IPM. PAN UK aims to meet this knowledge gap by making information and resources that promote 'progressive pest management' widely available. They are drawing on PAN's wide-ranging research of best practice, and on their own and others' experience of pesticide regulation and farmer participatory IPM strategies. The resources produced are the result of consultations and studies of needs at both policy and field level, and will be made available in English, French and Spanish.

In its first phase, the project has produced a guide to reducing pesticide use and developing and implementing IPM policies. Comprehensive information and resources have also been gathered and made available on pesticide hazards and IPM. Profiles provide a snapshot of how some countries in Africa are progressing in the transition to safer, more sustainable agriculture, and there is a database of projects containing a strong element of participatory IPM. *PMN* briefings advise on sustainable management of other major crops besides cocoa (coffee, cotton and fruit) and pests (locusts), introduce the concept of IPM, and give practical and regulatory guidance on pesticide issues. Also forthcoming is a report from field studies on 'Progressive pest management for food security and the environment' conducted in four countries (Senegal, Benin, Ghana and Ethiopia) in a variety of crops (cotton, vegetables, pineapple, and cereal grains and legumes). The findings from these case studies on the problems and costs associated with pesticide dependence will be shared with stakeholders and policy makers in Africa and Europe in order to develop recommendations for policy and field-level actions.

Information: www.pan-uk.org/Internat/IPMinDC/ipmindex.htm

Contact: Barbara Dinham, Director, Pesticide Action Network-UK
Eurolink Centre, 49 Effra Road, London SW2 1BZ, UK
Email: barbaradinham@pan-uk.org
Fax: +44 20 7274 9084

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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.

Community Involvement Underpins Biocontrol in Australia

The South African plant bridal creeper, *Asparagus asparagoides,* has made an impact in Australia and is listed as one of the twenty Weeds of National Significance. It was deliberately introduced in the mid 1800s owing to its popularity in bridal bouquets, and with the help of birds eating its berries and spreading its seeds, it is now slowly smothering its way across southern Australia. In severe infestations the foliage smothers all vegetation to a height of 2-3m. However, above-ground parts form only a fraction of the plant: the vast majority is hidden underground in the form of tubers. Its marked impact is being felt severely throughout numerous national parks and in some cases it is threatening the existence of Australian native species.

Bridal creeper is now a target of two biological control agents that have been introduced, by the Cooperative Research Centre (CRC) for Australian Weed Management and CSIRO Entomology, in an attempt to bring it under control. The first, a leafhopper, *Zygina* sp, was released in July 1999. [See also *BNI* **20(4)** 108N-109N (December 1999) 'Green giant'.] Its most dramatic impact has been seen in Western Australia (WA) where large areas of bridal creeper have turned white through the insect's sucking activity. Similar results are also being found in South Australia (SA) and New South Wales (NSW).

WA is also the site where thousands of schoolchildren have embraced this biological process, rearing and distributing as many insects as possible under the guidance of Technical Officer Ms Kathryn Batchelor and project leader Mr Tim Woodburn. The results have been overwhelming. By the end of 2000 over 40 schools and community groups had become involved in the campaign in WA and by the end of 2001 the numbers had climbed to more than one hundred.

The attack from the leafhoppers prevents the plant from photosynthesizing and causes it to gradually use its stored energy from the tubers, making them shrink. The continued shrinking of the tubers will give native plant seeds a greater opportunity for germination and establishment than is currently the case.

There are numerous generations of the leafhopper every year and this gives the insect the ability to build up numbers rapidly. However, more than one biological control agent is required and in July 2000 the rust fungus, *Puccinia myrsiphylli,* was released. The rust completes its life cycle on bridal creeper, infecting the leaves and stems. It obtains nutrients and water from the plant thus limiting resources available for the production of stems, fruit and tubers.

The fungus also destroys leaf tissue by reducing the photosynthetic surface of the plant, causing severely diseased plants to shed infected leaves prematurely. In the winter rainfall regions of South Africa, the rust is usually observed within 12 weeks of appearance of new shoots in autumn. From then on, the incidence of the rust steadily increases during winter to reach its peak in spring when the plants are flowering and fruiting.

Weed CRC/CSIRO pathologist Dr Louise Morin is in charge of the pathology work and has praised the efforts of community groups so far, all of which have had a big role to play with the distribution of both the leafhopper and the fungus. The importance of this role is only going to increase in the future.

CSIRO has recently received funding from the Natural Heritage Trust which will allow more community groups to get on board the redistribution process and help release and spread these agents across bridal creeper infested sites in a much more rapid and coordinated manner. The funding will allow these groups to be trained by CSIRO staff to develop the basic skills and understanding they will require. It will also allow for the development of release information kits outlining the processes, maintenance of a national database on release sites and further enhancement of the bridal creeper website (see below).

As well as the work being undertaken by Kathryn Batchelor, the Weed CRC's Mr Anthony Swirepik has been the National Redistribution Coordinator for biological control agents for the last 6 years and has a major role to play in this project. Swirepik's job will involve making further contact with appropriate groups, organizing biological agents for them to release, liaising with them to ensure all is going well, and determining the level of monitoring that is required. The monitoring will allow researchers to determine how quickly the agents are spreading and what other areas need to have releases made to ensure rapid coverage of bridal creeper infestations.

Control of massive environmental weeds such as bridal creeper can only be achieved with community support. Since the late 1980s CSIRO has been developing close relationships with groups that have an active interest in biological control. From humble beginnings, national programmes have now been developed and the future of some target weeds is looking bleak. This is a situation that could not have been achieved without the efforts of the community and the state departments that have been involved.

