General News

Rubber Vine in Terminal Decline

Successful control of rubber vine, *Cryptostegia grandiflora*, in Australia is being trumpeted as another triumph for classical biological control. The speed of the success probably owes as much to the development of mass production and field release techniques as it does to the efficacy of the rust pathogen. Following mass releases of the pathogen in 1995 the omens are now good for the long-term control of *C. grandiflora*, which has been described as the single biggest threat to natural ecosystems in tropical Australia and has cost Australian farmers millions of dollars.

Rubber vine is a Madagascan endemic genus comprising two species. Both are naturalized in northern Australia. They were introduced in the 19th century, particularly by mining communities in central Queensland, as ornamentals and also for the commercial potential of the latex they produce. Only *C. grandiflora* has become weedy, but it now has an estimated range of 40,000 km^2 in Queensland.

Although a number of herbicides are effective, infestations are so vast and remote that wide-scale spraying is neither economically nor environmentally acceptable. A biological control programme funded by the Queensland Meat Growers and Packers and implemented by Queensland Department of Natural Resources (DNR) and CABI *Bioscience* began in 1985. Since then, two agents have been introduced: the pyralid caterpillar *Euclasta whalleyi* and the rust fungus, *Maravalia cryptostegiae*. It is the rust fungus that is contributing most spectacularly to the weed's control.

This success of this project has been hard-won, for the optimum conditions for rust infection require wet season conditions, when releases are most difficult on the practical level. Classical weed biocontrol generally uses an inoculative approach, but the huge area infested together with the weed's rapid advance towards prestigious national parks in the Northern Territory meant an inundative approach was adopted. For this to be successful, three practical hurdles had to be cleared:

- Mass production of an adequate supply of viable inoculum
- Access to remote sites when roads were impassable
- Effective and portable means of application

Bulking up of quality-controlled spores for aerial releases was conducted in pot-grown plants kept in simulated-dew conditions in a growth chamber to promote inoculation, and subsequently transferred to a greenhouse. Spores were harvested using a cyclone spore collector [see *BNI* **20(2)**, 55N (June 1999) 'Cleaning up'], and air-dried for temporary storage. Releases were made during the wet season within 3-4 days of spore harvesting, during or just before rain to maximize the chances of infection.

Releases at 29 sites in January-March 1995 were made by light aircraft, as roads were generally flooded and/or impassable. This still presented hazards and access to some sites required exceptional flying skills. At some sites it was not possible to land at all and applications were made from the air.

Three application techniques were developed:

- A motorized knapsack mistblower, modified so it could be dismantled for carriage in a light aircraft. If applied before rain, spores were sprayed in aqueous suspension; if during or after rain, dry spores were introduced into the airstream at the end of the nozzle. This method was fast and effective and reached foliage up to 20 m above the ground (and similar distance horizontally). Areas of *ca.* 0.25 ha could be sprayed in 10-15 minutes.
- Suspensions were also applied to the underside of foliage using two types of hand-held hydraulic sprayers adjusted to deliver a fine spray pattern. Infection rates were as good but application rates were slower than with the mistblower.
- Inaccessible sites were sprayed from a light aircraft flying at *ca.* 100 m at an air speed of *ca.* 130 km/h by adapting equipment designed for dingo baiting. Spore solution released from a 100-mm diameter tube passing through the rear port-side of the aircraft became atomized owing to air shear, leading to precipitation on the foliage.

More *ad hoc* methods were used to give sufficient inoculum for further inundative releases. Pot-grown plants, infected by placing them around an infected plant in the open air, were deployed in rubber vine infestations. This method was ideally suited to a farmer participatory release programme initiated by DNR, as timing was not critical and plants could be watered as necessary and continued to produce spores for 3-4 weeks.

Field collection and re-distribution of fresh rust-infected foliage (placed onto or suspended from the canopy) when dew formation or rainfall was forecast, was also adopted widely by farmers. Although best infection rates were achieved when material was redeployed within 24 h, cool storage extended its 'shelf-life'.

All inoculation methods proved reliable in establishing the rust in the field, and dispersal was rapid. Dispersal increased exponentially over time, reaching a plateau 10-15 months after the releases when individual areas of infection merged. Twenty months after the releases, most of the rubber vine in the Gulf and Peninsula areas were infected by the rust. The rate of spread over subsequent years became difficult to estimate, but just over 3 years after release it had dispersed at least 550 km.

Within a few months of the rust's introduction, heavy leaf infection was evident at most release sites (most leaves were completely covered with pustules) and there was severe premature leaf fall. The significant levels of defoliation at most release sites at the end of the first wet season were accompanied by growth of native grasses amongst the rubber vine plants (and this has subsequently allowed the integration of fire as a management tool for the weed). Within 12 months, secondary effects became apparent. There were fewer flowers, and dieback of shoots and seedlings was observed. Four years after rust introduction, only very few seedlings were found amongst heavily infested plants and the rubber vine population had decreased 25-65%.

The effects of the rust do vary with groundwater availability. On seasonally dry soils, rubber vine has a semi-deciduous to deciduous habit. In a riparian situation and where the water table is high, the weed continues to grow during the warm dry winter season. The rust is virtually dormant during the dry season, so plants growing year-round can compensate during the dry season for rust-induced premature defoliation and have more flowers and fruit and less dieback than those growing in seasonally dry soils.

With substantial to complete control over its entire range in Australia predicted over the next 4-6 years, what has made this programme such a resounding success? The strategy of inundative release adopted by the programme and the successful negotiation of implementation hurdles outlined above has been crucial, but so has the impact of the pathogen on its host. Experimental results suggested that the rust could reduce leaf cover by 73% over a 12-month period, and flowering by 48% and pod production by 85%, and these predictions have been borne out by field observations. The invasiveness of rubber vine in Australia is attributed in part to prolific seed production (a single large vine may produce 8000 seeds from a single flowering) but the seeds rarely survive in the soil for more than a year, so reduced seed production had an immediate impact. In addition, heavy infection in the field led to widespread seedling mortality and death of older plants, especially in seasonally dry sites. Thus the rust's multiple impacts have been able to bring about a rapid reduction in the invasive ability of rubber vine.

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Paterson's Curse, a A$100M-a-Year Weed, Faces Biocontrol in Australia

Biological control is frequently claimed to be both environmentally and economically more sustainable than alternative methods, and chemical control in particular. However, rigorous assessments of biological control programmes are rare. Here we report on a benefit/cost (B/C) analysis of the programme for biological control of *Echium* spp. in Australia, which was begun by CSIRO in 1972. The new analysis projects economic gains from biological control based on observed values for the rate of spread of an insect agent and its impact on the target weed in Australia.

Echium plantagineum (Paterson's curse) is an introduced winter annual pasture weed of Mediterranean origin. Free of native Mediterranean plant and insect communities, it has become one of the dominant pasture weeds of temperate Australia. Although three other introduced *Echium* species (*E. vulgare, E. italicum* and *E. simplex*) occur as weeds in Australia, *E. plantagineum* is the most important as a pasture weed there, but in this study the four species are referred to collectively as '*Echium*'. Although relatively nutritious in terms of digestible nutrients, and valued as a pasture plant in some places, *Echium* contains pyrrolizidine alkaloids that are poisonous to livestock, reducing weight gain and wool clip and in severe cases leading to death. From its start as a garden flower in the 1840s, *Echium* is now estimated to occur as a weed on over 30 million hectares in Australia.

Echium was first suggested as a candidate for biological control at the Australian Weeds Council in 1971. From its base in Montpellier, France, CSIRO Entomology soon started surveys in the weed's native range. Of the hundred or more insect species recorded on *Echium*, eight were selected as possible biological control agents, with the first imported into quarantine in Canberra in 1979. In 1980, a small group of graziers and apiarists lodged an injunction in the Supreme Court of South Australia to stop the biological control programme as they considered the loss of *Echium* a threat to their livelihoods. The Biological Control Act 1984 established procedures for assessing and authorizing biological control programmes in Australia; a subsequent inquiry and B/C analysis was conducted by the Industries Assistance Commission (IAC), which concluded with the judgement that a biological control programme on *Echium* should go ahead[1].

The Supreme Court injunction was eventually lifted and the importation of insects into Australia resumed and rigorous specificity testing undertaken. Six insect species have been successfully released: a leaf mining moth, *Dialectica scalariella*, crown and root weevils, *Mogulones larvatus* and *M. geographicus*, a root beetle, *Longitarsus echii*, a stem boring beetle, *Phytoecia coerulescens* and a pollen beetle *Meligethes planiusculus*. Of these insects, *D. scalariella* and *Mogulones larvatus* were introduced first and have been released across the geographic range of the weed. *Mogulones larvatus* is known to be limiting the *Echium* population at two of the earliest release sites and approaching control at many of the younger release sites.

Based on the positive population trend of *M. larvatus* and its ability to limit the weed at an increasing number of sites, the economic analysis of the IAC report was revisited so projected economic gains from biological control could be quantified. Unlike previous B/C analysis of biological control, where an insect is given an arbitrary impact and rate of spread, the current analysis incorporates observed values based on the biology and ecology of *M. larvatus* and its weedy host, *Echium*, over the past 9 years.

Building the Model

Of some 1000 releases of *M. larvatus*, 400 have been confirmed successful in terms of insect survival to subsequent seasons. Of these successful releases, 189 were in the state of New South Wales (NSW), 143 were in Victoria, while South Australia (SA) and Western Australia (WA) had only 34 each. For this analytical model, the rates of spread of insects and development of attack rates on *Echium,* and the rates of expected progress of geographic coverage of maximum attack, based on field data and observations by scientists on the project, are described as functions of time. Function parameters differ according to climate zone in terms of the date of the autumn season break; both attack and spread rates are highest with an early autumn break (March) and lowest with a late break (May). This variation occurs because late breaks tend to decouple the occurrence synchrony of *Echium* and *M. larvatus.*

The study uses the district location, grazing area and stocking rate information supplied by the IAC, updating and correcting an earlier analysis[2], and overlaying the new insect release location and date data. Autumn break date classifications were assigned to districts according to the month in which greater than 25 mm median rainfall is received, based on long-term monthly median rainfall maps from the Bureau of Meteorology. This allowed projected extents of insect spread to be mapped.

