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General News

Knapweed Gall Flies in the Firing Line

Which is the villain, the insect or the mouse? That is one question raised in response to a recent paper (see below) concerning the indirect effects of gall flies, introduced for control of invasive knapweeds in North America, on mouse populations.

The thrust of the paper's criticism is that biological control scientists, and indeed regulators, focus too much on direct nontarget effects (i.e. host specificity) and overlook indirect impacts introduced agents might have on the food web. In answering the criticism, scientists involved in the programme call for patience (biological control is happening, but characteristically slowly) and a wider perspective, but they also accept there is much still to be learnt. Methods for determining host specificity are now fairly robust, but it is still impossible to predict every impact of an introduced species. This should not mean abandoning classical biological control, because there is often no practicable alternative and uncontrolled invasive species can have enormous and devastating effects on ecosystems. But we do need better ways of assessing how effective an agent will be, and we do need the resources and commitment to classical biological control to make sure programmes are carried through as quickly and effectively as possible.

And the answer to the question above? It depends on your point of view: increased mouse populations blamed on a 'failed' gall fly knapweed biological control agent, and now raising concerns owing to possible human health impacts, may themselves be blamed for limiting gall fly populations and thus the flies' effectiveness as biological control agents.

Paying the Price through Deer Mice

A paper in *Ecological Letters*[1] identifies an instance where a classical biological control agent has remained host specific, as predicted, but has had other nontarget impacts of an unforeseen nature. Dean Pearson and Ragan Callaway report the results of a study comparing deer mouse (*Peromyscus maniculatus*) abundance and Sin Nombre virus (SNV) incidence in grasslands in Montana (USA) with high and low levels of infestations of spotted knapweed and consequently high and low abundances of *Urophora* spp. gall flies.

Eurasian knapweeds form a large complex of invasive species found throughout the USA and Canada, and particularly as noxious rangeland weeds in the West. The *Urophora* gall flies are two of 13 insect species that feed on different parts of various invasive knapweed species which have been introduced over the last 30 years by biological control programmes in Canada and the USA. *Urophora affinis* and *U. quadrifasciata* were introduced and established in the western USA in the 1970s–80s against spotted knapweed (referred to commonly and in this paper as *C. maculosa*, although taxonomic studies[2] suggest it is *C. stoebe* or *C. stoebe* ssp. *micranthos*) and diffuse knapweed (*C. diffusa*). The adults lay eggs in the immature flowerheads, and the emerging larvae feed on the tissue of the galls they induce. Larvae overwinter in the seedheads, emerging the following June as adults.

Deer mice are the main reservoir for the hantavirus SNV, the primary cause of hantavirus pulmonary syndrome (HPS) in humans which is fatal in some 38% of cases. The disease first emerged in the southwestern USA and current thinking links outbreaks in humans with an increase in rodent populations (and therefore SNV prevalence) associated with an easing in the limitations of their food supply.

The problem, according to the paper, has arisen because the gall flies, although reducing seed production, have not effectively controlled the weeds. Instead the weed infestations provide a superabundance of food for the gall flies which swells their populations and they thus occur at much greater densities than in their native range in Europe; this in turn boosts food resources for consumers. From autumn through to spring, the overwintering larvae are a valuable food resource for deer mice in particular. In areas heavily infested with spotted knapweed, the gall fly larvae constitute 50% or more of deer mouse diet for most of the year and 85% in winter, which reduces the population decline typically seen at this time. As a consequence mice survival has increased: in spring, mice populations were twice as high in areas with large spotted knapweed infestations (and consequently gall fly populations) than in those without, and the incidence of deer mice testing positive for hantavirus in these heavily infested sites was three times higher than elsewhere. The evidence of the 3-year study suggests that mouse population differences between years were directly related to gall fly rather than weed populations. There were also indications that food abundance, as well as having a direct effect on hantavirus incidence through higher mouse numbers, might also have an indirect effect via increased transmission.

The authors note that this study illustrates an issue they have raised before (see [3] and references therein): the dangers of using host specificity alone to justify introducing exotic biological control agents, and that this approach ignores the potential for biological control agents to do anything other than consume nontarget species. They say that "efficacy is as important as host specificity for ensuring safe and effective biological control." Host specificity, they argue, is necessary but not sufficient for an introduced biological control agent which, to minimize indirect nontarget risks arising from food-web interactions, should also reduce target populations below

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the economic or (in this case more importantly) the ecological threshold of impact.

[1]Pearson, D.E. & Callaway, R.M. (2006) Biological control agents elevate hantavirus by subsidizing deer mouse populations. *Ecological Letters* **9**, 443–450.

[2]Ochsmann, J. (2001) On the taxonomy of spotted knapweed (*Centaurea stoebe* L.). In: Smith, L. (ed.) Proceedings, First International Knapweed Symposium of the Twenty-First Century, Coeur d'Alene, Idaho, 15–16 March 2001. USDA-ARS, Albany, CA, pp. 33–41.
www.sidney.ars.usda.gov/knapweed/images/proceed.pdf

[3]Pearson, D.E. & Callaway, R.M. (2005) Indirect nontarget effects of host-specific biological control agents: implications for biological control. *Biological Control* **35**, 288–298.

Additional source: USDA National Agricultural Library, National Invasive Species Information Center – species profile
www.invasivespeciesinfo.gov/

Patience Rewarded: Reflections on Knapweed Biocontrol

The Pearson and Callaway article, above, implies that the *Urophora* spp. gall flies released on spotted knapweed are undesirable agents because they are having indirect effects on deer mice populations, are ineffective biocontrol agents, and are super-abundant, thereby increasing their capacity to indirectly affect nontarget species. While the concern about indirect effects is understandable and valid, the assessment of the flies was inaccurate. The flies, particularly *U. affinis*, are indeed very abundant, but they have been extremely effective. They are reducing seed production of spotted knapweed in Montana by up to 90%. When considering the density of spotted knapweed in Montana, its reproductive potential, the large seed bank, and the long-term seed viability, the fact that spotted knapweed still persists at high densities in many areas is a reflection of the competitive ability of spotted knapweed and the customary slowness of biocontrol rather than the effectiveness of the *Urophora* flies. Patience is essential to realizing the effects of biocontrol.