There remains one more agent to be released against bridal creeper, the leaf-beetle *Crioceris* sp., and an application for its release is now being assessed by regulatory authorities. Both adults and larvae of this beetle feed on the young shoots and leaves of bridal creeper. It has one generation a year and is active during the autumn and early winter months when bridal creeper is commencing its rapid growth stage. All three biocontrol agents co-exist on the plant in its native South Africa, hence researchers anticipate that the action of these three agents will combine to bring around the future demise of bridal creeper.

Groups interested in the bridal creeper research programme are encouraged to check out the web site at:
www.ento.csiro.au/bridalcreeper

Contact: Kate Smith, CSIRO Entomology, GPO Box 1700, Canberra, ACT 2601, Australia
Email: kate.smith@csiro.au
Fax +61 2 6246 4177

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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.

BCPC Conference

This annual, international conference organized by the British Crop Protection Council (BCPC) for the global crop protection industry will be held in Brighton, UK on 18-21 November 2002, and this year focuses on pests and diseases.

Always a feature of this Conference is the presentation of new compounds and strategies for pest and disease management in temperate and tropical crops. Specialist sessions will examine key strategic topics that will influence the management of pests and diseases in the future with an emphasis on meeting expected challenges, including those faced in ICM (Integrated Crop Management) and organic farming and by use of biological control agents.

Website: www.bcpc.org/

Contact: Brighton Conference Secretariat, 5 Maidstone Buildings Mews, Bankside, London SE1 1GN, UK
Email: conference@bcpc.org
Fax: +44 20 7940 5577

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Reason to Consider GMOs

Partisan arguments over GMOs (genetically modified organisms) and their environmental effects continue to be highlighted in the world's media. Rational debate is going on, however, although that rarely makes headlines. Following on from our announcement of the IOBC Conference in Montpellier in November [see *BNI* December 2001], here are two more meetings this autumn on related themes.

GMO Biosafety Symposium

The International Symposia on the Biosafety of Genetically Modified Organisms (GMOs) have been held biennially, to address the scientific basis for biosafety issues associated with GMOs (including environmental, as well as human and animal health concerns). The Symposium series is designed for senior scientists, policy makers, regulators, environmentalists and industry representatives involved in the commercial release of GMOs. The 7th Symposium will be held on 10-14 October 2002 in Beijing, China, under the responsibility of the newly-founded International Society for Biosafety Research.

Sessions will focus on diverse issues, including

- New science for enhanced biosafety (chaired by Dr Joachim Schiemann)
- Consequences of gene flow (Dr Allison Snow)
- Why regulate and how (Prof. Julian Kinderlerer)
- Pest control and biosafety (Dr Marjorie Hoy)

Contact: Professor Hongya Gu, College of Life Sciences, Peking University, Beijing 100871, China
Email: biosafe@pku.edu.cn
Fax: +86 10 62751841 / 62751194

Ecological Dimensions of GMOs

An international conference is being organized jointly by the UK Association of Applied Biologists and the Royal Entomological Society to discuss the ecological dimensions of GMOs. This will be held in Reading University, UK on 9-11 September 2002.

Sessions will be organized on the themes:

- Gene flow and its consequences
- Impact of GMOs at the crop ecosystem level
- Soil and soil processes

Website:
www.aab.org.uk/meetings/mtgs2002/gmos.htm

Contact: Carol Millman
Email: carol.aab@hri.ac.uk
Fax: +44 1789 470 234

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Biocontrol in California

The 3rd California Conference on Biological Control (CCBC) will be held on 15-16 August 2002 at the University of California (UC), Davis, providing an opportunity to review the latest information on biological control and its application for pest management in California. Sessions will cover:

- Transgenic crops and their compatibility with biological control agents and other non-target organisms (Moderator: Brian Federici, UC Riverside)
- Invasion biology and lessons for biological control (Les Ehler, UC Davis & Michael Pitcairn, California Department of Food and Agriculture)
- Biological control of invasive species in California (Mark Hoddle UC Riverside & Ray Carruthers US Department of Agriculture – Agricultural Research Service, Albany)
- Reduced risk pesticides and compatibility with biological control agents (Nick Mills, UC Berkeley)

Conference information:
www.biocontrol.ucr.edu/

Or contact: Mark S. Hoddle, Department of Entomology, University of California, Riverside, CA 92521, USA
Email: mark.hoddle@ucr.edu
Fax: +1 909 787 3086

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IPPC in China

The 15th International Plant Protection Congress (IPPC) will be held in Beijing, China on 6-11 July, 2003, sponsored by the International Association for the Plant Protection Sciences and organized by: China Society of Plant Protection.

The 15th IPPC will focus on current progress in plant protection sciences and technology, and its foreseeable development in the 21st century. To meet the new challenge facing plant protection in the new millennium, the tentative theme of the Congress is 'The First Great Gathering for Plant Protection in 21st Century'. Topics covered will include:

- Extension of IPM strategy in the 21st century
- Resistance of crops to pests
- Biocontrol
- Chemical pesticides (new products, application techniques, resistance, pesticide management, etc.)
- Biotechnology for plant protection
- Plant protection and the environment
- Information technology in plant protection and pest prediction
- Ecological regulation and control of farmland pests
- Plant quarantine
- Relationships and coevolution of crops, pests and natural enemies
- Non-chemical pest control techniques

Pest management will also be considered by system, i.e.: grain crops, commercial crops, orchards, forests, vegetable crops, grassland, flowers and lawns, farmland, pre-planting and postharvest, and for farmland rodents.