We assumed for districts in which there had been more than one release, the maximum spread of insects from each release was to the area defined as the district total divided by the number of releases in the district. This is a conservative assumption given the fact that the earliest insect releases will have spread over greater surface areas and reached greater densities than later releases, and the fact that insects are not limited by administrative boundaries. These conservative assumptions were made to limit

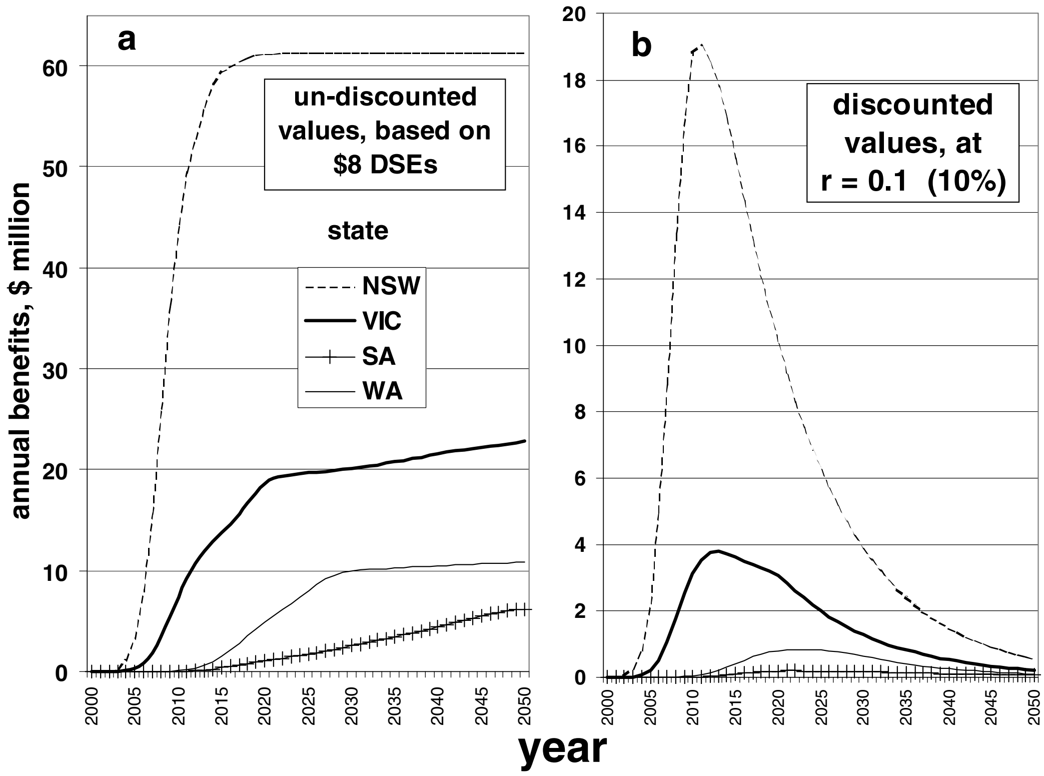

Figure 1. Projected annual benefits from biocontrol of *Echium* by state, due to insect releases in 1993-2000, A$ millions, with pasture values of A$8 per DSE.

the computational burden posed by 400 insect releases distributed over an 8-year period across 44 districts of varying size and divided into 130 sub-districts, depending on year of release. For each sub-district, year-by-year sequences of areas with partial relief were simulated, then aggregated back to the 44 districts as area equivalents with full economic loss relief.

There are several other conservative assumptions in our analysis. One is that all long-term biological control of *Echium* results only from the activity of *M. larvatus* even though there is good reason to anticipate complementary successes of the other agents released against the weed. The model conservatively assumes no further releases beyond the 400; in reality, state departments of agriculture continue to respond to farmers' requests, and the Australian Wool Innovation and Meat and Livestock Australia continue important support for releases of biocontrol agents against *Echium.* The model focuses on the valuation of increased pasture productivity and ignores reductions in conventional spraying costs. While reductions in pasture spray costs may be anticipated, these are likely to be replaced with the costs of measures taken by farmers to facilitate the success of the biological control agents and to limit reinvasion by other pasture weeds.

The model also ignores control costs and losses attributable to *Echium* as a weed in crops, which amount only to some A$1.2 million annually and may be assumed to continue indefinitely.

The economic damage caused by *Echium* in pastures is assumed to remain unaffected by *M. larvatus* at attack levels below 50%. Attack levels above this are assumed to result in increasing reductions in economic loss.

The attack and spread simulation model, set for the particular size, release dates and autumn break parameters of each sub-district, was used to generate a time series of areas with varying degrees of partial economic relief from *Echium*. The years required to reach these limits differed according to district size and number of releases. For each year in each district, a ratio was calculated of the (weighted) relieved area to the total area. These ratios were multiplied times the maximum proportions by which total stocking rates were assumed to be increased in the absence of *Echium* in the IAC report, district by district (these ranged from a maximum of 0.2 to a minimum of –0.1). Total stocking rates for each district were expressed as dry sheep equivalents (DSE) where 1 DSE relates to 1 wool sheep, 1.5 DSE for each meat sheep, 10 DSE for each beef animal and 15 DSE for each dairy cow.

In order to express the aggregate economic relief in dollar terms a conservative value per DSE recovered was wanted. The lowest gross margin per DSE in NSW is A$8.80 for wool-producing wethers. A value of A$8 per DSE was chosen as a conservative base for modelling, though values double this are recorded for sheep and cattle enterprises in NSW where the greatest infestations of *Echium* occur. The year-by-year estimates of dollar value loss relief were aggregated across districts by state.

Adding Up Results

The simulated time paths of the benefits for each state are projected in Figure 1. Illustrated are the projected four-state aggregate benefit streams for the case of A$8 per DSE (undiscounted in panel 'a' and discounted at 10% in panel 'b'). The greatest benefits from biocontrol of *Echium* are anticipated in NSW, followed by Victoria and Western Australia. Comparatively little benefit is expected for South Australia, where the late autumn breaks put *M. larvatus* at a disadvantage.

The biological control research and development programme was begun by CSIRO in 1972. Total R&D expenditures on *Echium* biocontrol by CSIRO and its

Table 1 Net present (2002) value of the *Echium* biocontrol programme, with 400 successful insect releases in 1993-2000, viewed over the 1972-2050 period (A$ millions).

Discount rate	Value of recovered pasture productivity (A$ per DSE)			
	A$4	A$8	A$12	A$16
5%	526	1074	1623	2171
6%	423	871	1319	1767
7%	343	714	1084	1454
8%	280	590	900	1210
9%	229	491	753	1015
10%	186	410	634	858
11%	151	343	536	729
12%	120	287	455	622
13%	92	239	385	532
14%	67	196	325	454
15%	43	158	272	386
16%	20	122	223	325
17%	-3	88	179	270
18%	-27	54	136	218
19%	-53	20	94	168
20%	-81	-14	52	118

partners from 1972 to 2001 have reached A$14 million. The sum of the undiscounted benefits (Figure 1) minus the cost stream, results in a time series of undiscounted net annual benefits. Several such series were created using a range of DSE values (A$4 to A$16 per DSE) and discounted at a range of rates (5% to 20%) to produce the results in Table 1.

With A$8 DSE's, annual benefits in terms of increased productivity of grazing lands are projected to increase from near-zero in 2000 to some A$75 million by 2015, and A$90 million by 2025. The discounted (5%) net present value (NPV) of the benefit-cost stream from 1972 to 2015 is projected at A$287 million, for a B/C ratio over 14:1. For the 1972-2050 period the NPV is A$1074 million for a B/C ratio of over 50:1. The internal rate of return (discount rate that drives the B/C ratio to zero) exceeds 19%.

Summing Up

The success story projected for biological control of *Echium* in Australia is likely to be at a slower pace than envisaged by the IAC (1985). Nevertheless, the return on investments is expected to be very respectable indeed. Keeping in mind that just over A$14 million has been spent on the biocontrol programme for *Echium*, the high net present values anticipated with all but the most extreme combinations of low DSE values and high discount rates (lower left corner of Table 1) give strong assurance of success.

Further analysis is needed to determine the value of targeting additional insect releases beyond the 400 of the 1993-2000 period where there may be gaps in populations that would otherwise take many years to fill.

Acknowledgements

This report represents a collaborative effort under the Cooperative Research Centre for Australian Weed Management (Weeds CRC). It corrects errors in an earlier version, which understated the contributions of *Echium* biocontrol in Western Australia[2]. It also updates all NPV estimates to a 2002 basis. The authors wish to thank David Vincent and David Pearce, of the Centre for International Economics (CIE), for raising a number of important questions over the course of the analysis. We thank those collaborating at the state level with CSIRO Entomology in releasing and monitoring biological control agents on *Echium*, in particular, those who provided the geo-referenced release location and date information required for this analysis: Kerry Roberts, Agriculture Victoria, KTRI, Frankston; Ross Stanger, SARDI, Entomology Unit, Adelaide; Paul Sullivan, NSW Agriculture, Tamworth; and Paul Wilson, Agriculture WA, South Perth. Funding support for such work from Australian Wool Innovation and Meat and Livestock Australia is also gratefully acknowledged.

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Update on the Status of Water Hyacinth on Lake Victoria

The water hyacinth (*Eichhornia crassipes*) invasion of Lake Victoria brought both invasive waterweeds and biological control to the world's attention in the late 1990s [see *BNI* **21(1)** (March 2000) 1N-8N 'Harvesters Get That Sinking Feeling']. Since then, media interest has been intermittent with occasional stories concerning apparent resurgence of the weed. However, the work of the scientific community has been relentless, with efforts focused on measures to bring about sustainable long-term control of water hyacinth in the Lake Victoria basin. No one involved imagines that the end is in sight, but significant advances have been made in building regional cooperation. Here, we look first at reasons for the water hyacinth resurgence in the lake, and what can and is being done to mitigate its impact. Second, we describe the beginning of a new collaborative biological control initiative in Rwanda, which is releasing *Neochetina* weevils into the main source of Lake Victoria's water hyacinth and, through public awareness exercises, publicizing both the dangers water hyacinth poses and what biological control is about.

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Resurgence in Lake Victoria: a Case for Optimism

Ugandan scientists of NARO's Biological Control Unit based at NAARI (National Agriculture Research Organization – Namulonge Agriculture and Animal Production Research Institute) under the leadership of James Ogwang were instrumental in the initiation and implementation of the successful water hyacinth (*Eichhornia crassipes*) biological control in Uganda's water bodies including Lake Victoria. Since the introduction of *Neochetina* weevils in 1995, an 80% reduction in water hyacinth populations has been recorded in the Ugandan waters of Lake Victoria. During their studies in 1997 and 1998, Ogwang and his team found, on average, some 25 adult weevils per plant at various sampling sites around the lake, and these huge weevil populations brought about one of the most spectacular crashes in a weed biomass in the history of biological control. However, since the second half of 2000 there have been reports of a resurgence of water hyacinth. This was an obviously cause for concern both for the people living around the lake and politicians, who feared that the control initially effected by the weevils might be short-lived and that the water hyacinth might be returning to plague them again.

Further studies on the recently appeared water hyacinth fringe showed that the young, healthy and rapidly growing plants were the result of the germination of seeds which had been deposited in the sediment before the previous mat crashed. Their germination was stimulated by the mat's collapse, which allowed easier light penetration of the water, while seedling growth was enhanced by high levels of nitrates and phosphates in the water due to runoff from agriculture and to the release of nutrients from the decaying water hyacinth mat. In contrast, the weevil populations in the area were very low, presumably because eggs, larvae and pupae sank with the previous mat and drowned, while adults would have dispersed as the plant quality of the old mat declined. Therefore the new growth was able to proliferate in the absence of weevils.

The weevils will, in due course, disperse naturally back onto these fringes of plants in the western arm of the Lake. Indeed, a survey conducted in October 2000, which recorded an average of three adult weevils per plant at one site, indicated that the weevils were already moving back. However, there are still pockets of water hyacinth that are devoid of adult weevil feeding scars, and it may be necessary to conduct some augmentative releases of weevils in these areas to speed up the biological control process.

In the long-term it is hoped that the situation on Lake Victoria will become more stable, that the resurgence of the weed will be attenuated and that continuing augmentative releases of the weevils will not be needed. Introduction of some of the other biological control agent species being used elsewhere in the world, especially those that have short generation times, are capable of rapid population increases, and are good dispersers might further reduce the extent of water hyacinth resurgence.