Fortunately, the concern about the indirect effects of the *Urophora* flies may soon become a moot point. After 30 years of biocontrol work on spotted knapweed, we are starting to see significant reductions in knapweed density in some areas of western Montana, due largely to an introduced root insect (*Cyphocleonus achates*), with complementary effects from other biocontrol agents, especially the *Urophora* flies.

The fact that the *Urophora* flies are having an indirect effect in North America is unfortunate, but not surprising in a general sense. There are indirect effects associated with every introduction of an exotic biocontrol agent anywhere. Unfortunately, it is not possible to predict all possible indirect effects, so we must be willing to accept some risk with biocontrol. Although not perfect, biological control remains the best option available for managing invasive weeds on rangeland.

Finally, while we worry about potential indirect effects by introduced biocontrol agents, we must not lose sight of the bigger problem: the impact of the invasive species on the overall ecosystem. An invasive weed like spotted knapweed has a tremendous impact on all trophic levels in the system, much more than the indirect effect of the one biocontrol agent species.

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Cause and Effect, and How to Make a Better Biocontrol Agent

Pearson and Callaway's article, above, raises alarming concern that host specific insect biological control agents of weeds could open a Pandora's box of problems. Considering that trophic interactions can cascade up and down food webs, it would seem impossible to predict all possible adverse indirect effects. One might therefore conclude that it is never worth the risk to introduce another biocontrol species into an ecosystem, regardless of its host specificity. However, before panicking, it would be wise to: (i) put the study in perspective, (ii) consider the alternatives and (iii) learn from our experiences.

The crux of Pearson and Callaway's article is that the mouse population was low in the spring of 2001, which was the only year when fly populations were low and spotted knapweed populations were high. However, for this year, fly populations were based on autumn 2000 (during drought) whereas knapweed abundance was measured in spring 2001 (post drought). The low fly populations (in autumn 2000) were actually based on an estimation using the number of old stems remaining in the spring of 2001, not a real count. The corresponding knapweed population was based on percent cover measured in June 2001, presumably after the spring mouse census, and after the end of the drought. Knapweed forms flat-lying rosettes in the autumn, which may persist through the winter if protected under snow, and additional seedlings and rosettes develop in the early spring. Plants do not form stems until late spring. Knapweed rosettes do not provide much 'cover' for mice during winter, compared to the tangle of old stems from the previous autumn. The best measurement for winter 'cover' available in this study is the previous year's stem count. But, stem counts are directly correlated to *Urophora* numbers (especially in 1999 and 2000, when actual *Urophora* numbers were not observed). Thus, this paper provides no direct proof that *Urophora*, rather than knapweed abundance, is affecting the mouse population. Furthermore, given the strong invasiveness of spotted knapweed in western Montana, finding naturally occurring areas of high and low density close to each other suggests that such areas differ in some other respect (e.g. water table, soil porosity, shading, prior use of residual herbicide). So, the differences in mouse populations between the high knapweed and low knapweed sites could also be due to site characteristics other than knapweed density. A manipulation study would have been more conclusive. Without excluding the flies (e.g. by cages or insecticide), it is difficult to separate the effect of knapweed from that of *Urophora*.

I have no doubt that mice prey on the overwintering *Urophora* larvae, but what did they feed on before the arrival of knapweed and *Urophora*? Despite Pearson and Callaway's paper, summarized above, and other published studies of the knapweed–*Urophora*–deer mouse–hantavirus relationship, we lack knowledge of what the mouse populations were like before knapweed became abundant, and before *Urophora* became abundant. Furthermore, rodent populations are known to fluctuate in response to changes in food abundance and predator–prey cycles. So, this 3-year study indicates that both knapweed productivity and mouse populations were low during the 2000 drought, but we do not know anything else about long-term changes. How did the arrival of spotted knapweed, and later the arrival of the fly, affect the mice? If the abundance of *Urophora* could cause a catastrophic increase in deer mice or hantavirus, then I think it would have been noticed by the public during the past 20 years. Perhaps a 2- to 3-fold increase in mouse populations over 2 to 3 years is not very critical. In any case, hantavirus continues to be a rare disease in western Montana[1].

Pearson and Callaway's article emphasizes the need for biological control practitioners to consider indirect nontarget effects, in addition to direct nontarget effects. Under current regulations in the USA, environmental safety of prospective biological control agents of weeds is primarily assessed by considering direct nontarget effects[2]. As these authors mentioned, this is a fairly well-developed science with strong predictive power[3]. However, they also imply that biological control practitioners focus only on evaluating host plant specificity. Most practitioners are well aware that it takes more than host specificity to achieve a satisfactory level of control. Biological control is an applied field, and the goal is to reduce the target plant, not simply release new alien species with the hope that something good might happen. As early as 1973, attempts were made to develop rating systems to help choose the best prospective agents[4]. Then, the motive was primarily to reduce cost and save time, whereas today the motive of minimizing adverse nontarget effects should be added. Nevertheless, it was early appreciated that efficacy depended on more than host plant specificity, and the details of how to assess agents was debated for at least 10 years[5]. Selecting only agents that have potential to control the target is an element of the international 'Code of Best Practices' for biological control of weeds, which was first proposed in 1999[6].

I agree with Pearson and Callaway that it is not desirable to produce large numbers of alien insect biocontrol agents and not reduce the population of the target weed. It is likely that such large numbers of insects will be exploited by or affect some other component of the ecosystem. So, should we stop the future introduction of alien biological control agents? Unfortunately, the rate at which unpermitted alien species are arriving is increasing and our ability to control them is limited mainly to quarantine (prevention), pesticides, mechanical control and biological control. Once an alien pest is widespread, the only practical option is biological control. As part of the review process to obtain US state and federal permits to release a biological control agent, the potential nontarget impacts on plants, animals and people are assessed and compared to the potential benefits of successful control. Doing 'nothing' often has a high environmental and economic cost. This does not mean that biological control has free licence. Releasing a biological control agent is irreversible, so it is important to anticipate potential nontarget effects to minimize negative impacts. Releasing highly effective agents should achieve this, but how do we know which ones will be effective?