Conference information:
www.ipmchina.net/

Or contact: Ms Wen Liping, Secretariat, 15th IPPC, C/O Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100094 China
Email: ippc2003@ipmchina.net
Fax: +86 10 62815913

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African Insect Science

The 15th Biennial Meeting and Scientific Conference of the African Association of Insect Scientists (AAIS) will be held in Nairobi, Kenya on 11-14 June 2003, in partnership with the Entomological Society of Kenya (ESK). The conference coincides with AAIS Silver Jubilee (25th Anniversary) celebration.

The theme of the 15th Biennial Meeting will be 'Integrated Pest (IPM) and Vectors Management (IVM) on African Rural and Urban Livelihoods: Perspective and Future Strategies'. Subthemes will be:

- Impact of IPM on food and horticultural crops production/productivity
- Impact of IVM on human, animal and plant health
- Capacity building, collaboration and networking
- Environment, biodiversity and natural resource management
- Advances in biotechnology and biosafety
- Conducive policy environment for IPM: modalities and content

Contact: The Hon. Secretary, AAIS, Dr Francis E. Nwilene, West Africa Rice Development Association, 01 BP 2551, Bouaké 01, Côte d'Ivoire
Email:
f.nwilene@cgiar.org / aais@icipe.org

Local Organizing Committee (LOC): Entomological Society of Kenya (ESK), PO Box 76662, Nairobi, Kenya

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IOBC Made Easy

IOBC (the International Organization for Biological Control of Noxious Animals and Plants) has a revamped website at:
www.oilb.agropolis.fr/

IOBC was established in 1956 as a global organization and promotes environmentally safe methods of pest and disease control. As a voluntary organization of biological control workers, it gives individuals and organizations the opportunity to participate in biological control activities beyond their specific jobs and workplaces, to step outside their bureaucracies, and to contribute to the promotion of biological control worldwide. IOBC has developed a structure based primarily on a regional basis, but with another (working group) layer defined by topic, to meet these challenges. Currently there are six Regional Sections and ten Global Working Groups. Information dissemination is not easy in such a devolved structure – yet good communication is key to IOBC achieving its aims.

The new site overcomes some of the hurdles. Easily navigable links between regions and working groups, with contact details, websites and newsletters, allow visitors quickly to gain an overview IOBC's interests, and for biocontrol workers in one (geographical or topical) area to keep up to date with other activities and interests of members.

Contact: André Gassmann, CABI Bioscience Switzerland Centre, CH-2800 Delémont, Switzerland
Email: a.gassmann@cabi-bioscience.ch
Fax: +41 32 4214871

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Linking African IPM Practitioners

The new Africa Link website is live at:
www.ag.vt.edu/ail
and in French at:
www.ag.vt.edu/ail/french/index.htm

The website has been developed by the Africa Integrated Pest Management (IPM) Link, a project of the IPM Collaborative Research Support Program (IPM CRSP), managed by the Office of International Research and Development (OIRD) of Virginia Tech in Blacksburg, Virginia, USA with funding from two US Agency for International Development (USAID) units (the Bureau for Africa, and the Office of Sustainable Development).

The website is the latest venture of the project, which is fostering the development of a network of IPM practitioners in sub-Saharan Africa by facilitating access to the latest electronic communication and information exchange tools, in collaboration with AfricaLink (a USAID initiative), and with the Consortium for International Crop Protection (CICP).

The AFRIK-IPM listserv has been operating as an electronic forum for networking and information sharing between Integrated Pest Management (IPM) professionals throughout sub-Saharan Africa since March 1998, when it was set up for participants of the IPM Communications Workshop for Eastern/ Southern Africa, held at the International Center for Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya. Since then it has continued to serve individuals inside and outside the African continent with an interest in promoting IPM research and information dissemination for sub-Saharan Africa.

Contact: Miriam Rich, Office of International Research, and Development, 1060 Litton Reaves Hall (0334), Virginia Tech, Blacksburg, VA 24060-0334, USA
Email: mrich@vt.edu
Fax: +1 540 2316741
Website: www.ord.vt.edu

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Good Ideas from the Global IPM Facility

The legendary efficiency of the African 'bush telegraph' as an information dissemination system has been brought bang up to date by the Global IPM Facility.

eWAZO (from 'wazo', Kiswahili for 'idea') is a new bi-monthly news service to provide information from IPM programme development activities focusing on IPM policy, education, and research at regional, country and local levels. Launched in January 2002 by the Global IPM Facility from their office in the UN Food and Agriculture Organization (FAO) headquarters in Rome, it will be edited by Kevin Gallagher:
Email: global-IPM-L@mailserv.fao.org.

To subscribe to this free service, contact M.E. Tagliati
Email: Elisabetta.Tagliati@fao.org

Also keep an eye on the revamped Global IPM Facility website, available in English, French and Spanish at:
www.fao.org/globalipmfacility/

Although still under development, this looks set to provide a wide range of information about the Facility, its co-sponsors and donors and other international IPM-related information. Already available is useful information on its operations, which includes pages describing field activities throughout the world.

Text-only and full versions of the complete site, to cater for all needs, set a good example that others could follow!

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New Whitefly Website

After 3 years of being hosted by the John Innes Centre in Norwich, UK, a new EWSN (European Whitefly Studies Network) website is now live at:
www.whitefly.org

The site is designed to provide rapid access to a wide range of whitefly-related information, including EWSN members' expertise and publications, EWSN activities including meetings, sponsors and partners (with links to websites) and the EWSN newsletters. Coming on-line are links to databases to allow access to detailed information on whitefly species, whitefly-transmitted viruses, natural enemies and control strategies, together with a facility for submitting new information and asking questions.