However, the long-term biological control of water hyacinth on Lake Victoria will rely heavily on a reduction in the nutrients entering the lake

Source: Ogwang, J. (2001) Is there resurgence on Lake Victoria? *Water Hyacinth News* No. 4, pp. 1-2.

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Rwanda: Regional Cooperation in Action

Although water hyacinth (*Eichhornia crassipes*) in Lake Victoria is heavily attacked by *Neochetina* weevils, the Kagera River feeds large quantities of uninfested weed into the lake in the form of mats torn away from riverbanks or as individual plants. The implementation of a biological control programme within the headwaters of this river system in Rwanda to reduce the water hyacinth biomass entering the lake is therefore a key part of long-term control. The urgency of the situation is underlined by James Ogwang, Ugandan National Agriculture Research Organization – Namulonge Agriculture and Animal Production Research Institute (NARO-NAARI), who found on a visit in February 2002 that Rwandan highland water hyacinth colonization is increasing. New infestations are being reported from previously clear water bodies with alarming frequency. Regional collaboration is currently supporting both biological control and public education initiatives in Rwanda.

The Kagera River system has as one of its primary sources the Mukungwa River, high in the Virunga mountain range near Ruhengeri, Rwanda. This river flows south to join the Nyabarongo River, which then joins a smaller tributary near the Burundi border to form the Kagera River. The Kagera turns north, flowing between first Rwanda and Tanzania and then, turning east, through Uganda and Tanzania before finally reaching Lake Victoria. In total, the river system is some 500 km long and includes waterfalls, lakes and swamps. It is infested along its entire length by water hyacinth, but it is the last 160 km, below the final waterfalls at Kikagati in Uganda, where the weed grows unaffected by turbulent waters associated with elevational drops. Downstream of this point the river flattens and, as it flows across the Tanzanian floodplain, water hyacinth flourishes along riverbanks out to about 2 m from the shoreline. Water currents and velocity prevent water hyacinth from growing much further out, except in some bends, inlets and sloughs, or during periods of drought or flood. However, the two banks of the river produce 320 km of linear shoreline growth potential for the weed to a width of approximately 2 m, which is equivalent to some 64 ha.

The extent of the problem this creates is clear from estimates of the volume of weed pouring into the lake by Clean Lakes, Inc. (CLI). Within 1 km of Lake Victoria, the daily rate of weed flowing down the Kagera River ranges from 0.2 ha/day to more than 1.5 ha/day (an average 0.75 ha/day or 300 ha/year), depending on seasonal river volume conditions. If a growth rate model of 1% per day were assumed, then these 64 ha growing along the shoreline would generate about 0.64 ha of new weed growth/day – and this is, on average, equivalent to rates documented elsewhere.

The governments of Kenya, Tanzania, Uganda, Rwanda and Burundi have begun to coordinate water hyacinth control efforts through regional organizations such as the East African Community, the Lake Victoria Fisheries Organization, the Lake Victoria Environment Management Programme (LVEMP) and the Nile Basin Initiative, and through bilateral agreements. Recent activities in Rwanda provide an example of this in action. A Memorandum of Understanding on Common Agricultural Issues signed in 1997 by the governments of Uganda and Rwanda paved the way for the countries to commit to full collaboration in the management of water hyacinth, beginning high in the Kagera River basin watershed. Funding and technical support for the implementation of the biological control programme for water hyacinth in Rwanda is being provided by CLI through a 2-year Cooperative Agreement with the United States Agency for International Development, Greater Horn of Africa Initiative (USAID-GHAI) through the Regional Lake Victoria Water Hyacinth Management Program, and by the Institut des Sciences Agronomiques du Rwanda (ISAR).

In the first part of the programme, training activities and visits were carried out in Uganda and Tanzania. In November 1999, CLI facilitated the training of Rwandan and Burundian government officials in Uganda, led by James Ogwang together with staff of the Uganda Ministry of Agriculture, Animal Industries and Fisheries/Water Hyacinth Unit (MAAIF/WHU). Subsequently, ISAR staff visited the LVEMP-operated weevil rearing facilities at Bukoba and Kyaka in Tanzania in mid 2000. Ogwang followed this training up during a visit to Rwanda in February 2002 and provided fine-tuning advice for optimizing rearing.

In the meantime, a site was identified and the first weevil rearing station established in 2000 at the Karama Animal Husbandry and Fisheries Unit, an ISAR branch located some 70 km southeast of Kigali on the shores of a small water body, Lake Kilimbi, near to the Nyabarongo river. Also during this period, authorizations to export and import weevils, respectively, were obtained from the relevant Ugandan and Rwandan authorities.

In September 2000, some 850 weevils (both *N. bruchi* and *N. eichhorniae*) were collected from the NAARI weevil rearing tanks by NAARI, ISAR, and CLI staff. They were transported to Rwanda by air, and then by road to the ISAR/Karama rearing facility where they were used to inoculate water hyacinth in previously established tanks. First releases into the Kagera River system were made later that month in the seasonal Lake Kiruhura, a small depression near the Nyabarongo River 20 km south of Kigali. This 1+ ha site was 60% infested with water hyacinth. Weevil impact monitoring using remote satellite imagery was also initiated, with the assistance of the US Geological Survey, to support documentation of weevil release efficacy. This is using IKONOS 1-m PAN and 4-m multispectral band data in coordination with the US Geological Survey-EROS Data Center (USGS-EDC).

Exchange country visits provided opportunities to identify further needs and make plans. In December 2000, CLI supported a visit by MAAIF/WHU to Rwanda to review biological control efforts and to interact with counterparts in ISAR. Amongst suggestions made following this visit were needs for (a) two more rearing stations for weevil mass rearing and distribution, and (b) sensitizing the public to the dangers from water hyacinth. There were also calls for capital equipment, for coordination between institutions, and for Rwanda, especially the Kagera River system, to be included in the planned regional surveillance system. A report made following this visit by MAAIF/WHU to the LVEMP regional water hyacinth group meeting also laid the groundwork for a larger regional study visit which took place in July/August 2001.

In June 2001, a baseline survey of various water hyacinth parameters was carried out at four locations in the Kagera River system: Ruhengeri on the Mukungwa River, near Kigali on the Nyabarongo River, Kibungo on the Kagera River, and Lake Mihindi on the Kagera River within the Akagera National Park. Two additional sites for water hyacinth weevil rearing station establishment were selected at ISAR/Ruhengeri and Lake Ihema within the Akagera National Park. A follow-up visit in July 2001 was made to establish these stations and to improve facilities at the ISAR/Karama rearing station. The new stations were stocked with weevils imported from Uganda in July-August 2001.

During his visit in February 2002, Ogwang together with ISAR staff began monitoring the establishment and impact of the weevils at four points along the river system: at Ruhengeri, Karama, Lake Mihindi and upstream of the Rusomo Falls. They recorded plant growth parameters and weevil numbers and feeding scars per plant for each location. Accumulated information will allow the project to assess whether any changes are needed in the strategy of weevil use for water hyacinth control.

In late October 2001 CLI and ISAR staff looked for the uppermost infestation of water hyacinth within the Kagera River system, evaluated weevil status in the rearing stations, made more weevil releases, and finalized plans for a public awareness campaign. The highest point of infestation was found at an elevation of 1649 m on the Mukungwa River in Ruhengeri Prefecture. CLI and ISAR staff made an historic, but symbolic, release of two weevils from the Ruhengeri rearing station here. Weevil life cycles were found to be longer at the high altitude of the Ruhengeri rearing station where dry season temperatures rarely exceed 25ºC, and damage to water hyacinth plants was correspondingly less than at lower altitude sites. This is consistent with findings elsewhere that the weevils are less effective control agents in cool/high altitude conditions.

Temperature is probably not the only factor to affect weevil performance. Throughout the Kagera River system, and especially in the middle to lower system, it is suspected that high year-round sediment loads in the main river will be limiting to weevil populations due to sediment adhering to cocoons and suffocating pupating larvae or adhering to roots and reducing available pupation sites. In February 2002 Ogwang found that although weevils were established close to the highest point of water hyacinth infestation and there was slightly more feeding damage than in December 2001, their populations remained low. He agreed that this was probably partly temperature-related but, noting the turbidity of the river water (a result of massive soil erosion), suggested that the weevils were unlikely to perform well here. Instead, he suggests that the local population should be encouraged through local political organizations to participate in manual removal of the weed, an activity which could be promoted in conjunction with the purchase and distribution of appropriate tools.

Project participants currently consider that other areas in the middle and lower Kagera basin with clearer waters (i.e. dry season floodplain ponds, swamps and lakes) are likely to provide better habitat for weevils. Ogwang noted that the waters lower down the river system were fresher and cleaner in February 2002 than the previous October. This coincides with the end of the short rainy season that typically runs from October through December.

The ISAR/Karama site was not visited during the October 2001 visit, but a tank of weevils from the Ihema rearing facility was released into Lake Ihema so that all life cycles of the weevil would be present to begin dispersing. Two tanks were also transported to Lake Mihindi, where the infested plants were placed among shoreline infestations and in open water adjacent to a large mobile infestation covering several hundred hectares. In February 2002, Ogwang found weevil activity at this site significantly better than higher in the watershed. He found that cultures contained predominantly *N. bruchi*; this reflects the situation around Lake Victoria, where *N. bruchi* predominates over *N. eichhorniae*. Ogwang also found that local villagers were keen to become involved in biological control activities, wanting to know what the weevils looked like and participating in another redistribution exercise to Lake Mihindi. He suggests that where weevil rearing facilities exist, the local population should be integrated in the weevil release process. He notes that this will be possible only after establishment of organized village committees headed by keen leadership. Experience in Uganda, he says, shows that local villagers become active if such a programme gives them a sense of responsibility and ownership.

The importance of the project and involving the public is underlined by the recent confirmation of water hyacinth infestations in Lake Mpanga, where dense mats occur along the shore closest to the Kagera River. Ogwang suggests that this would be a good site strategically for a fourth weevil rearing facility: with clear water and a well-organized fishing community keen to be involved, it is an ideal location for distribution of weevils to this and nearby lakes.

Spreading the Message

A public awareness campaign was begun in November 2001 at six locations in Rwanda: a fishing community outside the Akagera

National Park boundary, three villages on the Kagera River system in different parts of the country, the ISAR/Ruhengeri weevil rearing station, and a trading centre near Kigali. Each meeting followed the same format, which focused on demonstrating the impact of water hyacinth and the weevils through visual aids (water hyacinth posters, weevil-free and weevil-infested plants, and blown-up aerial and land-based photographs of affected areas and the various control options). At each meeting, a local leader introduced the water hyacinth topic. Next, CLI and ISAR team members were introduced, and they talked about the origin, distribution and impacts of water hyacinth, both in the Kagera River and in Lake Victoria. They went on to explain control options, and in particular biological control using the weevils. The implementation of control in Rwanda was discussed and the weevils' life cycle explained. The meeting then looked at water hyacinth posters, after which there was a question and answer session. Following a closing session, large and colourful posters (in Kinyarwanda, French and English) were distributed, and finally people were invited to observe the release of weevil-infested plants into water hyacinth-affected water bodies.