Unfortunately, our ability to predict the level of success to be achieved by releasing a particular biological control agent is very poor, except in those cases where it previously has been released against the same weed in a similar environment. Success generally depends upon achieving high numbers of biological control agents, and this depends upon the suitability of many environmental factors, both abiotic and biotic. Such information is often poorly known for biological control agents before they are released. Often, they occur in remote locations and in small numbers on plants that are uncommon in their land of origin. Nevertheless, ecological studies of prospective biological control agents are increasingly being performed. Perhaps the most difficult factor to assess is susceptibility to natural enemies in the new region before release.

So, were *Urophora* spp. the wrong insects to introduce for spotted knapweed? Although I do not believe that *Urophora* spp. alone are effective enough to control spotted knapweed (a perennial plant), early reports of their impact in Canada indicated that they could reduce seed production of diffuse knapweed (a biennial plant) by 95%[7]. However, infestation rates are now much lower[8]. One reason for the failure of *Urophora* may be that North American predators discovered *Urophora* as a new food. The overwintering larvae are known to be eaten by birds, deer and mice, to the extent that few remain by the time the adults emerge in early summer. So, it could be argued that these predators are preventing *Urophora* from controlling the knapweed. If it is true that *Urophora* is augmenting the mouse population, then the mice must be depressing the *Urophora* population. Causation in trophic relationships can be bidirectional. Disruption of potentially effective biological control agents has been observed in other systems[9]. Although biological control practitioners are aware that susceptibility to predation is not a desirable attribute, they may not be placing as much importance on invulnerability to predation and parasitism as they should be[10]. Fortunately, diffuse knapweed is being effectively controlled by a combination of biocontrol agents[8,11], and there are indications that other agents are starting to control spotted knapweed (see 'Patience rewarded, reflections on knapweed biocontrol', above).

Nevertheless, it is important to realize that a half-finished biological control project could theoretically be worse than having none. Considering how long such projects can last, it behooves us to muster sufficient resources and commitment to complete a project as fast as possible to minimize possible transient indirect nontarget impacts, which can occur when both the weed and insects are superabundant.

[1]www.cdc.gov/ncidod/diseases/hanta/hps/noframes/caseinfo.htm

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Assessing Assessments

An article in the February 2006 weed biocontrol newsletter from Landcare, New Zealand[1] notes that one of the commonest questions (after 'what will it eat next?') concerns how successful a biocontrol agent might be. It is reassuring though hardly surprising to read that a lot of effort goes into selecting biocontrol agents that are likely to succeed, and that the aim is to introduce as few as possible to achieve control.

Methods used to try and identify the best agents include life cycles studies (for example: species with multiple generations per year are a good bet, root feeders tend to be useful against perennial weeds…), assessing impact in their native range (though this is not foolproof), and looking at what has worked in the past or elsewhere. Other tactics involve simulating biological control, either practically using herbicides or with computer models, to see what impact controlling the weed will have on community succession, and to identify the vulnerable points in the weed life cycle.

The article goes on to discuss on the importance of follow-up, describing the importance of post-release monitoring for checking on establishment and non-target impacts. Reviewing various methods for evaluating impact, it concludes that existing techniques do not allow the impact of control agents to be predicted with any degree of certainty, but the main obstacle to evaluating biological control is lack of funding. It argues that "the challenge is for scientists to persuade funders to support the assessment component of projects" whilst also noting that it is up to the scientists to find quicker and better ways of predicting and assessing success.

Hayes, L. (ed) (2006) How successful will they be? Landcare Research New Zealand Ltd 2006, *What's New in Biological Control of Weeds* **35**, 6–8.
www.landcareresearch.co.nz/publications/newsletters/weeds/index.asp#control

South American Beetle Fighting the Plant from Hell: Tropical Soda Apple

Tropical soda apple (TSA), *Solanum viarum*, also known as 'the plant from hell' is a perennial prickly bush native to South America that has been spreading rapidly in the southeastern USA since it was found in Glades County, Florida in 1988, and as with many other non-native plants nobody knows how it got there. TSA is invading pastures, vegetable fields, and conservation areas displacing other vegetation and forming impenetrable thickets in some areas. In 1992 approximately 150,000 acres (60,700 ha) of grasslands were estimated to be infested and economic losses to Florida cattle ranchers at this time were estimated at US$11 million (or 1% of total state beef sales). In the early 2000s, the infested area has increased to more than one million acres (some 404,700 ha) of improved pastures, citrus groves, sugarcane fields, vegetable crops, sod farms, and woody areas. TSA also causes unquantified losses to vegetable growers (a sector worth some $1.7 billion annually in Florida) because six plant viruses are transmitted by insect vectors from TSA to cultivated solanaceous crops including tomato, potato and pepper.

Although probably first introduced into Florida by cattle importation from Brazil, the rapid spread of TSA in the southeastern USA and Puerto Rico is attributed to its large reproductive potential and easy dissemination by cattle and wildlife that ingest the fruits – seeds remain viable after passing through the digestive tract. Each TSA plant can produce more than 100 fruits and approximately 500 seeds per fruit during a growing season. Control efforts since the early 1990s have included chemical herbicides and mowing. However, these control tactics are relative expensive, provide a temporary solution, and may have negative effects on nontarget plants and animals.

A biocontrol programme searching for insects in the area of origin of TSA (Brazil, Argentina, Paraguay, Uruguay) was initiated by Dr Julio Medal of the University of Florida in 1977 funded by the US Department of Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS) and Florida Department of Agriculture & Consumer Services, and working in collaboration with Brazilian university researchers, and the USDA – Agricultural Research Service (USDA-ARS) South American Biological Control Laboratory (SABCL) in Hurlingham, Argentina. In exploratory surveys conducted in South America in 1994, Medal found the chrysomelid leaf beetle *Gratiana boliviana* on TSA plants in southern Brazil. A high level of specificity and significant defoliation of TSA were demonstrated in host specificity tests conducted at the Florida Biological Control Laboratory quarantine in Gainesville, the USDA-ARS-SABCL in Argentina, and the USDA-ARS quarantine in Stoneville, Mississippi, and in extensive field surveys and open-field tests conducted in South America. Finally, after 5 years of intensive plant feeding and oviposition tests, *G. boliviana* was approved (in May 2003) for field release in the USA to join the battle against the 'plant from hell'.