Contact: EWSN Research Facilitator, Department of Disease and Stress Biology, John Innes Centre, Norwich Research Park, Colney Lane, Norwich NR4 7UH, UK
Email: network.ewsn@bbsrc.ac.uk
Fax: +44 1603 450045

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Rice IPM CD

RiceIPM is a new interactive information and identification system released in November 2001 by the Centre for Pest Information Technology and Transfer (CPITT) and IRRI (the International Rice Research Institute), who have developed it jointly, with the help of an international team of IPM specialists from Southeast Asia. CPITT, part of the University of Queensland, Australia, develops innovative tools for training and decision support, which are currently being used in more than 25 countries.

The new CD is structured according to the competency standards required for proficient IPM and thus aims to provide extension officers, researchers, students and farmers with a user-friendly and comprehensive source of information and training materials for improving management of pests in tropical rice.

The new CD uses a range of techniques, including video, images, hypertext links and interactive keys, to cover pest ecology; crop checking; major insect pests, rats, diseases, weeds, nutrient deficiency and toxicity; crop growth and pest damage; pest management options and decision-making and economics. A separate section provides material for researchers and advisers on various aspects of implementing IPM, including Farmer Field Schools, multimedia campaigns, and stakeholder workshops.

Information:
www.cpitt.uq.edu.au/software/riceipm/

Obtainable from: CPS-Marketing and Distribution Unit, IRRI, DAPO Box 7777, Metro Manila, Philippines
Email:
e.ramin@cgiar.org / irripub@cgiar.org
Fax: +63 2 761 2404 / + 63 2 761 2406
Webpage:
www.irri.org/pubcat2000/
newtitles.htm#IPMCD
Price: US$5 to developing countries / US$35 to developed countries

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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.

Arthropod Biocontrol Meeting HI-lights

The First International Symposium on Biological Control of Arthropods (1st ISBCA) was held on 14-18 January 2002 in Honolulu, Hawaii, USA, and attended by 150 scientists from 25 countries. This meeting launched a new series of meetings that will be held every four years. The goal of the meeting was to bring together scientists working on the use of predators or parasitoids for control of insects or mites to discuss projects and issues. The format of the meeting is small (about 200 key people) with no concurrent sessions and plenty of time for discussion.

Introduction, augmentation and conservation biological control were each covered by a full day of 16 talks each, with the opening day devoted to consideration of issues and methodologies affecting biological control projects broadly. The meeting series is 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 new ISBCA is intended to bring together people working on control of insects and mites to foster communication and stimulate work on issues of common interest.

The first day of the meeting (Monday) was opened by a keynote address from Mark Hoddle of the University of California and a special talk by Jim Cullen of Australia (CSIRO) honoring Doug Waterhouse, recently deceased. The first session, 'Issues in Future Expanded Use of Classical Biological Control', was opened by Matthew Cock of CABI *Bioscience*, followed by Lloyd Loope of the US National Park Service, Frank Howarth of the Bishop Museum, Barbara Barratt of AgResearch in New Zealand, and Don Sands of CSIRO in Australia. Issues discussed included perspectives on the rising tide of invasions in an age of global trade, legal issues in the regulation of biological control, and technology for estimating host ranges of new parasitoid species being studied for introduction. The second session of the day, 'Methods to Colonize, Evaluate, and Monitor Natural Enemies', presented material on studies of native whitefly host relationships in Australia, introduced whitefly parasitoids in the US, and the successful control of a eucalyptus borer in California. The afternoon programme continued with a session, 'Use of Molecular Methods in Classical Biological Control', organized by Marjorie Hoy of the University of Florida, which featured case studies on how to use molecular methods to do such things as separate out cryptic species in natural enemy collections, exclude contaminating pathogens in groups of natural enemies in quarantine, and obtain field estimates of predation and parasitism. This session was followed by 'Modeling and Theory as Tools to Clarify Causes of Success or Failure of BC Projects', organized by Nigel Barlow of AgResearch in New Zealand, with presentations by scientists from California, France, and the Czech Republic.

Tuesday was devoted to studies of biological control through augmentation of natural enemies. The keynote speaker for the day was Kevin Heinz of Texas A & M University (USA). Two sessions focused on crop-specific examples: 'Successes in Augmentative Biological Control', which covered use in greenhouses and apples and 'Survey of Actual and Potential Use in Outdoor Crops', organized by Bob Luck of the University of California, USA, on use of augmentative biological control in citrus and hops. The other two sessions covered economics of natural enemy production ('Economics of Production and use of Reared Natural Enemies', organized by Ron Valentin, Koppert, Canada, Inc.) from the producer’s perspective and the ecology of natural enemy movement ('Post-Release Dispersal, Distribution, and Impact of Augmented Natural Enemies in Field Settings', organized by Livy Williams, US Department of Agriculture; USDA).

The middle day of the programme was devoted to a tour of the Island of Oahu, with stops to see natural enemy research on mites on papaya and mealybugs on pineapple, and also stops at the State Department of Agriculture and the USDA fruit fly research laboratory.

Thursday was devoted to studies of biological control by means of natural enemy conservation. The keynote speaker was H. F. van Emden of Reading University, UK. Sessions were presented on 'Nectar Feeding by Parasitoids' (organized by George Heimpel of Minnesota, USA and Robert Pfannensteil, Texas, USA), featuring speakers from Australia, New Zealand, and the Netherlands; on 'Alternative Hosts and Habitat Refuges for Natural Enemies' (same organizers); on 'Effects on Natural Enemies of Using *Bt* Crops in IPM Systems' (organized by Brian Federici, University of California, Riverside); and 'Pesticide Effects on Natural Enemies' (organized by Livy Williams, USDA).