Additional weevil releases and monitoring activities are set to continue. More public awareness exercises are also being conducted. Encouragingly, efforts so far appear to be bearing fruit. For example, Ogwang found that villagers including children at the village he visited near ISAR/ Karama in February 2002 were aware of the biological control project's activities. At Lake Mpanga, Ogwang found local people keen to talk about the weed and the posters were popular.

For the future, though, there is more to be done. First, the public awareness campaign should be intensified to educate people throughout the country about the weed – this could take place at universities, local government offices, key ministries, and in major towns or trading centres.

Second, collaboration between ministries and institutions responsible for management and control of water hyacinth in Rwanda and in its East African country counterparts, which has underpinned the progress made so far, should be further strengthened. In addition, the Government of Rwanda should be encouraged to put in place a mechanism to stop or limit the spread of water hyacinth, especially by ornamental plant sellers.

To accelerate the release programme, additional rearing centres or increased capacity of existing stations are needed. A complete survey of the major rivers and lakes of Rwanda would allow the extent of water hyacinth distribution in Rwanda to be determined accurately. Alternative biological control agents, such as the mite *Eccritotarsus catarinensis*, should be considered, but this would need consensus from countries of the Lake Victoria basin.

Sources: Moorhouse, T.; Agaba, P.; McNabb, T. (2000) Recent efforts in biological control of water hyacinth in the Kagera River headwaters of Rwanda. *In*: Julien, M.H.; Hill, M.P.; Center, T.D.; Ding Jianqing (*eds*) Proceedings, 2nd Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth, Beijing, China, 9-12 October 2000.
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www.cleanlake.com/Rwanda3rd-9th.htm

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Buckthorn Biocontrol for North America

Exploratory entomology carried out in the 1960s is underpinning a new North American-funded CABI *Bioscience* project based at the Switzerland Centre in Delémont. CABI *Bioscience*, in partnership with the State of Minnesota Department of Natural Resources, aims to find biocontrol agents for the buckthorns *Rhamnus catharticus* and *Frangula alnus*, which are invasive in North America and cause significant economic and environmental damage.

Buckthorns (Rhamnaceae) are small trees or shrubs and occur worldwide. Eurasian species were introduced to North America in the mid 19th century and both *R. catharticus* and *F. alnus* have spread widely in Canada and the USA. *Rhamnus catharticus* has a vast range bounded by Nova Scotia in the northeast, Saskatchewan in the northwest, Kansas in the southwest and North Carolina in the southeast. *Frangula alnus* is found in northeastern USA and southeastern Canada. Probably because of its history as an ornamental, *F alnus*' distribution pattern tends to be associated with urban centres and nearby wetlands, although it is spreading into natural and agricultural areas. *Rhamnus catharticus*, in contrast, was widely planted in hedges and farm shelterbelts and less as an ornamental, and it is more widely distributed and more common in rural areas than *F. alnus*.

Both species are spread primarily by seed in the wild, with many animals (particularly birds and small mammals) who eat the ripe fruit acting as vectors, although in wetland areas seeds are also dispersed by water. The buckthorns have long growing seasons, rapid growth rates and resprout vigorously following top removal. In North America, their leaf break occurs before most other woody deciduous plants, and senescence occurs later. They form dense, even-aged thickets, and the large leaves and continuous canopy formed by lateral crown spread create dense shade. These characteristics often obliterate native species and alter the composition of the forest communities these species have invaded. Allelopathy may also contribute to invasiveness.

In North America, *R. catharticus* invades many types of habitat including moist and dry upland sites, but grows best in well-drained soils and is less vigorous in dense shade. It has spread into floodplain and riparian forests, oak forests, woodland edges, ravines, fence rows, old fields and prairies. By contrast, although *F. alnus* invades some of these habitats, it is above all an aggressive invader of wetland habitats, including wet prairies, marshes, calcareous fens, sedge meadows, sphagnum bogs and tamarack swamps. *Frangula alnus* colonization is enhanced by drainage intervention that favours woody growth.

These invasive buckthorns, though, also pose an agricultural threat. They are alternate hosts of crown rust fungus, *Puccinia coronata*, which can severely reduce oat yields, and also of the soyabean aphid, *Aphis glycines*, a major pest in eastern Asia which has recently become established in North America.

From previous studies, we know that more than 200 species of arthropods and 40 species of fungi are associated with buckthorns in Eurasia, of which about 18 and 14, respectively, are likely to be restricted to the genera *Rhamnus* and

Frangula. Some dozen of these have been prioritized by the project for further study, which will initially focus on host plant testing in Switzerland. Host range testing of potential arthropod biological control agents carried out in the 1960s involved very little testing of nontarget buckthorns, however, and a priority of the project is to remedy this. Already, a proposed test list has been drawn up which includes over 40 related species, including native American species, closely related species and sympatric species as well as economically and culturally important species.

A number of fungi have also been identified as potential biological control agents. Field surveys in Europe will assess their impact in the field, so promising candidates can be prioritized for further study.

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Dr S.P. Singh Retires after a Distinguished Career

After nearly four decades in the service of biological control and entomology, Dr. Surinder Pal Singh retired in February 2002. His name has been closely linked with biological control in India and he has been instrumental in building a strong institution for biological control in the country.

Born on 11 August 1941 in Faridkot in the land of five rivers, the Punjab – a state with well-developed agriculture, and also noted for its men of valour and industriousness and its fun-loving people – Dr S. P. Singh was the eldest in a family of three brothers and one sister. His early education was in Faridkot itself but he went on to complete his Bachelor's degree in Agriculture from College of Agriculture, Ludhiana during 1961. His early passion for insects saw him complete his Master's degree in Entomology from the same college in 1963. After a brief stint in the Punjab Agriculture Department, he started his research career in entomology as a Research Assistant in the Ludhiana College in 1963. In 1967 he commenced his service in the Indian Council of Agricultural Research (ICAR) by joining the Central Potato Research Station, Patna and remained in the service of ICAR until his retirement.

His strong interest in entomological research in general, and biological control in particular helped him gain a Ministry of Education, Government of India scholarship from 1968 to 1973 for advanced postgraduate research in bioecology and biological control of cotton bollworm. This earned him his PhD from the Kuban Agricultural Institute, Krasnodar in Russia. It also helped him pick up the Russian language, which he remembers to this day.

Back in India he was appointed in 1974 as Scientist in Agricultural Entomology at the Central Horticultural Research Station (Indian Institute of Horticultural Research (IIHR) – ICAR), Chethalli, Karnataka State and is continuing to live in this state even after his retirement. He went on to become the Head of the Station from 1980 for more than 3 years. He was appointed as Project Co-ordinator, All India Co-ordinated Research Project on Biological Control of Crop Pests and Weeds at IIHR, Bangalore in 1984. In 1988, he was transferred as Project Co-ordinator (Biological Control) and Head, Biological Control Centre, which was located at the erstwhile Commonwealth Institute of Biological Control (CIBC) Indian station, Bangalore. The Centre was upgraded to the Project Directorate of Biological Control (PDBC) and Dr Singh was appointed Project Director in November 1993, in which capacity he worked until his retirement.

Biological control has been his forte from the time he started his work on biological control of cotton bollworm for his doctoral thesis in Russia. His early years of research on citrus pests were spent in quantifying the role of natural enemies in suppression of several citrus pests. The significant role played by him in evolving production and release technology for *Cryptolaemus montrouzieri* and its effective transfer to the farmers of Kodagu district under the Lab to Land programme from 1978-83 is still remembered by farmers in the district. This also paved the way for commercialization of technology for suppression of mealybugs on crops such as citrus, coffee and grapes. He has been a champion of basic research on biological control and has led this in many areas, including biology and ecology of natural enemies, rearing techniques for natural enemies, development of temperature- and insecticide-tolerant strains, enhancing the potential of natural enemies, tritrophic interactions between natural enemies, host insects and host plants, and introduction of exotic natural enemies. Dr Singh has also been instrumental in developing biocontrol-based technologies for the management of mealybugs, scales, psyllids and lepidopteran pests of maize, sugarcane, tomato, cabbage, cotton and other crops.

He was quick to react to changing pest scenarios especially in relation to the problems due to introduced pests. One such case was when the *Leucaena* psyllid was accidentally introduced in the late 1980s. His vision and pragmatic approach, which led to classical biological control through the introduction of *Curinus coeruleus* from Mexico via Thailand, saved the subabul plantations from the ravages of this pest and today the coccinellid is well established in India. To Dr Singh also goes the credit for playing a significant role in developing the first endosulfan-tolerant strain of *Trichogramma chilonis* in the world. The technology was taken up immediately by private industry for large-scale production and field use in crops. This product is now in use on more than 24,000 hectares in India.

The credit for developing and sustaining the phenomenal growth of PDBC should go to Dr Singh's enthusiasm, zeal and vision. The institute started with just six scientists and today has a core of 25. The coordinated project also grew from ten centres initially to 16 centres now. To achieve and sustain this he encouraged his team of young scientists to explore new vistas in biological control. He also took pride in the excellent capabilities of his team of scientists and undertook strong confidence building measures in young workers. Dr Singh was instrumental in opening new laboratories to initiate work in areas such as entomopathogenic nematodes, biological control of nematodes, plant disease antagonists and weed pathogens. His dynamic leadership and perseverance enabled PDBC to secure funds from a wide variety of national and international funding agencies, which helped to equip laboratories and also enabled scientists to visit leading institutions in other parts of the world and bring themselves up to date on the latest advances in the field. The ultimate recognition of his institution-building capability came when PDBC was adjudged as the Best Institution in ICAR in 1998, just 5 years after its establishment.

Dr Singh's capabilities in research, leadership and institution building helped gain biological control recognition as a primary tool in pest control in India, and resulted in the World Bank-NATP recognizing PDBC as a Team of Excellence in biological control in India for developing human resources in biological control.

He has guided the research work of many postgraduate students and has contributed significantly to the literature on biological control through published papers and books. His books include titles on production technology for natural enemies and 15 years of research on biological control in India. Dr. Singh has travelled widely across the globe and has visited Russia, the USA, Tunisia, Taiwan and Malaysia.

His outstanding contribution to the field of entomology has been widely recognized in the many awards and fellowships conferred on him, and has led to his inclusion as a member of national review teams and expert panels. He has been a leading figure in prestigious scientific societies, and is the President of the Society for Biocontrol Advancement and Editor of the Biocontrol Newsletter. He has also been a member of the editorial boards of a number of national and international scientific journals, including, of course, *Biocontrol News and Information.*

His retirement was marked by entomologists in Bangalore joining the staff of PDBC in February to wish him a long and fulfilling retirement to be spent with his wife and son. Those who worked with Dr Singh will remember him for his infallible memory, independent and strong opinions about people, and the unflagging zeal, enthusiasm and energy with which he carried out his work.

By: S. Ramani and S. K. Jalali (PDBC, Bangalore)

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Australian Moves in Europe

John Scott, the current Director of the CSIRO's European Laboratory in Montpellier, France, will be finishing his term in July 2002. CSIRO's European laboratory has a traditional role in the exploration and testing of biological control agents for Australia, having been the source lab for very successful control projects against skeleton weed, ragwort, nodding thistle and Paterson's curse. The role of the laboratory is expanding to act as a European portal for a range of CSIRO's other activities (see website). John will be replaced by Andy Sheppard for a 3-year term in July. Like John, Andy is an ecologist working on invasive plants and their management strategies and has an active international collaborative project on brooms and gorse.