Initial field releases of the beetle began in August 2003 in Polk County, Florida, and since then approximately 45,000 beetles have been released in 20 counties in Florida, two counties in Georgia, two counties in Alabama, and one county in South Carolina. The beetles have established at all sites where they were released in 2003 and 2004 except in one location in north-central Florida because of the continued herbicide applications by the land owner. Evaluation of the defoliation effects of the beetles on TSA plants showed moderate defoliation (from 30 to 50%) at two of the monitored Florida release sites, and high defoliation (70 to 100%) at three of the monitored Florida release sites. Fruit production of TSA plants has been drastically reduced from an average 50–60 fruits/plant to very few small deformed fruits at two of the monitored release sites. The beetles dispersed on average 1.6 km (1 mile) per year from the initial release site in central Florida. The impact studies also included observations on possible nontarget effects, if any, on closely related plant species growing in the release area. Two years post-release, no nontarget effects have been observed on the closely related adventive species *Solanum capsicoides* (red soda apple), and *Solanum torvum* (turkey berry) that are growing in close proximity to TSA.

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Potential Use of *Trichilogaster acaciaelongifoliae* as a Biocontrol Agent of *Acacia longifolia* in Portugal

Acacia longifolia (long-leafed wattle) was introduced into Portugal from Australia over 150 years ago to curb sand erosion in coastal dunes and as an ornamental in the horticultural trade. The distribution of *A. longifolia* has increased greatly following successive fire events and it is now one of the worst invasive plant species along the Portuguese coast. Biological control is considered to be the most promising, economic and sustainable method for the control of *A. longifolia* in Portugal and will accord with IUCN (World Conservation Union) guidelines for the development of control campaigns to prevent loss of biodiversity due to invasive alien species (IAS). If specificity test results support its release this will be one of the first planned introductions of a classical biological control agent against an environmental weed species in Europe.

Work initiated 3 years ago, as part of the INVADER (Invasion and Ecosystem Restoration) research programme (www.uc.pt/invasoras) coordinated by the University of Coimbra (IMAR – Botany Department) in collaboration with Escola Superior Agrária de Coimbra and Institute for Nature Conservation, led to legal authorization for the introduction of *Trichilogaster acaciaelongifoliae* (an Australian gall wasp) into quarantine for host specificity tests on a defined list of plant species (www.uc.pt/invasoras/lista). The project has been conducted in close collaboration with entomologists at the University of Cape Town in South Africa who have considerable experience in biological control of invasive alien plants in general and with the use of *T. acaciaelongifoliae* for biological control of *A. longifolia.*

Trichilogaster acaciaelongifoliae is a bud-galling pteromalid wasp that prevents its host plant from flowering normally and deforms vegetative growth. The female wasps lay eggs on the young flower or vegetative buds which become galled when the larvae start to develop. This association drastically reduces the number of seeds produced by the plants and stunts vegetative growth. The agent is very efficient at exploiting its host plant, and seed production by *A. longifolia* has been reduced by more than 90% since the introduction of the wasp into South Africa in 1987.

Specificity tests in South Africa showed the wasp to be highly specialized and only able to exist in association with *A. longifolia* and a closely related species, *A. floribunda*. There have been no undesirable non-target effects since the release of *T. acaciaelongifoliae* in South Africa, although very occasionally stunted galls are observed on some of the other invasive Australian *Acacia* species. Additional specificity tests are being performed in Portugal to confirm that *T. acaciaelongifoliae* can be used with safety against *A. longifolia*. The genus *Acacia* does not include any native species in Europe but over 12 species have been introduced from other regions of the world, particularly Australia. Of these, *A. dealbata, A. melanoxylon, A. longifolia, A. retinodes* and *A. saligna* have become invasive in different regions of the continent.

In November 2005, a consignment of galls was received from South Africa and housed in a quarantine facility at Escola Superior Agrária de Coimbra. These galls were confined in emergence cages and the female *T. acaciaelongifoliae* adults that emerged were exposed to the test plants. The first phase of the experiments involves females confined on each of the plant species to be tested with closely observation to detect oviposition. Flower and vegetative buds are dissected to detect laid eggs. Species on which eggs are found will then be subject to development tests in quarantine and, if necessary, monitoring tests will be undertaken under natural conditions in South Africa where the wasps can be exposed to plants without the stresses induced by quarantine confinement.

The results so far have been promising but on-going experiments will need to continue to confirm the safety of the gall wasp and its efficiency for the control of *A. longifolia*. In the final phase, tests will be carried out with the agent confined in fine-gauze sleeves on test plants under natural conditions in Portugal. This experiment will only include plant species on which eggs were laid under quarantine conditions. At the same time the suitability of the climate for *T. acaciaelongifoliae* in different regions of Portugal will be analysed to determine the potential distribution of the wasp and its ability to cope with movement from the southern to the northern hemisphere.

In preparation for post-release evaluation studies on the impact of *T. acaciaelongifoliae* on seed production and vegetative growth, the reproductive and vegetative potential of *A. longifolia* in Portugal is being quantified before release of the wasps.

Trichilogaster acaciaelongifoliae is regarded as the most promising option for control of *A. longifolia*, one of the worst IAS in Portuguese coastal areas. It is hoped that the specificity tests will confirm that the wasp is sufficiently specific to be released in Portugal before the invasion problem becomes any worse.

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Can Biocontrol Clear Britain's Balsam Highways?