The final day of the programme (Friday) was given over to recent projects of classical biological control. Tom Bellows, University of California, Riverside was keynote speaker and speakers addressed projects from Benin, Guam, Papua New Guinea, Australia (Queensland), New Zealand, the USA (Florida and California), Japan and Switzerland. In addition, there was a session organized by Russell Messing of the University of Hawaii 'Monitoring for Effects of Biocontrol Agents on Nontarget Organisms'.

The proceedings of the meeting (short papers of all 147 presentations – 66 talks and 65 posters) will be published with support of the US Forest Service and free copies will be available by late summer 2002 (contact Roy Van Driesche for copies).

The next meeting in this series will be held in late September-early October, 2005 in Switzerland in the high Alps. Ulli Kuhlmann, CABI *Bioscience* Switzerland, will put together the local organizing committee. An international programme committee to develop the meeting's content will be headed by Mark Hoddle, University of California, Riverside. Anyone interested in helping on the committee should get in touch with Mark.
Email: mark.hoddle@ucr.edu

The long term importance of this series of meetings will be in fostering closer contact among insect biological control workers and providing a forum for discussion of critical issues and organizing *ad hoc* groups to address them. We hope to have approximately 200 of the world’s top people in attendance in Switzerland.

By Roy Van Driesche, Department of Entomology, University of Massachusetts, USA
Email: vandries@fnr.umass.edu

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Hot Topics in Australasian Plant Pathology

The Australasian Plant Pathology Society was founded in 1969 and every 2 years an organizing committee from an Australian State or Territory or New Zealand has convened the APPS conference and held it at a local venue. The 13th Biennial Australasian Plant Pathology Society Conference was held in Cairns in north Queensland, Australia on 24-27 September 2001. This was the first time the conference had been held in a regional location and the first time it had been held in a tropical location. Around 325 delegates from 20 nations attended the conference and preceding workshops. Delegates came from all states of Australia, New Zealand, South Africa, Japan, Papua New Guinea, Fiji, Samoa, Indonesia, Vietnam and Thailand. Some delegates travelled from Europe and the USA to participate in the conference.

The workshops that preceded the conference dealt with a wide range of topics including:

- Identification and classification of Ascomycetes
- Identification and classification of Ustilaginomycetes
- Uncultivable plant pathogens
- Introduction to Bionavigator
- Soil nematode ecology
- Plant defence mechanisms
- Dieback in tropical rainforests
- Diagnosis of plant diseases caused by bacteria
- Plant pathology diagnostics

The workshop on plant defence mechanisms proved to be the most popular at this year's conference. The nematode ecology workshop run by Dr Gregor Yeates was able to use the diversity of nematodes assemblages to demonstrate the impact that differences in agricultural practices have on the soil ecology. A report on the results of this workshop is to be published in the *Australasian Nematology Newsletter* December publication.

The conference was divided into three symposium sessions, 25 concurrent sessions and eight poster sessions.

The first symposium on Pathogen Dynamics in the Plant Environment dealt with genetics and genomics of fungal pathogenicity (Dr Richard Oliver), cellular interactions of biotrophic fungal pathogens (Dr Michelle Heath) and microbial ecology in the rhizosphere (Dr Dan Kluepfel). The second symposium, focussing on getting the message out, dealt with relaying information to farmers about plant diseases and the importance of two-way communication when dealing with complex issues such as plant diseases (Dr Joe Noling & Dr Joe Kochman). An account of what farmers are faced with was given by Mr Alan Zappala who manages a mixed farming enterprise which includes sugarcane, tropical fruit and flower production. The final symposium dealt with plant pathology in the tropics. The pest and disease situation of sugarcane production in Papua New Guinea, the home of sugarcane, was highlighted by Dr Lastus Kuniata. The need for quality biodiversity through resistance breeding and use of wild types was presented by Dr Jill Lenne. The diagnostic and advisory support needed in developing countries to deal with plant diseases was highlighted by Dr Mark Holderness.

Two additional keynote addresses were given by prominent international delegates on fungal population genetics (Dr Bruce McDonald) and on virus vector relationships (Dr Tom Pirone). The presidential lecture (Dr David Guest) and the McAlpine Memorial Lecture (Dr Alan Dubé) both highlighted the difficulty in funding plant pathology research, an analysis of external factors influencing research and employment of plant pathologists as well as the need for succession planning to ensure high quality plant pathology research continues in Australasia.

There were 141 oral presentations and 159 poster presentation at the conference. The concurrent oral and poster sessions were categorized into extremely diverse subject groups. Oral session topics were soil borne diseases, exotic pathogens and quarantine, disease surveys and new pathogens (two sessions), biological control of weeds, virology (two sessions), bacteriology, plant pathogen interactions (two sessions), population genetics of pathogens, epidemiology, diagnosis and detection (two sessions), phytoplasmology, disease management (three sessions), nematology, breeding for disease resistance, biocontrol of pathogens, diseases in natural ecosystems, induced resistance, and tropical plant pathology (two sessions). Contributed posters were divided into suitable topic groupings and each poster presenter was given a short period of time, in designated poster discussion sessions, to informally present a brief overview of their work to interested listeners. Poster discussion session topics were detection and diagnosis, disease management, nematology/bacteriology/phytoplasmology/virology/diseases of uncertain etiology, fungal diseases (two sessions), breeding for disease resistance, disease and weed management, and host pathogen interactions.

Following the conference, two busloads of delegates were given a chance to see first hand, Australian tropical agriculture and horticulture in action. As always, this meeting facilitated ample social interaction and informal networking. A welcome mixer and the formal dinner took place at the Cairns Convention Centre. A farewell function was held poolside at a nearby hotel.