Websites:
CSIRO: www.csiro.au
CSIRO European Lab: www.csiro-europe.org/lab.html

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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.

Droplets of Wisdom

Concerns in the media about pesticides are often largely misplaced: with some problems over-stated and real issues not addressed. Various proposals to cut down pesticide use are impractical and clearly have been rejected by 'the market'. The total value of world sales increased some 2.5 times to US$30 billion during the final two decades of the 20th century, and the agrochemical industry has attributed the lack of growth over the last 3-4 years as a temporary problem, related to low prices for agricultural produce.

Misdirection of public concern is unfortunate, because real problems with pesticides remain, including: hazards with human health (especially with insecticides and where regulatory standards are poor), environmental contamination, possible residues on food (food safety), and failures in control due to pest resistance or resurgence. However conflation of pesticide issues can lead to inappropriate measures being taken; for example, restrictions adopted in Europe (where food safety and environmental concerns are major issues) are often unsuitable in tropical countries (where food security and human health predominate). Impartial information can be difficult to find, especially data relevant to developing countries and information that focuses on practical measures to reduce (but not necessarily eliminate) pesticide use. Since the late 1980s, this area of R&D has been constituted a 'no man's land' for funding and support [see *BNI* **21(4)**, 96N-100N (December 2000), 'Rational pesticide use: an alternative escape from the treadmill'].

Farmers are concerned about the high costs of pesticides, yet generally little is done to improve the quality of application, which is almost always highly inefficient. Spray drift has been identified as a problem (which indeed it may be), but many so-called solutions may also reduce efficiency of dose transfer, thus increasing rather than decreasing the pesticide consumption. Many of the problems could be alleviated by implementation of known technologies, within an appropriate infrastructure of education and policy. Rational Pesticide Use (RPU) is a concept that focuses on their better selection and utilization (applying safer agents more efficiently), as opposed to promotion of pesticides.

The DROPDATA website pages describe current and future activities of the CABI *Bioscience* RPU Unit, and collaborating partners including the International Pesticide Application Research Centre (IPARC) at Silwood Park. We aim to develop linkages between research groups and extension workers and have two primary objectives:

- To give technical information on application techniques (the DROPDATA resource pages)
- Examine wider issues related to pesticide use (advocacy and description of RPU techniques)

Recent developments include:

- Publication (for the first time) of the British Crop Protection Council (BCPC) protocols for evaluating agricultural spray nozzles
- Provision of presentations about RPU, downloadable utilities and linkages with other webpages promoting similar objectives
- Advice on biopesticide delivery systems, including information on the 'MycoHarvester', a device that can revolutionize the formulation of beneficial fungal agents by small- to medium-scale enterprises
- Information on improving pesticide application to tropical tree crops such as cocoa (cacao)

The way in which the DROPDATA website is developing as a practical resource for stakeholders, from farmers to researchers, is illustrated by the information being added on tree crops. The second part of this article describes a project which is contributing new understanding and knowledge on the tricky problem of effective pesticide application in these crops.

Collaborative Cocoa Disease Control

Techniques used by smallholder farmers for applying pesticides to tree crops, such as cocoa, are often especially poor. In practice it is common to encounter farmers who use knapsack sprayers, fitted with cone nozzles, to 'squirt' the tank mixture onto higher branches; most of the liquid then falls back onto the ground and is wasted. The information in the cocoa section of the DROPDATA website has been distilled from a project in Costa Rica and Brazil involving CABI *Bioscience*, CATIE (Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica), and a number of partners in Brazil, the UK and the USA. The project is funded by the United States Department of Agriculture (USDA).

Fungal diseases are a principal constraint to world cocoa production and two of these – witches' broom (*Crinipellis perniciosa*) and frosty pod rot (*Moniliophthora roreri*) – pose a special threat to livelihoods in Latin America and their management remains problematic. Chemicals such as copper fungicides are poisonous, have limited efficacy and a long-term impact on the environment (in spite of being permitted for restricted use in 'organic' agriculture). While biological control agents may offer the most sustainable long-term solution, there are many technical, commercial and conceptual issues of development yet to be resolved. What both synthetic and biological pesticides have in common currently is an inadequate standard of application to crops: poor formulation, spray droplet size and coverage substantially affect their efficacy.

The CABI-CATIE-USDA project aims to improve delivery systems (especially formulation and application techniques) for promising microbial agents, such as isolates of hyperparasitic fungi in the genus *Trichoderma*. However, techniques developed may also be used in the application of conventional chemical fungicides, which are being used as standards in the field-testing programme. Ultimately, the goal is to assemble a 'toolkit' of practical, efficient and safe solutions to key problems, and encourage farmers to adopt them. This will have multiple benefits: improving the efficacy of control and operator safety, while reducing control costs and adverse environmental impact.

Recent laboratory and field work has enabled project partners to make provisional recommendations on operational settings for the two most commonly used fungicide application techniques: portable hydraulic sprayers and motorized knapsack mistblowers. Work on optimization continues to further reduce volume application rates (and thus increase work rates) for hydraulic sprayers, and more field evaluations are aimed at minimizing dosages of chemical fungicides and maximizing the potential of microbial biocontrol agents.

Websites:
www.dropdata.net
www.cabi-commodities.org

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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 biological control and IPM aimed at students, farmers, extension staff, policymakers or the wider public.

Rice Seed Health Looking Shipshape

Recent visitors to a village market in Bogra in Bangladesh found something unusual on display: an array of tables and potted rice plants surrounded by a cluster of farmers keen to explain how these objects related to improved rice yields in their fields. This Going Public exercise was part of an innovative project for improving rice seed health amongst resource-poor farmers.

Rice production is crucial to the Bangladesh economy. Some 75% of the cropped area and 83% of the total irrigated area are devoted to rice cultivation, and an estimated 60-70% of the labour force is employed in rice production, processing marketing and distribution. However, up to 95% of rice farmers in Bangladesh rely on their own seed for establishing the next season's crop. Declining seed quality owing to pests and diseases is a major problem, partly attributable to improper seed drying and storage during the rainy season. Appropriate farmer training (and particularly of women, who are mainly responsible for post-harvest activities) would enable farmers to improve seed quality, for until now they have had little understanding of the impact of improper drying and storage on seed health.

The Seed Health Improvement sub-Project (SHIP) operates under the PETRRA (Poverty Elimination through Rice Research Assistance) project, funded by DFID (UK Department for International Development). SHIP began in 1999 as a collaboration between BRRI (Bangladesh Rice Research Institute), IRRI (International Rice Research Institute), CABI *Bioscience* and a number of national and international NGOs in Bangladesh. The project is using Participatory Technology Development (PTD) and Farmer Participatory Research (FPR) approaches to reduce losses in crop yield and post-harvest through the development, evaluation and recommendation of appropriate seed health practices at farmer, seed industry and research levels.

During the first 18-month phase of the project, the existing on-farm situation was assessed regarding seed-borne rice diseases and quantified yield losses. Using formal survey and Participatory Rural Appraisal (PRA) techniques, socioeconomists from IRRI investigated farmers' own perceptions of seed health problems and their solution. The survey collected data from 560 plots at seven key sites in different agroecological zones of Bangladesh using multistage purposive sampling. Also during this phase, farmers' seed management practices were assessed together with the effects of improved seed quality on reducing pest damage. These activities facilitated the drawing up of a demand-led prioritized programme for implementation during the second phase of the project.

Farmer training in the first phase focused mainly on manual seed cleaning, while local collaborators honed skills in collecting and analysing socioeconomic and field pest data. Farmer trials in Chuadanga, for example, investigated the performance of crop grown from 'cleaned' and 'uncleaned' seed, and the relative expediency of different seed cleaning and sorting procedures. Farmers acknowledged that using clean seed gave more vigourous and healthier plants and (up to 22%) higher yields, and said they would continue to adopt this practice. However, they pointed out that seed sorting and cleaning is slow and tedious, is difficult for people who are older and/or have bad eyesight, and bending to sort on the floor gave back ache. Solutions proposed included involving younger people in seed cleaning and sorting, taking breaks from the activity, and sorting on a table rather than the floor.

The second phase of the SHIP project began in 2001 with activities focused on improving post-harvest treatment of rice destined for seed, including drying and storage. Two workshops facilitated by CABI *Bioscience* introduced project staff, field researchers, local engineers, administrators, etc. from the seven key sites to participatory approaches, including discovery learning, action planning, documentation, impact assessment and facilitation (for this last topic, CABI *Bioscience* worked closely with a local facilitator from the Participatory Promotors Society of Bangladesh, PPS-BD). Project staff and facilitators then initiated FPR/ PTD activities in their villages, but what each village focused on depended on farmers' priorities and time schedules. At an early stage, it became apparent that although there were many problems, there was enormous potential and enthusiasm for developing appropriate solutions.

In Gazipur, Barisal and Chuadanga, FPR focused on assessing storage containers and the use of seed preservatives (neem). However, inventorying traditional technologies and knowledge may uncover a wider range of options for testing – for example different neem preparations, other botanicals such as tobacco, or the use of desiccants such as chalk.

In Bogra and Rangpur, the emphasis was on developing better drying methods through PTD. Through discovery learning, women in one village came up with the concept of mobile drying tables, which they subsequently designed and made with the help of their husbands or of local craftsmen, using locally available and low-cost materials. Drying is particularly problematic for the rice crop harvested at the end of April/May, which is the beginning of the rainy (*boro*) season. Improperly dried seed is the primary cause of poor seed health and germination during storage. During this project, however, an astonishing array of designs has been developed: apart from improved drying all models have multi-purpose use: larger stronger tables are used for threshing – and relaxing on afterwards! Lighter models are used for storage in the kitchen when not needed for drying. There was even a folding table, which could be stored on the roof while not in use.

A trial of the innovative feedback and scaling-up approach, Going Public, involved a village picture exhibition and a crossroads demonstration of the multi-purpose seed drying tables developed by the villagers. This stimulated a two-way exchange between project participants and passers by and provided quick feedback, new perspectives and additional knowledge. A subsequent Going Public session at a local market exhibited three models of drying tables, potted mature rice displaying disease (brown spot) symptoms, along with cleaned and uncleaned seed and 2-week old seedlings grown from the two seed batches. Farmers trained through the project took over the role of explaining the benefits of cleaned and properly dried seed to their fellow-farmers. A profitable side-effect of the project is that the farmers are also developing a business mentality and are starting to sell their own quality seed. The Going Public approach has provided the trained farmers with confidence to start marketing their acquired skills and knowledge. The Going Public approach uses an arena where farmers meet naturally, rather than special meetings, which has distinct advantages: farmers are not placed in the unfamiliar setting of a formal meeting, and resource-poor farmers often cannot afford to set time aside for formal training sessions.

Next, the SHIP project aims to tackle the effects of pest insects, diseases and weeds in seed health through discovery-based learning exercises. CABI *Bioscience* will develop the capacity of local researchers for turning scientific information into discovery learning exercises. These are aimed at improving farmers' knowledge about storage pests and diseases, including diagnostics, biology and ecology and management options. Apart from these activities, training is being provided in methodologies for scaling-up and disseminating the outputs on a national scale.