This summer, just like the last, landowners, anglers and water pursuit enthusiasts in the UK will be preparing to wage war on Himalayan balsam, *Impatiens glandulifera*. 'Balsam bashing', as it has come to be known, involves groups of people, sometimes volunteers, sometimes employees, working their way up an infested river bashing and pulling this precocious weed before it flowers and sets seed. Despite this effort it is debatable which side is winning. Few river systems in the UK are free from the weed, leading to British rivers being described as 'Balsam highways', and still the pungent sickly smell produced by the flowers lingers in the air in late summer.

As an invasive weed Himalayan balsam is highly effective. Belonging to the family Balsaminaceae, which contains some 850 species including many ornamentals favoured for their attractive, colourful and unusually shaped flowers, Himalayan balsam was first introduced to the UK in 1839, from its native range in the Himalayas. This, now the country's tallest annual, is displacing biodiversity and out-competing native species for light, space and resources. Armed with a highly effective dispersal mechanism, an aggressive growth rate and aided, in some cases, by human dispersal Himalayan balsam has spread rapidly throughout riparian systems and damp woodlands to occupy over 50% of the UK's 10-km recording squares, a grid system covering the UK which is used to map species distribution. Mainland Europe has similar problems with over 12 countries reporting Himalayan balsam as invasive and the weed is present and spreading in New Zealand, Canada and the USA. In the UK alone it would cost up to UK£300 million to eradicate the weed from the countryside.

Its ability to tolerate a range of soil types enables Himalayan balsam to invade not only waste ground, damp woodland and riverbanks but also vulnerable habitats including Sites of Special Scientific Interest (SSSIs) and national parks, bringing the plant in direct competition with rare species. Himalayan balsam has the highest nectar sugar content of any other European species, giving the plant a competitive advantage over native species. Indirectly, Himalayan balsam can successfully compete against natives for pollinators thus reducing the fitness of the native plants by reducing seed set and genetic diversity in the population. When the plant dies down in the autumn it leaves the banks bare of vegetation and increases the potential for bank erosion. Dead plant material can become incorporated into the water body adding to the flood potential.

Current control measures are often inadequate mainly because they are rarely attempted on a catchment basis. In the UK, in certain circumstances, with consent from the Environment Agency, glyphosate can be applied to stands of Himalayan balsam near water bodies. However, many countries in Europe strictly forbid the use of chemicals in or near water, leaving manual control as the only option. Manual control, when executed, can produce effective results, as the seed bank is relatively short lived, about 18 months. Unfortunately though, Himalayan balsam often grows in difficult to reach or inaccessible areas. With so many restrictions now placed on controlling weeds by waterways in Europe invasive species management must explore new possibilities including biological control.

Scientists at CABI are looking to begin a biological control programme against Himalayan balsam in 2006. Preliminary studies suggest that in its native range Himalayan balsam is attacked by an array of natural enemies including insects that feed on all parts of the plant. There is also clear evidence of pathogen damage indicative of the genus *Puccinia.* It is hoped that this suspicion will be confirmed soon in the field. A consortium of UK funders, including the Environment Agency and Network Rail, will fund parts of this project. The control programme will consist of a two-phased approach, which is now the normal procedure for a biological control programme. Dividing the work into distinct phases enables the first phase, the feasibility study, to be relatively cheap, compared to the second phase. The first phase will consist of an initial survey to the native range of the weed to collect potential agents which, if found, will be shipped back to CABI's quarantine facility in Ascot, UK for initial host range testing. A detailed report will also be commissioned which includes a full literature review and herbarium study. If potential agents are identified, and funding has been secured, the project will develop into a second phase, a full biological control programme. The second phase would consist of numerous surveys covering the whole native range of the weed and full host specificity testing. Only once an agent has passed all the tests, and host specificity has been confirmed, would it be recommended for release, but final authorization will depend on the risk assessment made by the local quarantine organization. Biological control is not expected to totally eradicate Himalayan balsam from the UK, but to reduce it to an acceptable level, where it is no longer a threat to biodiversity. When successful, a biological control programme can save countries millions in lost revenue and an unquantifiable figure in terms of ecosystem preservation.

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REBECA Explores European Biocontrol Agent Registration

Within Europe, current regulation requirements hinder market access to biological control products. The EU (European Union) Policy Support Action REBECA has been set up to seek balanced regulatory guidelines that will redress the accessibility problem while ensuring continued safety of biological control agents (BCAs) on the European market.

Biological control provides safe measures to control pests and diseases in agriculture, horticulture and forestry. Due to restrictions on the use of chemical pesticides and the development of pesticide resistance, growers suffer from the lack of effective control measures. Additional problems occur with the management of pesticide residues in horticultural crops which are continuously harvested. BCAs offer environmentally safe and effective alternatives. The EU market for beneficial invertebrates (IBCAs) like insects, mites and nematodes has rapidly increased during the last two decades surpassing an annual turnover of €125 million. A major reason for this growth is because most European countries have not regulated the use of IBCAs. Innovation was quickly transferred to the growers. As a consequence IBCAs have significantly contributed to the control of introduced pest species and have prevented major damage. Nonetheless, concerns about the safety of exotic IBCAs have now resulted in the development of guidelines to assess the safety and to regulate the use of IBCAs in many European countries. Yet regulation can easily exaggerate risks of IBCAs that have been used over the last two decades without causing any damage. The objective of the REBECA Action is to review current guidelines and propose a balanced regulatory system taking into account the low risks related to the use of IBCAs.

Microorganisms (bacteria, viruses and fungi), pheromones and plant extracts have always had to be registered according to EU directives. The procedures are based on rules originally developed for synthetic pesticides. Although the relevant EU directive (91/414/EEC) has been adapted to better meet the requirements of BCAs, registration is still time consuming, capital intensive and unpredictable. In contrast to the USA, where more than 59 microbials are registered and processing of the registration files usually lasts 2 years, European authorities have registered only five products within the last 7 years and national registration in the member states has yet to happen. Consequently only a small number of products are currently available on the European market and the biocontrol industry has stopped investment in new microbial products. In many cases the registration costs exceed the expected turnover, as the specificity of biocontrol agents limits their market potential. Consequently, low risk plant protection products are kept off the market.