The 14th Australasian Plant Pathology Society Conference is to be held in conjunction with the 8th International Congress of Plant Pathology in Christchurch, New Zealand on 2-7 February 2003 at the Christchurch Convention Centre. Information on the conference can be accessed at their website:
www.lincoln.ac.nz/icpp2003

By: Tony Pattison, Queensland Department of Primary Industries, Centre for Wet Tropics Agriculture, PO Box 20, South Johnstone, Qld 4859, Australia
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Fax: +61 7 4064 2249

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Weed Biocontrol in Europe

The latest weed biological control workshop of the European Weed Research Society (EWRS) was held in the School of Plant Sciences, the University of Reading, Reading, UK on 6-7 January 2002 and was attended by 28 delegates from eight countries. These workshops are run by the Biological Control Working Group of the EWRS and are held roughly every 2 years (recent ones have been held in Switzerland, Germany and France). They aim to provide an informal forum for the discussion of current research and weed biological control issues in Europe.

Dick Shaw (UK) started proceedings by discussing the challenges facing classical biological control of weeds in the UK. Despite much experience with natural pest control there has never been a full release of a weed biological control agent in Europe: a successful example would greatly help facilitate the further development of this field. Heinz Müller-Schärer (Switzerland) then described the genetic population structure of *Senecio vulgaris* in relation to its pathogen *Puccinia lagenophorae*. Despite significant within and between population genetic variation in susceptibility to the rust fungus, sustainability of biological control was estimated as high as no incompatible reactions were observed. Blair Grace (Switzerland) followed and reported that placing inocula of *P. lagenophorae* in the field early in the growing season can make *S. vulgaris* less competitive against carrots, thus increasing their marketable yield. This could be a promising example of the systems management approach.

Jonathan Gressel (Israel) described recent work in obtaining hypovirulence against *Abutilon* in *Colletotrichum coccodes* after introducing the *nep 1* gene. He then talked about a proposed system for 'bio-barcoding^{TM}' mycoherbicides to mark and protect transgenic and/or patented lines, or to trace mycoherbicides in the environment. This was followed by four papers exploring different aspects of herbivore interactions with weeds. Alois Honek (Czech Republic) described the development of two Coleoptera seed predators of *Taraxacum officinale* in relation to their temperature requirements, Esther Gerber (Switzerland) reported on experiments into the effect of the root herbivore *Ceutorhynchus scrobicollis* on the invasive weed *Alliaria petiolata*, an environmental weed in North America, Ian Keary (UK) reported on experiments determining the effects of insects and fungi, applied alone and in combination, on the establishment of *Rumex obtusifolius* in *Lolium perenne*, and Urs Treier (Switzerland) explained the effect of cattle and mollusc grazing on seedling recruitment of the mountain grassland weed *Veratrum album*.

The second day of the workshop started with a paper by Alan Gange (UK) describing the results of some novel experiments investigating the potential for biological control of *Poa annua* in sports turf using mycorrhiza which appear to be antagonistic to this weed. This was followed by three papers reporting experiments into biocontrol of *Orobanche* using fungi. Dorette Müller-Stöver (Germany) described successful greenhouse trials of a granular formulation of *Fusarium oxysporum* f. sp. *orthoceras* against *O. cumana*. However, the level of the disease and its influence against *Orobanche* emergence was far lower in the field compared to the pot experiments. Joseph Hershenhorn (Israel) detailed several new pathogens against *Orobanche* that were being tested in the greenhouse and Jonathan Gressel (Israel) gave a talk on work in his lab on engineering hypervirulence in *F. oxysporum* and *F. arthrosporioides* pathogenic on *O. aegyptiaca* using genes that cause overproduction of IAA.

In addition, posters were displayed on allelopathic compounds from *Inula viscosa* (Joseph Hershenhorn, Israel), the potential of biological control as a management tool for *Rhododendron* in the UK (Marion Seier, UK), progress on the Japanese knotweed biological control programme in the UK (Dick Shaw, UK), and the insect natural enemies of *Cuscuta* and *Orobanche* in Slovakia (Peter Toth, Slovakia).

The workshop finished with a guided visit to CABI *Bioscience*'s Ascot weed biological control laboratories. The papers presented at the workshop demonstrated that research into the biological control of weeds in Europe is still strong, with a great diversity of target systems and biocontrol approaches being investigated. It is especially healthy that new approaches are also being actively investigated. However, bearing in mind the opening presentation, there was a discussion session during the workshop on ideas for improving the visibility of weed biological control and the working group in Europe. It was decided that as a first step a web-site would be set up to provide a forum for exchange of ideas and information.

The next working group meeting will be held in conjunction with the EWRS symposium in 2004.

For an email copy of the abstracts from this workshop, or to be placed on the (e)mailing list, please contact the working group chairman (Email: p.e.hatcher@rdg.ac.uk).

By Paul Hatcher, University of Reading, UK

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New Books

Beautifully Moth-Eaten

This book* is a welcome second volume in an ACIAR (Australian Centre for International Agricultural Research) series on using arthropod agents for biological control of water hyacinth (*Eichhornia crassipes*). Happily, like its predecessor, it is as useful and authoritative as it is good to look at, and provides a complete 'do-it-yourself' guide to the use of two lepidopteran biological control agents using the CSIRO methods that have been successfully employed in many programmes.

The first volume** in the series dealt with *Neochetina* weevils; this second volume deals with the moths *Niphograpta albiguttalis* and *Xubida infusellus*. Both books include introductory sections on the biology and impact of water hyacinth, together with options for its management, and then go on to deal with the agents and their use in biological or integrated control. This book describes the biologies and host ranges of the moths, gives a history of their introductions and a comprehensive summary of host specificity testing. The outstanding feature once again, however, is the clearly written, highly illustrated sections on rearing, releasing and monitoring techniques for those who want to use the moths for biological or integrated control of water hyacinth.