Already, though, a shift in the mindset of the participating farmers can be seen, from "we know nothing" to a level of confidence that allows them not only to make suggestions for improving post-harvest technology, but also to take control of developing their ideas and communicating their findings to other farmers. Such success has been achieved through focusing on the needs of the farmers, keeping open minds, and stressing a people-centered rather than a technology- or science-focused approach. As a direct spin-off, the national research curriculum is now partly driven by project activities in communities. In this way, the SHIP project is beginning to have a direct impact on improving livelihoods for resource-poor farmers in Bangladesh, but the approaches pioneered here have potential applications on a much wider scale in other crops and other countries.

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Publicizing Parthenium Biocontrol

The Indian National Research Centre for Weed Science (NRCWS) in Jabalpur has gone on the offensive against *Parthenium hysterophorus*, and is busy recruiting the general public as allies in its war.

The invasive potential of *Parthenium* in India is fuelled by its capacity to germinate throughout the year in a wide range of environments and soils, and the massive numbers of lightweight seeds it produces. Quite apart from the losses this leads to in agricultural, forestry and horticultural crops, the plant is also allergenic and toxic and causes serious health problems in livestock and man.

The NRCWS is therefore developing a proactive approach to manage this weed, with public awareness and participation playing key roles. It initiated an awareness campaign in and around Jabalpur involving governmental and non-governmental organizations, residents, schools and village councils [gram panchayats]. At meetings in July 2001, local residents saw thousands of biological control agents (the Mexican beetle *Zygogramma bicolorata*) being released, and methods of mass rearing were also demonstrated. Cultures of the beetle may be obtained free of charge, and cheap and easy rearing methods are being developed at NRCWS. After seeing the beetle in action, many people contacted the Centre and obtained cultures.

The effect of the beetle releases will be monitored over time. It is recognized that this is just the beginning, and that complete biological control of this weed is a long way off still. However, by engaging the public actively in the process, the NRCWS aims to increase the numbers of beetles released, improve public understanding of biological control, and increase public awareness of the dangers of this weed.

Source: Anon (2001) Biological warfare against parthenium intensified. *Weed News (a newsletter of National Research Centre for Weed Science, Jabalpur)* Vol. 1 No. 4, p. 1.

NRCWS website: www.nrcws.org
Email: nrcws@sancharnet.in

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Children Trade Places with Banana Farmers

'Trading Places' was the first in a series of public Internet debates organized by WWF (the Worldwide Fund for Nature). The 2-week debate in March 2002 used bananas to help children explore how consumer choices in the UK impact on people and environments around the world. The debate formed part of 'Fairtrade Fortnight', a campaign by the Fairtrade Foundation that focused on the links between consumers and producers. By involving children, WWF aims to bring sustainability issues into the classroom, allowing pupils to communicate with a range of stakeholders on key environmental questions. The debate forms part of WWF's preparation for the World Summit on Sustainable Development in Johannesburg, South Africa this September.

For the 2 weeks of the 'Trading Places' debate, children between the ages of 9 and 11 took on the role of West Indian smallholder banana farmers faced with a series of environmental and economic dilemmas. At the outset, they were given fact files on bananas, Fair Trade and the World Summit, and an introduction to the banana industry and international trade. Competition between large companies and small island producers was explained, together with the status of the preferential trade agreement between small Caribbean islands and the European Union (the World Trade Organization (WTO) ruled to abolish this after representations by large banana companies, a decision that is currently under appeal). The children opted for one of three roles: a farmer of a long-established smallholding who decides to remain independent and hopes the trade agreement is upheld; a small farmer who decides to sell his/her land and become an employee of a banana company that has a large plantation on the island, or a farmer who joins a Fairtrade cooperative. The children were asked to think about the wider repercussions of their decision on the families – on their ability to grow their own food, for example.

Newsflashes throughout the debate gave the youngsters fresh angles to consider and introduced them to problems faced by banana growers in an economy heavily dependent on growing and exporting bananas to Europe. To help, the children could draw on websites and online experts. The debate had input from diverse international banana expertise including Agrofair, Banana Link, CABI *Bioscience,* Chiquita, the Fairtrade Foundation, journalists, Oxfam, the Rainforest Alliance, WINFA (Windward Islands Farmers' Association) and WWF, as well as real banana growers and plantation workers.

The young virtual farmers began by having to cope with a hurricane and its aftermath, which led them to discuss refugees and disaster relief. Next, the school leaving age was raised, and they debated education and child labour issues. A news flash reporting alarms about pesticide use in bananas and its health implications for workers and consumers prompted a discussion about pesticide safety and worker protection. The next flash revealed an outbreak of black Sigatoka (*Mycosphaerella fijiensis*) on organic farms on the mythical island, and they were given a briefing on the epidemiology and control of the disease. Subsequent discussions brought out the conflicts between organic and non-organic production, especially when faced with containing such a disease.

The following news flash announced that the large banana company planned to expand its plantation on the island, and the children had to consider their options: remain independent, sell up or go co-operative. This was followed by the final flash, which dealt with the special trade agreement, and the children had to re-evaluate their position in the light of the hypothetical failure of the appeal.

The enthusiasm of the children as the debate progressed was self-evident. In their summing up, they agreed that they had learned a lot about bananas and Fair Trade, and about more complex topics such as pesticide use and smallholder livelihoods. Some issues were not easy for children to grasp; "difficult but fun", as one student wrote. One great success was the rapport built up between children and experts. The children were delighted be able to ask questions and to receive answers to every one, and, as Moderator Gillian Symons said, they asked some very interesting questions which the experts enjoyed answering. She added that the children came to some very thoughtful conclusions; WWF representatives will present these to world leaders at the World Summit. As Margaret Beckett, Secretary of State, DEFRA (UK Department for the Environment, Food and Rural Affairs) said at the launch of the debate, children will be the beneficiaries of the decisions taken by world leaders in Johannesburg this year. She described the World Summit as a landmark opportunity, 10 years on from the Rio Earth Summit, to set a framework for sustainability and improving the quality of life of people now and in future generations all over the world. She said that the UK government wanted to hear from children: about their concerns and what they are prepared to do to tackle some of the problems. WWF will be hosting a further primary school debate and two for secondary schools before the World Summit takes place.

Websites:
WWF Debates:
wwflearning.co.uk/ourworld/debates.shtml
Fairtrade Foundation:
www.fairtrade.org.uk

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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.

Chromolaena Workshop

The 6th International Workshop on Biological Control and Management of *Chromolaena odorata* will be held at the Indonesian Oil Palm Research Institute in Medan and on Samosir Island in Lake Toba, which is some 1000 m above sea level, on 17-21 February 2003. The workshop will continue the tradition of the past five workshops held in Bangkok, Bogor, Abidjan, Bangalore and Durban, of bringing together scientists and others involved in dealing with this weed, but will also consider other weeds.

Chromolaena odorata, a neotropical weed which has become a serious problem in West and South Africa, tropical Asia, and Micronesia, invades pastures, vacant lands, roadsides, plantation crops and disturbs forests; it suppresses local fauna, becomes a fire hazard, restricts movement of wildlife and interferes with cultivation. The main part of the workshop will cover taxonomy, ecology, biology and different methods of control of *Chromolaena*. The second part will cover biological control of other weeds in Indonesia and exploratory work done for natural enemies.

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International Bemisia Workshop

The 3rd International Bemisia Workshop will be held in Barcelona, Spain on 17-20 March 2003 and will be hosted by the entomology team in the Plant Protection Department of the Institute for Food and Agricultural Research and Technology (IRTA) at Cabrils.

The main goal of the meeting will be to provide an opportunity for scientists working on *Bemisia tabaci* to present and discuss the latest research on this pest and the different approaches for its control. The following topics will be addressed:

- Biology of *B. tabaci* (including taxonomy, morphology, life history, sex ratios biotypes, etc.)
- Virus-vector relationship and epidemiology
- Cultural control (UV plastics, screens, vegetable cover crops, etc.) and plant resistance/tolerance to insects and associated viruses
- Biological control (including biology of natural enemies, side effects of pesticides on natural enemies, etc.)
- Chemical control and resistance to pesticides
- IPM programmes (methods and practice in integrating different control strategies for *B. tabaci*)

Contact: Secretariat, Bemisia Workshop 2003, Gran Via de les Corts Catalanes, 454 1º – 08015, Barcelona, Spain
Email: bemisia2003@otac.com
Fax: +34 93 3252708
Website: www.irta.es/bemisia2003

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China Hosts Exotic Pest Control Meeting

The International Symposium on Exotic Pests and their Control (ISEPC) will be held at Zhongshan University, Guangzhou, China on 17-20 November 2002. Organized by the State Key Laboratory for Biological Control and the Institute of Entomology, Zhongshan University, the meeting is jointly supported by the Plant Quarantine Association of the Plant Protection Society of China, the Entomological Society of Guangdong Province and the Plant Quarantine Association of the Plant Protection Society of Guangdong Province

The lead theme is 'Theories, control strategies and technologies of exotic pests related to plant protection'. Session topics will be:

- Taxonomy, biology and ecology
- Eradication
- Biological control
- Inspection and quarantine

Contact: ISEPC Secretariat, The State Key Lab for Biocontrol / Institute of Entomology, Zhongshan University, Xingangxi Road 135#, Guangzhou 510275, China
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XII World Forestry Congress

The XII World Forestry Congress, 'Forests, Source of Life', will be held in Quebec, Canada on 21-28 September 2003. Jointly organized by the Department of Natural Resources Canada and the Quebec Ministry of Natural Resources, in collaboration with the FAO (UN Food and Agriculture Organization), it will explore innovative ways to address current and emerging issues, including those of a cross-sectoral and inter-disciplinary nature.

Sessions focusing on people's expectations and the current status and outputs of the world's forests will be complemented with sessions on identifying how to improve management, institutions and policies, and on ecoregional assessments of forest and tree management in terms of sustainable development. A first call for voluntary papers and posters has been announced – see the website for a wealth of detail on programme plans and other information.

Contact: Secretariat, 2003 World Forestry Congress, 800 Place d'Youville, 18th Floor, Québec, Canada G1R 3P4
Email: sec-gen@wfc2003.org
Fax: +1 418 694 9922
Website: www.wfc2003.org

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EPPO Standards On-line

All EPPO (European and Mediterranean Plant Protection Organization) Standards are now available on the EPPO website (except the EPPO Guidelines on Efficacy Evaluation of Plant Protection Products) at:

www.eppo.org/Standards/standards.html

EPPO Standards are the result of work undertaken by different technical bodies of the organization, and act as recommendations to the national plant protection organizations of its member countries. They are Regional Standards in the sense of the revised IPPC (International Plant Protection Convention). There are Standards in two main fields of EPPO activity: plant protection products and phytosanitary measures. Of particular interest to *BNI's* readership are three concerned with safe use of biological control (PM6):

- PM 6/1. First import of exotic biological control agents for research under contained conditions
- PM 6/2. Import and release of exotic biological control agents
- PM 6/3. List of biological control agents widely used in the EPPO region (updated annually)

The first two Standards provide guidelines to national authorities in the EPPO region on the introduction and release of exotic biological control agents, so as to identify and avoid hazards for agricultural and natural ecosystems. They are intended for use in relation to future introductions, and not retrospectively. The third Standard derives from the extensive existing knowledge of and previous experience with the use of introduced biological control agents in countries of the EPPO region. It has two parts: the first for commercially available organisms is available; the second, which deals with successfully introduced classical biological control agents, is in preparation.