The REBECA Action will review current European legislation, guidelines and guidance documents and compare them with legislation in countries where the market introduction of BCAs has been more successful. Potential risks of BCAs will be assessed and proposals be developed on how regulation of BCAs can be balanced according to their potential hazards. REBECA will form a network of all stakeholders from industry, science, regulatory authorities, policy and environment to provide the expertise and critical mass necessary to improve regulatory procedures for BCAs and spread knowledge and experience in regulation and safety of BCAs in Europe.

For more details on the REBECA Action please go to www.rebeca-net.de.

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Hand-Carrying to the USA

On 15 December 2005, the US Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ) rescinded the prohibition on moving biological control agents (as well as plant pests, federally listed noxious weeds, parasitic plants, bees, and earthworms) in personal baggage (i.e. hand-carrying), the bonded carrier requirement, and the requirement for inspection at the APHIS-PPQ inspection facility in Beltsville, Maryland. Current permit holders must request, in writing, an amended permit from APHIS-PPQ if they wish to hand-carry biological control agents from their place of origin to any port of entry in the USA and then hand-carry the organisms to any APHIS-approved quarantine facility within the USA. Amendments to existing permits require 5 to 10 working days for processing. Authorization to hand-carry will only be issued to citizens or permanent residents of the USA with a valid passport or permanent visa. Hand-carry authorizations will not be issued to foreign nationals or individuals with temporary visas. Authorization to hand-carry is not transferable and cannot be assigned to other individuals or organizations not identified on the permit. Requests to hand-carry are authorized based on factors that include risk of the organisms to agriculture and the environment, country of origin, and whether material was collected in the field or reared in the laboratory. Denial of a request to hand-carry will not prejudice the issuance of a permit for receipt of the organisms by other means.

Ten to 20 days prior to each hand-carrying event, the permit holder or designee must notify the PPQ Permit Compliance Officer by email or telephone to provide specific information on the hand-carrier's identity, the anticipated first port of arrival into the USA, the expected date and time of arrival, and flight number if travel is by airline. Customs and Border Protection (CBP) Agriculture Inspectors at the port of entry will document and facilitate the entry of organisms. Individuals carrying permitted organisms must present to CBP Agriculture Inspectors their US passport or visa, a copy of the PPQ permit authorizing hand-carrying including all applicable attachments, and a valid red/white shipping label issued to that numbered permit. Inspection by CBP Agriculture Inspectors must confirm that all hand-carried articles are securely packaged. In the event that a problem is detected, the CBP Agriculture Inspector may seize the package and require its movement to the nearest PPQ Inspection Station for processing or clearance. After CBP Agriculture confirmation and clearance through the first port of entry into the USA, hand-carried organisms must be transported directly to the containment facility authorized in the permit.

These policies and procedures became effective on 1 March 2006 and will surely make it easier to import natural enemies following foreign exploration.

The policies and procedures do not apply to the hand-carrying of living organisms passing in transit through the USA and its territories or possessions. Properly packaged organisms may be hand-carried by in-transit passengers because they do not pass through customs.

Persons in APHIS PPQ and their telephone numbers are listed on the website: www.csrees.usda.gov/nea/pest/in_focus/invasive_if_aphis.html

Stop Press! As part of the US Department of Agriculture's overall eGovernment initiative to transform and enhance the delivery of its programmes, services and information, on 3 April 2006 APHIS launched ePermits, a new electronic system to streamline the import process. This Web-based tool, which is being released in phases, allows the electronic filing, processing and tracking of permit applications. Submitting applications and receiving permits via the Internet will save customers a tremendous amount of time and effort. The current phase allows individuals to process permit applications on-line for certain plant protection and quarantine and biotechnology and regulatory services' notifications. Veterinary services is in the process of finalizing its system and plans to launch its ePermits section on 3 July 2006.

For more information on ePermits see: www.eauth.egov.usda.gov

Prosopis in Africa: No Miracle Solution

Following on from the *Prosopis* articles in the last issue, articles from Kenya and Ethiopia in this issue examine lessons to be learnt from the recent introductions of *Prosopis* to these countries, and their (actual or potential) positive and negative effects on livelihoods, while another from Egypt highlights its impact on biodiversity. Some of the content is depressingly familiar (e.g. lack of prior assessment, poor documentation) and underlines the importance of risk analysis for proposed agroforestry introductions. Given the experiences of South Africa and Australia (see previous issue), the outlook in these countries might not seem promising, and an examination of the socioeconomics of pastoral communities in the marginal lands typically affected by *Prosopis* in eastern Africa highlights the dangers of making sweeping generalizations about how to manage the tree. But as more is learnt about *Prosopis,* why problems emerge and how best to deal with them, all affected countries would benefit from this knowledge. In the Kenyan article, which also outlines a new research-based project, there is a call for improved coordination and information sharing through a *Prosopis* network. This would be of particular benefit to countries such as Egypt where long-term management options have yet to be identified. While not underestimating the obstacles ahead, the Kenyan and Ethiopian articles describe how these countries are taking a pragmatic approach to *Prosopis*, with stakeholders and communities working towards limiting further spread and integrating control (potentially including biological control) and utilization. A key message from the Ethiopian article is that *Prosopis* control is expensive, and will only be sustainable if utilization can contribute significantly to the cost, so the two are inextricably linked.

Prosopis in Kenya: Acquiring the Knowledge for Informed Management

Fuelwood shortages and land degradation problems in the arid and semi-arid areas of Kenya motivated the Government of Kenya and various development partners to promote the introduction of *Prosopis* species in the 1970s and 1980s[1]. The *Prosopis* species thought to have been introduced to Kenya include *Prosopis pallida* and/or related hybrids and *Prosopis juliflora* and/or related hybrids[2]. It is the latter group that has become such a concern. The benefits of *Prosopis*, including its ease of propagation, its rapid growth, and its use in the provision of shelter, fodder and fuel, were soon appreciated. As a consequence, people began to plant *Prosopis* extensively. Its rapid spread has been further facilitated by free ranging livestock and wild animals in its introduced range. These animals have proved to be very effective seed dispersers, eating the seed pods and spreading the seeds in their dung. This uncontrolled spread and negative traits such as the displacement of valuable indigenous flora, the formation of impenetrable thickets, its strong thorns, and pods that cause tooth decay in livestock limit its usefulness as fodder[3]. For many of Kenya's pastoralists yesterday's 'miracle tree' has been transformed into today's 'devil tree'.