*Julien, M.H.; Griffiths, M.W.; Stanley, J.N (2001) Biological control of water hyacinth 2. The moths *Niphograpta albiguttalis* and *Xubida infusellus*: biologies, host ranges, and rearing, releasing and monitoring techniques for biological control of *Eichhornia crassipes*. ACIAR Monograph Series No. 79, 91 pp. ISBN 1 86320 295 1

**Julien, M.H.; Griffiths, M.W.; Wright, A.D. (1999) Biological control of water hyacinth. The weevils *Neochetina bruchi* and *N. eichhorniae*: biologies, host ranges, and rearing, releasing and monitoring techniques for biological control of *Eichhornia crassipes*. ACIAR Monograph Series No. 60, 87 pp. ISBN 1 86320 267 6

Obtainable from: ACIAR, GPO Box 1571, Canberra, ACT 2601, Australia.

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South African Weed Handbooks

Two useful handbooks in relation to 'New Legislation Benefits Weed Biocontrol in South Africa' (see General News, this issue) are described here.

Declared Weeds and Invasive Plants in South Africa

The main objective in producing this handbook* was to enable members of the public and the relevant authorities to identify the declared weeds and invaders covered by the Conservation of

Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA), as amended during March 2001. It is the officially recognized guide to the plant species banned or regulated by the amended CARA regulations, sanctioned by a foreword by the Minister for Agriculture and Land Affairs.

Even dedicated environmentalists despair at the task of learning to recognize the almost 200 plant species on the list, remembering to which category each belongs and learning how to deal with each category. Several over-zealous gardeners and land managers have acted on rumours, mistakenly destroying indigenous trees or species not mentioned in the CARA regulations.

The new book should put an end to the uncertainty and rumours amongst gardeners, horticulturists, foresters and agriculturists about which plants may stay, which ones have to be removed, which ones may no longer be sold and which ones may only grow in demarcated areas. In the words of the Minister for Agriculture and Land Affairs "It is a guide that is long overdue, and will provide for a systematic and sustainable assault on invasive alien plants".

Some of the features of the new book are:

- descriptions, distribution maps and line drawings of 234 species of alien weeds and invasive plants in South Africa (including some species that have been proposed for legislation but have not yet made it into the CARA list)
- all 198 species of declared weeds and invaders, and a complete copy of the regulations concerning their control
- colour photographs of 100 species including some of the less familiar ones
- a quick guide to the identification of the major groups of plants, based on characteristics that are always visible and easy to understand
- an indication of whether the plant species are subjects of herbicide registration and biological control, and whether they are poisonous or irritant
- other sources of information, a comprehensive glossary and an index to botanical and common names

The major sponsors of this publication were the Department of Water Affairs & Forestry and the National Department of Agriculture.

Rehabilitation of Areas Cleared of Alien Plants

This handbook**, which includes region-specific 'GRAB-A-GRASS dials', is aimed at people who want to clear alien vegetation from their land without causing soil erosion or a resurgence of weed seedlings in the cleared areas.

It provides guidelines and recommendations for the selection of suitable grass species, using practical rehabilitation methods after removal of alien vegetation. Integrated control strategies for alien plants have been categorized for alien trees, shrubs, succulent species and herbs. The book contains colour photographs and easy-to-follow graphics.

Part 1 of the book deals with the integrated control of alien plants and covers:

- control of standing trees
- how to fell trees and control stumps
- burning strategies
- how to control alien shrub species
- follow-up control methods including chemical, mechanical and biological control
- planning for integrated alien plant control

Summary tables at the end of part 1 describe provincial distribution and abundance of the most common alien plants, and the available mechanical, biological and chemical methods for their control.

Part 2 reports back on five workshops that were held to collate the known information on the selection of grass species for rehabilitation. It introduces suitable grass species to cover bare soil after alien plant control, and explains how to select the grass species according to land-use aims and environmental constraints.

A 'GRAB-A-GRASS dial' provided with the book is an easy-to-use device composed of three rotating discs. The discs have windows cut into them, which describe in detail the seven steps to follow when using grass to rehabilitate and manage alien plants.

Part 3 describes harvesting methods for grass species that are not commercially available, and practical grass planting methods that have been tried and tested over many years.

This book also forms part of two alien plant control courses approved through Act 36 of 1947 for the registration of Pest Control Operators.

*Henderson, L. (2001) Alien weeds and invasive plants: a complete guide to declared weeds and invaders in South Africa. Pretoria, South Africa; ARC-PPRI, PPRI Handbook No. 12, 300 pp.

**Campbell, P. (2001) Rehabilitation recommendations after alien plant control Pretoria, South Africa; ARC-PPRI, PPRI Handbook No. 11b, 124 pp.
[This book notice is adapted from *Plant Protection News* No. 59, Summer 2001.]

Available from: Mrs Hannetjie Combrink, the PPRI Librarian, Private Bag X134, Pretoria 0001, South Africa
Email nipbhc@plant1.agric.za

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Proceedings

Enhancing Biocontrol Agents and Handling Risks

This publication* is the proceedings of a NATO Advanced Research Workshop held on 9-15 June 2001 in Florence (Italy). Initially it annoyed me immensely. I declare a slight prejudice in reviewing this book, based on the preface. The first sentence makes no sense, raising doubts about the care taken with the editing, and throughout the book there are annoying, but unimportant, formatting errors.