The IPPC ISPMs (International Standards for Phytosanitary Measures) are also now available on the website, and the latest files of phytosanitary regulations can be downloaded monthly.

Contact: EPPO, 1 Rue Le Nôtre,
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Fax: +33 1 42 24 89 43
Website: www.eppo.org

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IOBC Fruit IPM Guidelines

The IOBC Commission on Integrated Production (IP) Guidelines and Endorsement has approved in April 2002 the 3rd edition of the Guideline for the Integrated Production of Pome Fruits as well as the new Guideline on Integrated Production of Olives. The English texts of these documents can be downloaded directly from the Website of the Commission at: www.sar.admin.ch/faw/iobc

Printed versions of the documents as IOBC Bulletins (with translations into major languages) are in preparation.

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IOBC Water Hyacinth Meeting Delayed

The next and 3rd meeting of the IOBC Global Working Group on Biological and Integrated Control of Water Hyacinth, which was scheduled to be held this August in Kampala, Uganda has been postponed until August 2003. This is to give people time to find funding to attend. Organizers urge would-be participants to start to look for funding now. (If you have already registered interest, the organizers will be in contact shortly.)

Contact: James Ogwang, Biological Control Unit, Namulonge Agricultural and Animal Production Research Institute,
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New Books

New Australian Classic

Australia was the source of the first insect natural enemies successfully imported for biological control of an arthropod pest; namely the very successful control of the cottony cushion scale (*Icerya purchasi*) in California by the vedalia beetle (*Rodolia cardinalis*) and a cryptochetid fly (*Cryptochetum iceryae*) in 1888-89. Australia was also one of the first countries to import arthropod natural enemies for biological control following news of this success. Thus, Australia has had more than a century of experience in biological control and is one of the top ten countries importing natural enemies. Thus, this new review[1] is most welcome because the previous comprehensive review of biological control results in Australia by Frank Wilson[2] was published in 1960 and much progress has been made since then, and some earlier results have been re-evaluated. This new book reviews results obtained against some 98 arthropod pests or groups of pests while Wilson reported on only 53 such attempts. Wilson also included attempts to control weeds, now covered in summary form on a worldwide basis and regularly updated by Mic Julien[3].

The term ‘classical biological control’ to describe the importation of exotic natural enemies to control introduced pests came into general use around the time of the centenary of the introduction of the vedalia beetle into California and is in fact a misnomer, as other forms of biological control involving the augmentation of existing natural enemy species have been in use since at least the 3rd century AD when it is reported that nests of ants were being sold in the market in Canton for control of citrus pests. The meaning of the term is often extended, as in this book, to include natural enemies imported against native pests also.

The book is a fitting memorial to the late Doug Waterhouse who was a lifelong proponent of biological control, first in Australia while working for CSIRO Entomology and after his retirement when he promoted biological control in the Pacific Region and Southeast Asia. During his retirement he wrote, or was co-author of eleven other books reviewing biological control in these regions, showing how further progress might be made and identifying new targets. His co-author, Don Sands, has been actively involved in biological control projects in Australia and the Pacific for more than 20 years.

The main body of the book comprises separate chapters on each of the 98 pests or groups of pests. Each of these comprises a brief précis and succinct accounts of the biology, pest status and biological control. Where appropriate, in addition, there may be comments on the taxonomy of the pest, comments on the outcome of the biological control including suggestions for further work, short accounts of the biology of important control agents and tables listing native natural enemies. The results are summarized in a table that precedes the pest chapters and in a brief overview at the end. There is also a list of localities mentioned in the text and an outline map showing the position of each of them. The book is completed with an extensive reference list, an index of arthropod names (including authorities and classification) and a general index where other groups of organisms are similarly treated.

The final overview shows that highly or moderately effective control has been achieved against 30 out of 44 (i.e. 67%) exotic major pests in all or part of their range. Similarly effective controls have been achieved against 19 out of 28 (i.e. 68%) exotic minor pests but only 5 out of 15 (i.e. 33%) native (or presumed native) pests. Interestingly, 19 (or 63%) of the exotic major pests, 17 (or 89%) of the minor pests and 4 (or 80%) of the native pests against which useful results have been achieved are Homoptera. This follows the trend in other regions and has been frequently noted. However, the overall success rates are high in comparison with other regions and may reflect the isolation of Australia and its unique fauna and flora which has shown little resistance to invasion by exotic pests and, by inference, less resistance to the establishment of exotic natural enemies. In this respect the programme for control of cattle dung and dung breeding flies by the introduction of dung beetles is relevant, since Australia lacked both native ungulate herbivores and dung beetles specialized to utilize their dung prior to the arrival of European colonists.

Another probable reason for the relatively high success rate is the degree of effort, both in terms of research and funding, put into biological control programmes by CSIRO and State entomologists fulfilling DeBach’s often quoted dictum that the results of biological control programmes are proportional to the effort. Throughout the 20th century Australia was noted for the extent of its research and insistence on rigorous evaluation of potential control agents before authorizing their introduction which has been shown to enhance the rate of successful introductions.

Since progress in biological control depends on past results which provide valuable information for future programmes against the same or related pests in other regions, this book will be an essential reference for biological control practitioners. It will also be a fruitful source of information for ecologists interested in analysing the results of introductions of exotic species, pest invasions and means to ameliorate their impact on native fauna and flora.

Finally, the book is produced to a high standard, but at a reasonable price for individuals who wish to possess their own copies of this authoritative review of progress in Australia against many widespread invasive pests of importance to agriculture, animal husbandry and human well being.

[1]Waterhouse, D.F.; Sands, D.P.A. (2001) Classical biological control of arthropods in Australia. Canberra, ACT; ACIAR Monograph Series No. 77, 560 pp. Hbk. Price A$60.00. ISBN 0642457093 [Also available on CD: Price A$54.00. ISBN 0642457107]

[2]Julien, M.H.; Griffiths, M.W. (*eds*) (1998) Biological control of weeds: a world catalogue of agents and their target weeds (4th ed) Wallingford, UK; CABI *Publishing*, 240 pp.

[3]Wilson, F. (1960) A review of the biological control of insects and weeds in Australia and Australian New Guinea. Farnham Royal, UK; Commonwealth Institute of Biological Control, Technical Communication No. 1, 102 pp.

By: D. J. Greathead

❑

Latest in Canadian Biocontrol

This book* is an extensive review of the biological control programmes against insects, mites, weeds and pathogens conducted in Canada between 1980 and 2000. Although not explicitly mentioned, it is one of the latest of CABI's Technical Communications, a series that is focused on providing a comprehensive review of biological control based on a country/ regional basis. The Canadian contribution to this series has been substantial as three of the original series were devoted to reviews of Canadian biological control (No. 2 covered the early 20th century up to 1959; No. 4 dealt with the period 1959-68, and No. 8 1969-80). From this point alone, Canadian biological workers are to be congratulated for keeping their projects and programmes written up and published; biological control is still a practice that relies on previous experience more than on hard science and the Canadian experience is invaluable in this regard.

As the Editors point out, this volume differs from the previous reviews in some important ways. The increasing global problem of invasive species threats is treated as a subject in its own right and there is good discussion on how Canada is trying to balance regulatory legislation for these pests *vs* legislation for the introduction of biological control agents. The importance of taxonomy to biological control is given prominence. There is also much more on pathogens both as targets and as agents (the latter including pathogenic and antagonistic actions) than in earlier volumes. The pathogenic groups covered include viruses, bacteria, fungi and nematodes. There is also less on the introduction of insect agents, particularly for the management of forest pests. This approach in the book reflects the thrust of Canadian research over the last 20 years or so. The traditional grouping of pest problems in the Canadian volumes has also been changed for the better; insect pests of agriculture and forestry have been grouped together because several insect pests are a problem in both systems.

Canada is still investing heavily in biological control, and this technique of pest management is particularly relevant now environmental concerns have surfaced. Nonetheless, the focus of the Canadian work in biological control is fundamentally changing with more emphasis on the utilization of its own natural enemy resources. Many biological workers have contributed to this volume and the account of their combined experience makes essential reading for anyone engaged in this field.

*Mason, P.G.; Huber, J.T. (*eds*) (2002) Biological control programmes in Canada, 1981–2000. Wallingford, UK; CABI *Publishing*, 583 pp. Hbk. Price £95.00/ US$175.00. ISBN 0 85199 527 6

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Scelionid Parasitoids of Acrididae

Scelio spp. have the distinction of being the only common hymenopterous parasitoids of Acrididae, which are unusual in having principally dipterous parasitoids. *Scelio* spp. are also the only important parasitoids of the egg stage of these insects. They have been reported from eggs of acridids on all the inhabited continents and have been studied as potential biological control agents, or important mortality factors, of many pest species. This book*, in spite of its title, contains a critical review of the world literature on the biology, ecology, host relations, and biological control significance of the genus *Scelio*. Therefore, it will be of interest for all concerned with the ecology or control Acrididae as well as specialists interested in the Scelionidae.

The book begins with a useful chapter detailing and critically reviewing methods for collection and rearing *Scelio* spp. as well as museum techniques for taxonomic studies. The next two chapters on biology and ecology will be the most useful for non-Australian readers undertaking field studies and pest management. It is shown that although *Scelio* spp. seldom achieve high levels of parasitism, they may sometimes help suppress host populations. Notably, one species from Malaysia, *S. pembertoni*, has been introduced in Hawaii for the control of the rice grasshopper, *Oxya japonica*, and is the only example of successful 'classical' biological control of an acridid pest. The proposed introduction of *Scelio* spp. into the USA for control of prairie grasshoppers is discussed. It was refused on the grounds that *Scelio* spp. are not host specific and that non-target species could be at risk. However, the authors also discuss the host range of *Scelio* spp. and provide a comprehensive world list of host records. They conclude that, at least some species of *Scelio* may not be as polyphagous as is often believed, and that their further use as biological control agents should not be rejected without further careful field studies to determine more precisely the determinants of host range. It is also suggested that *Scelio* spp. may be ineffective control agents in many instances because they are unable to adapt to environments modified by agriculture. This also implies that they are sensitive to changes in land use and action may be required to conserve species diversity.

It is stressed that systematic research is essential for establishing a solid framework for ecological studies and biological control alike. The remaining chapters set out to do this. They begin with a detailed description of the external morphology and a phylogenetic study of the genus (with particular reference to Australian species). A key to known males and females precedes the detailed descriptions of the Australian species, including the redescription of 33 species and the description of a further 26 new species. These descriptions are accompanied by drawings and SEM photographs illustrating the sculpture of the cuticle and by distribution maps for each species. The book is completed with a comprehensive reference list and indices to genera and species of scelionids and their hosts.

In conclusion, this is an excellent monograph and could usefully be used as a model for other such studies of taxa containing species of economic importance.