Although not quantified, it is thought that *Prosopis* can now be found in about 50% of areas that are favourable for its growth in Kenya[2]. Without any doubt, *Prosopis* has become the most controversial introduced agroforestry species in Kenya. Once thought to be an unmitigated blessing, its apparently uncontrollable spread has recently raised a huge amount of concern in the country, where it is threatening the very existence of many local communities[4].

A recent investigation into the socioeconomic impacts of *Prosopis* in the Baringo District found that the tree's livestock-related impacts resulted in an average annual cost:benefit ratio of $US550:350 cash equivalent per person – a huge net loss in an area where average annual cash equivalent incomes are less than $1000 per person[5].

Conflicting views have made it difficult to find a clear consensus on the way forward for *Prosopis* management in Kenya. At one extreme, there have been widespread calls for its eradication from the country, though such a course of action is, for practical purposes, impossible. At the other end, as knowledge of its utilization increases by the day, many people feel *Prosopis* has been a net benefit[6].

In spite of the obstacles involved, the Government of Kenya, along with other stakeholders, is moving towards a consensus position. A national workshop on 'Integrated Management of *Prosopis* in Kenya' held at Soi Safari Club, Lake Baringo in October 2003 and attended by 66 participants from a variety of interest groups, agreed to adopt an integrated strategy for the management of *Prosopis* in Kenya[7]. Some of the key elements of such a strategy, identified at the workshop, included: policy and legislation changes (for example it is currently illegal to produce charcoal from *Prosopis*), increased utilization of *Prosopis*, and the consideration of a range of control options for *Prosopis* including biological control. An application has been made for the importation of a species of seed-feeding bruchid beetle, *Algarobius prosopis*, from South Africa (but originally from the southwestern USA) for pre-release testing by the Kenya Forestry Research Institute (KEFRI).

Utilization of *Prosopis* as a management tool has been tried in other countries and Kenya needs to learn from the experiences of these countries. For example, in South Africa, harvesting of pods and timber is impractical in many cases, because much of the *Prosopis*-invaded area is in remote, inaccessible and inhospitable parts of the country. Many of the enterprises that have been initiated, often with public funds, have failed because of the unavailability of suitable logs and because of high transport costs. In South Africa all utilization projects and other control methods that have been attempted have not had a noticeable impact on the weed and invasions have continued unabated[8].

Experiences from Australia and South Africa show that the use of biological agents such as seed feeders alone will not solve the *Prosopis* problem. The seed feeders may, however, play an important role in long term integrated management of *Prosopis* by reducing the seed load. It is likely, therefore, that their principal impact would be to reduce the rate of spread of *Prosopis*. This could significantly reduce a species' potential for negative impacts while it is still localized, but not when it has occupied so much of its potential range, as is the case in Kenya today. It would appear to be important to consider the introduction of seed feeders at the onset of agroforestry programmes, when there are indications that the introduced plant species will become invasive[9].

The example of *Prosopis* in Kenya illustrates a common concern relating to agroforestry introductions. In common with many such introductions, no form of risk analysis was undertaken beforehand, resulting in the indiscriminate planting of an indeterminate species in many of the most marginal parts of the country. If such an analysis had been performed, it is almost certain that only *P. pallida* of known provenance would have been introduced to Kenya and that *P. juliflora* would not have been introduced at all.

The situation today is somewhat different. In 1996, the government established the Kenya Plant Health Inspectorate Service (KEPHIS). All imports of plant material are now regulated by KEPHIS in line with the International Plant Protection Convention (IPPC), which recommends the undertaking of weed risk analysis for plants to be considered for introduction.

Prosopis species are difficult to identify[10] and hybridize readily[11]. These traits, together with the poor documentation of the *Prosopis* introductions to Kenya, underpin the need to conduct systematic studies to clarify the taxonomic composition of the *Prosopis* population in the country. This is not an academic exercise, as species and hybrid identity strongly influence invasiveness[12].

In order to understand the invasiveness of *Prosopis* in Kenya, CABI, together with local and international partners, is conducting research to answer some fundamental questions such as the following:

- What is the current extent of the *Prosopis* invasion in Kenya?
- What are the spatial dynamics of *Prosopis* spread and what areas are susceptible to future invasion?
- What is the species composition of *Prosopis* in Kenya, and how does inter- and intra-specific hybridization and variation influence invasiveness?
- What is the effect of the *Prosopis* invasion on key biodiversity components and what is the potential for the utilization of local insects and diseases associated with *Prosopis* in an integrated management programme?

The distribution mapping, and climate matching modelling, will allow the identification of areas that are susceptible to invasion but are hitherto only lightly infested or not infested at all. Management measures aimed at the initial and most effective stages of the invasive species management hierarchy (i.e. prevention and early warning and rapid response to new infestations) can be implemented in these areas.

Determining the possibility of a link between taxonomy and invasiveness in *Prosopis* will stimulate further research into the nature of this link and will help to ensure that taxonomic considerations are given due prominence in any *Prosopis* management efforts.

If promising biological control agents are found to exist in Kenya already, it may be possible to enhance their impacts by measures such as environmental manipulation or inundative release. If this potential does not exist, or is insufficient by itself, then strategies involving classical biological control may need to be considered.

The broader biodiversity survey work will quantify how the *Prosopis* invasion impacts upon key biodiversity components. This will increase our knowledge of invasion biology, and help to shape investigations into the functional consequences of changed community patterns resulting from biological invasions.

The concerns generated by *Prosopis* in Africa in recent years have generated a lot of work involving many institutions. This work has often been conducted in isolation, with insufficient sharing of knowledge and coordination between the individuals and institutions involved. One way of improving coordination and information sharing would be the creation of a Pan-African *Prosopis* Working Group, involving stakeholders from Kenya, Ethiopia, South Africa and other African countries. The working group could act as a knowledge hub, assisting the dissemination and integration of the large body of knowledge that exists on *Prosopis*, for the improved future management of the species in the continent.