Then later in the preface came a paragraph that was preposterously arrogant and untrue. "A large proportion (but not all) of the major groups intent on enhancing biocontrol agents attended the workshop and contributed to this volume." What nonsense! There is only one representative from sub-Saharan Africa, so what of the International Institute of Tropical Agriculture in the Republic of Benin, CAB International Africa Regional Centre and the International Centre of Insect Pathology and Ecology (both from Kenya), Kawanda Agricultural Research Institute in Uganda etc., etc. South America and Asia are not represented at all. Even from the UK at least three significant groups were not present.

And then: "Some could not attend, leading to a few gaps in subject matter." Indeed, for example the use of insects – not unknown as control agents, viruses for insect control perhaps, something more than a passing mention of mass production. Some may consider agricultural management relevant, the ecology of insects, their pathogens and the environment has recently been shown to be critical and quality control of biological pesticides is pivotal etc., etc. A few gaps in subject matter!

The volume reads (largely but not exclusively) as one for the academic rather than the practitioner and there is a strong emphasis on genetic engineering and on pathogens. With a more accurate title and less pomposity in the preface, the book would have been easier to evaluate dispassionately. Within the limits of speculative and innovative research on enhancing pathogens as biocontrol agents with an emphasis on genetic engineering and handling risks, it is a good book with many interesting chapters. However, despite the comments above about the limitations of coverage, there is still much to cover and it is difficult to see who the audience would be. A specialist is unlikely to learn much new and the generalist is faced with very specific examples (often used as generalizations). The chapters vary in depth and the very diverse topics means that the book lacks continuity, although this is probably inevitable when dealing with innovation.

There are 24 chapters, in four sections, plus six one-page abstracts. The first section, on Needs for Enhanced Biological Agents and Strategies for Enhancement, contains three papers with an eclectic mix of biocontrol agents against weeds, a genetically modified virus for fertility control in rabbits and the use of microbial toxins.

Technologies of Enhancing Biocontrol Agents contains eight chapters that the session organisers divide into five groups with brief descriptions (these session summaries are probably the best way of getting the essence of the book). Aspects of production and delivery of pathogens are briefly covered. Here again titles can be misleading. What does “Enhancing Biological Control Through Superior Formulations: A Worthy Goal But Still Work in Progress” mean? As it turns out, it is a very interesting and informative chapter on a very specific matter, improved shelf life of *Metarhizium anisopliae* blastospores. Why couldn’t it say that? But the section also contains fascinating chapters on natural phytotoxins for weed management, using genes from biocontrol agents (neither, incidentally, biocontrol agents as per the book title) enhancing bioherbicides by, for example, manipulation of the culturing media, and enhancing antagonists of postharvest diseases.

The remainder of the book consists of five chapters in Risks from Enhanced Biocontrol Agents and their Mitigation, eight in Genetics and Molecular Biology of Enhancing Biocontrol Agents, and six one page abstracts. These are outside my area of expertise, but a couple could be valuable reference chapters. “Introducing Transgenic Biocontrol Agents into the Environment: Legal, Ethical and Political Problems” is very readable and informative and the title describes the content.

One very good aspect of the book is the attention paid to references, which are usually very comprehensive. But overall, this is a book that could be occasionally dipped into: one to borrow and not to buy.

*Vurro, M.; Gressel, J.; Butt, T.; Harman, G.E.; Nuss, D.L.; Sands, D.; St. Leger, R. (2000) Enhancing biocontrol agents and handling risks. Amsterdam, The Netherlands; IOS Press. NATO Science Series: Life and Behavioural Sciences, Vol. 339, 200 pp. Hbk. ISBN 1 58603 216 X. Price US$90/€95/UK£60.

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IOBC Water Hyacinth Meeting in Beijing

The proceedings of the 2nd Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth have now been published*. Held in Beijing, China under the auspices of the International Organization for Biological and Integrated Control of Noxious Animals and Plants (IOBC) in October 2000 [see *BNI* **22(1)**, 16N-17N; March 2001], the meeting brought together 31 delegates from 11 countries. It was organized by the Institute of Biological Control, Chinese Academy of Agricultural Sciences (CAAS), and supported by the National Natural Scientific Foundation of China, CAAS.

The proceedings contain 22 papers, including three keynote presentations which review arthropod biological control of water hyacinth (M. H. Julien); opportunities, challenges and developments in its control by pathogens and mycoherbicides (R. Charudattan); and the current status of research on the weed in China (Ding Jianqing, Wang Ren, Fu Weiding & Zhang Guoliang).

Other papers give a broad coverage of key issues and challenges in water hyacinth management, and include news of progress made and obstacles still to be overcome from South Africa, Zimbabwe, Malawi, Rwanda, Tanzania, Kenya, Egypt and China; assessments of research programmes on mycopesticides; weed and natural enemy ecology; safety and host specificity and efficacy testing of natural enemies; potential new agents – needs and new exploration; and knowledge dissemination initiatives.

The volume includes session summaries, recommendations for future research and the mission statement developed by the Global Working Group at this meeting.

*Julien, M.H.; Hill, M.P.; Center, T.D. (*eds*) (2001) Biological and integrated control of water hyacinth, *Eichhornia crassipes*. Proceedings of the Second Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth, Beijing, China 9-12 October 2000. Canberra, Australia; Australian Centre for International Research, ACIAR Proceedings No. 102, 152 pp. ISBN 1 86320 319 2 (print) / 1 863 20 320 6 (electronic)

Printed copies from: ACIAR, GPO Box 1571, Canberra, ACT 2610, Australia

Electronic version downloadable from: www.aciar.gov.au/publications/proceedings/102/index.html

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