*Dangerfield, P.C.; Austin, A.D.; Baker, G.L. (2001) Biology, ecology & systematics of Australian *Scelio*: wasp parasitoids of locust and grasshopper eggs. Collingwood, Victoria, Australia; CSIRO Publishing, 254 pp. Price: A$170.00. ISBN 0643067035

By: D.J. Greathead

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Weed Risk Assessment

This book* is a timely publication in a new and expanding discipline: new, because risk assessment has rarely been considered, at least on a scientific basis, for plant species; and expanding, because increasing trade and globalization are leading to increasing plant movement – intentionally, as well as accidentally – between previously-isolated geographic regions, countries and continents. In order to prevent the predicted 'McDonaldization' of the world's flora, urgent action is required to better regulate and monitor such plant exchanges, and, thereby, to identify and 'weed out' the potential invasive species.

The threat from invasive alien weeds to ecosystems is ranked second only to habitat destruction and hence the book is aimed at a wide audience, from applied and theoretical life scientists to quarantine officers and policy makers. As reflected by the background of the editors, there is a strong Southern Hemisphere bias to the contents, although this strengthens rather than weakens the book since most of the relevant work on evaluating and managing alien weeds has been undertaken in this region. The 19 chapters, arranged under three main headings (Overviews, National Perspectives, and Regional Perspectives) with a final synthesis by the editors, embrace recent theories on plant invasions, as well as introducing various models for weed risk assessment and detailing procedures for ranking invasive species on a range of scales to assess weeds of both regional and national significance.

Australia, in particular, has put considerable resources into developing a scoring system for weediness and several chapters report recent significant advances resulting from initiatives by the Australian Weeds Committee which has promoted a National Weeds Strategy. The resultant Weed Risk Assessment System is described in detail (P. C. Pheloung) and generates a numerical score, based on answers to 49 simple questions, which is positively correlated with weediness. The example illustrated is *Chromolaena odorata* – or Siam weed as it is misleadingly called since it is of neotropical origin – but, from this reviewer's experience at least, several of the answers are questionable. For example, there is no doubt that this weed does exhibit allelopathic traits and that it also acts as a host for agricultural pests and pathogens: e.g. *Zonocerus* grasshoppers in West Africa and anthracnose (*Colletotrichum* spp.) in Asia. Nevertheless, there is no doubt that this will prove to be an extremely valuable and user-friendly method of predicting environmental hazards posed by alien plant species. Such a system is now essential since there has been a recent and fundamental shift in the position adopted by the Australian Quarantine & Inspection Service in their approach to regulating plant imports, abandoning a prohibited list in favour of a permitted list. In effect, this means that all plant species not on this permitted list are denied entry until they have been assessed for weediness. Importers previously supplied only details of the genus and species of plant to be introduced and, clearly, there was insufficient information on which to base an informed decision as to their potential weediness and the long-term threat to the environment. This reviewer is in no doubt that similar weed risk assessment systems should be universally adopted not only to keep out invasive alien plants but also the pests and pathogens they may be harbouring.

The book, therefore, is an essential read for all those involved, either directly or indirectly, in plant trade, especially quarantine policy makers; since, as the promotional blurb somewhat self-importantly proclaims, this "may help reduce weed impact and thereby improve living conditions for people throughout the world." It is something of a pity, therefore, that in the final synthesis, there is no attempt to at least summarize actual or potential management strategies for plant species which have already become invasive, especially, of course, the classical biological control approach which has been employed so successfully in the Southern Hemisphere against a number of alien weeds.

*Groves, R.H.; Panetta, F.D.; Virtue, J.G. (*eds*) (2001) Weed risk assessment. Collingwood, Victoria, Australia; CSIRO Publishing, 244 pp. Price A$80.00. ISBN 0 643 06561 X

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Tropical Weed Management

Weeds have plagued crop growing since the time the first plants were domesticated. Globally, about 8000 species of plants have been termed weeds; of these, around 250 are classed in the literature as serious weeds. The importance of weeds in world agriculture is well illustrated by the amount herbicides now used: during the last two decades, global pesticide sales have increased by about 250% and nearly half of these sales are for herbicides. This excellent book* is about weed management in the humid and sub-humid tropics. These two zones are characterized naturally by forest and savannah biomes respectively, and of course both are also characterized by a wide range of farming and cropping systems. Smallholder farms are particularly common in these regions. The soil fertility in both biomes is mainly an outcome of the balance between rapid plant growth and the breakdown of litter. In evergreen and monsoon forest areas, water erosion is important, and thus most investment is made in tree crops such as coffee, cacao and rubber. At the other end of the spectrum, in dry savannah areas where soil fertility is low, farmers mostly invest in annual crops.

Weeds are mostly a problem because they reduce yields of crops through competition; but weeds can have other important negative impacts such as being alternative hosts of pests and plant pathogens. As van Rijn points out, alarmingly, 17 of the world's worst weeds have a wide range of climatic and soil tolerance and are thus important in both the humid and sub-humid zones. Important species include *Cyperus rotundus* and *Rottboellia cochinchinensis*. However, besides these global weeds, there are many other troublesome weeds that are important on a regional basis. Good examples are the neotropical species, such as *Chromolaena oderatum*, which is highly invasive in the forests of tropical Asia, and other species such as *Digitaria horizontalis* and *Euphobia heteropsylla*, which are problematic in upland farming areas.

Van Rijn's book is an excellent review of the subject area. There is broad coverage and it is well referenced. The sequence of subjects is also satisfying. The first chapters cover weed impacts, ecology, and weeds in relation to different farming and cropping systems/crop performance in tropical regions. The section on weed ecology is refreshing as it underpins most of the book. All too often texts on weed science tend to focus on the problems related to particular management strategies whereas successful control can depend on a good understanding of the dynamics of the weed in question. Plants can have complex ecologies and van Rijn includes the important human dimensions that contribute to the dynamics of species such as human-mediated dispersal.

The next chapters in the book provide a brief review of the main weeds of the humid and sub-humid zones and then a review of main control methods. Ecological, cultural and mechanical control are obviously important in the zones covered by the book and these forms of management are given due prominence. Reviews of the current state of weed management in the major cropping systems are covered in the remaining chapters. There are sections on cereals, tuber crops, fruit crops, grain legumes/vegetable crops, plantation crops and weed fibres; there are also two additional sections by other authors covering pastures (L. 't Mannetje) and aquatic weed management (A. H. Pieterse). These sections leave a strong impression of the huge constraints that weeds pose to farmers. While those involved in cash crops may be able to afford herbicides, many smallholders still rely heavily on traditional methods of management. There is still much to be done to transfer the benefits of integrated management to smallholders. There is also scope for the development of biological control to complement traditional practices.

This is a book for researchers and extensionists. Most importantly, it will be an important resource for workers in the developing world where access to up-to-date information is sometimes hard to get. This book is a broad 'toolkit' of knowledge which introduces the interested worker to the current state of play and also provides the necessary links to other works with more detailed information.

*van Rijn, P.J. (2000)Weed management in the humid and sub-humid tropics. Amsterdam, The Netherlands; Royal Tropical Institute, 234 pp. Pbk.
Price €31.50. ISBN 90 6832 123 4

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Proceedings

Indian Invasive Forest Weeds

Exotic species invasion has been identified as one of the biggest threats to biological diversity around the globe, second only to habitat destruction. Weeds, owing to inherent properties of efficient nutrient uptake and use, easily invade disturbed land with adverse effects on the ecosystem. They thus pose a serious challenge to sustainable management of forest ecosystems, and to the conservation of biodiversity.

This beautifully produced book* is the proceedings of a workshop which concluded a project funded by DFID (UK Department for International Development) and conducted by Kerala Forest Research Institute (KFRI) and CABI *Bioscience*. The project studied the invasion of the weed *Mikania micrantha* in the Western Ghats in southern India, and involved mapping the distribution and spread of *Mikania*, evaluating its socioeconomic impact, and evaluating pathogens for potential as biocontrol agents. The workshop gave an opportunity to draw together the findings of the project, but by providing a meeting ground for scientists, foresters, agriculturalists and policy makers and allowing them to share experiences, exchange views and evolve strategies for controlling weeds, it was an opportunity to review the overall situation in India.

This publication, then, reviews the population characteristics, taxonomy and ecology of the major moist forest weeds in India and their management aspects. It provides an insight into the current status of weed invasions in the moist tropical zones in India and the challenges they present. Dr S.P. Singh's keynote address reviews past programmes of classical biological control for invasive weeds in India, but concludes that further efforts are now needed to fine-tune the technology evolved in these projects. The next paper (S.T. Murphy) reviews the characters of invasive alien weeds in tropical rainforest zones and their range dynamics, and discusses the consequences for long-term impact in different landscapes and how this has to be related to management strategies. P.S. Ramakrishnan then sets the Indian experience in the larger global context of land use change. He stresses that the interconnected dimensions of biological invasion demand an integrated view, linking the ecological and social processes determining land use dynamics.

The remaining 18 papers deal with the current distribution, impact in terms of costs and benefits, and management of invasive moist forest weeds in India including *Chromolaena odorata, Lantana camara, M. micrantha, Parthenium hysterophorus* and *Eichhornia crassipes* (water hyacinth). The papers focus on different parts of the country (Karnataka, Kerala, Madhya Pradesh and Northeastern India) and cover a range of ecosystems (tea, agroforestry and wetland systems) and include specific cases such as wildlife sanctuaries. The whole range of management options is also considered, from biological methods including classical biological control and bio-pesticides, to chemical methods and botanicals, to integrated management.

The proceedings conclude with a series of recommendations for action against the weeds identified at the workshop as the most serious threat to the moist tropical zones of India.

*Sankaran, K.V.; Murphy, S.T.; Evans, H.C. (*eds*) (2001) Alien weeds in moist tropical zones: banes and benefits. Proceedings of a workshop, Kerala, India, 2-4 November 1999. Peechi, Kerala, India/ Ascot, UK; Kerala Forest Research Institute/CABI *Bioscience*, 172 pp.

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West African Cocoa Workshop

The English version of the proceedings of a West African cocoa workshop, held in Cotonou, Benin in November 2001, is available on the Internet*. The French version in is preparation, and both will then be printed. Jointly organized by CABI *Bioscience* and IITA (the International Institute of Tropical Agriculture) and sponsored by STCP (the Sustainable Tree Crops Program) and BCCCA (the Biscuit, Cake, Chocolate and Confectionery Alliance, UK), it provided scientists from

West African cocoa-producing countries a platform to exchange ideas [see *BNI* 23(1), 14N-15N (March 2002) 'West African recipe for cocoa IPM'].

The proceedings begin with papers outlining current STCP, BCCA and DFID (UK Department of International Development) research programmes in West Africa. Two further introductory papers describe biological control of pests and diseases of tropical tree crops, focusing on cocoa and coffee, and farmer participatory approaches to cocoa IPM implementation. Next, country papers from Benin, Cameroon, Côte d'Ivoire, Ghana, Guinea Conakry and Nigeria provide an up to date summary of the status of pest and disease problems, and research and its implementation in West Africa.

The subsequent part of the proceedings is devoted to regional and national workshop sessions, which provided the mechanism for identifying key constraints to cocoa production in the region, and capacities and gaps in regional capabilities for tackling them. This leads into a final section, which includes both the summary of on-going and potential regional cocoa IPM research and implementation, and the proposal for follow-up cocoa IPM research drawn up by participants.

*Vos, J.; Neuenschwander, P. (2002) West Africa regional cocoa IPM workshop, Cotonou, Benin, 13-15 November 2001. Egham, UK/Cotonou Benin; CABI *Bioscience*/IITA, 77 pp.

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