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Current Status and Future Prospects for *Prosopis juliflora* in Ethiopia

Prosopis juliflora, probably introduced to Ethiopia in the 1970s, is spreading at a rapid rate in the arid and semi-arid east of the country with a number of extremely negative social, economic and environmental consequences. There is a widespread agreement that something must be done about *Prosopis* in Ethiopia and in spite of conflicts of interest, a consensus is emerging. This article documents the introduction and spread of *Prosopis* in Ethiopia, its impacts, the biological and socioeconomic factors that have contributed to its invasiveness in Ethiopia, and current and proposed future management actions to limit its spread and negative impacts.

Introduction and Spread

Precise details of the introduction of *Prosopis* to Ethiopia, such as the dates of introduction, planting locations, responsible authorities, type of germplasm and its provenance, were never formally documented. One recent written account refers to the recollections of local people from the Amibara District of the Afar Regional State, who stated that *Prosopis* was introduced in the early 1970s through the Middle Awash Irrigation Project[1]. Local elders of the Afar community expressed their willingness to allow seedlings to be planted in areas under their jurisdiction, after being shown *Prosopis* seedlings and told of the benefits of the tree: as a windbreak to protect citrus and cotton fields, as a means of ameliorating the harsh climate of the area, and as a source of livestock feed. *Prosopis* was planted over large areas of Ethiopia until the late 1980s, and some planting still continues but not on the same scale as before.

Work carried out by the Ethiopian Institute for Agricultural Research (EIAR; formerly known as the Ethiopian Agricultural Research Organization, EARO) and the Henry Doubleday Research Association (HDRA), UK has confirmed that the species commonly found in the east of Ethiopia is *P. juliflora*[2].

The Amibara District, the putative starting point for the spread of *Prosopis* in Ethiopia, is located in the Middle Awash Basin of the Afar Regional State, 280 km east of Addis Ababa. It represents a degraded semi-arid acacia bush-land ecosystem, with a mean maximum temperature of 42°C and a mean annual rainfall of 564 mm. The district is mainly characterized by pastoralist farming systems with extensive areas of communal rangelands. Cattle, camels, goats and sheep are the principal livestock. There are also a few commercial farms in the locality, growing mostly cotton under irrigation.

Since the mid 1980s *Prosopis* has spread rapidly in eastern Ethiopia, from the Middle Awash Valley into the Upper Awash Valley and Eastern Hararghe. It is now common, not only in the type of semi-arid rangeland habitat into which it was first introduced, but in a variety of other habitats including large-scale farms, and riparian zones. Quantitative assessments of the area covered by *Prosopis* and its rate of spread have not been undertaken in Ethiopia, though it has been estimated that *Prosopis* now covers 15,000 ha of land in the Amibara District[3]. Even in the absence of precise figures, it is clear from all accounts that the spread of *Prosopis* in Ethiopia has increased in the last decade, both in terms of areal extent and plant density[1,2,3,etc].

Negative Impacts of Prosopis juliflora

There have been widespread calls for the eradication of *Prosopis* from Ethiopia in spite of the fact that this option is no longer practically possible[3]. The *Prosopis* situation has been debated in the national parliament and several articles have appeared in the national press which describe *Prosopis* using emotive epithets such as the 'devil tree'[4]. The principal reason for these outcries is the reduction in rangeland carrying capacity, and the consequent severe impact on the livelihoods of thousands of pastoralists that have followed *Prosopis* invasion. Desirable native multipurpose trees, such as *Acacia nilotica* and *A. tortilis*, and native pasture grasses, have been displaced by *Prosopis*, which forms very dense, thorny, almost impenetrable thickets that severely impede access by people and their livestock. The leaves of *P. juliflora* in Ethiopia are unpalatable, in contrast to the *P. juliflora* lines introduced to some countries. Other negative impacts on livestock include physical injury from *Prosopis* thorns. According to many local people, more cattle have died because of *Prosopis* in recent years than through drought[3].

Other reported negative impacts of *Prosopis* include the following: wounds and subsequent infections in people from the sharp thorns; the frequent colonization of irrigation canals by *Prosopis*, limiting the visibility and accessibility to them for supervision and maintenance, resulting in flooding hazards and wastage of irrigation water through seepage; increased populations of mosquitoes; increased rodent populations (who feed on *Prosopis* pods) leading to additional pest problems and further reductions in the densities of desirable grass species; and reduced water availability due to a presumed *Prosopis*-induced lowering of the water table[3].

In most cases, land invaded by *Prosopis* is simply abandoned, increasing the pressure on the already scarce land that has not yet been colonized by *Prosopis*. Commercial farms affected by *Prosopis* have been able to clear it from their land but must do so continually and at great expense. Between 2001 and 2004, one large commercial cotton estate in the Middle Awash Valley spent an average of some US$200 per hectare per year on *Prosopis* clearance, through a combination of bulldozing, manual clearance and burning[3]. The authorities also have to spend considerable sums on clearance along irrigation canals. In many cases the expense has proved too great and irrigation canals have become overgrown with consequences as outlined above[1].

Benefits of Prosopis juliflora

Although dramatically outweighed to date by its negative impacts, there have been some benefits from *Prosopis* in Ethiopia. It is a useful shade tree; it is used for fence and house construction where other more favoured trees are absent; and it is used as fuelwood and for charcoal making (though this practice is illegal – see below). Charcoal made from *Prosopis* is less valuable than that made from indigenous acacia trees (US$1.7/sack and US$2.3/sack, respectively, at 2004 prices and the June 2004 exchange rate of US$1 = 8.6 Ethiopian Birr)[3], but can be a significant source of income. Charcoal makers who made charcoal from *Prosopis* earned an average of US$72 per month from this source – a significant sum in country in which 82% of individuals live on less than one US dollar per day.

Prosopis has the ability to grow in highly saline soils. Certain irrigated areas in eastern Ethiopia have been associated with a rising water table and consequent increasing soil salinity. *Prosopis* has helped to reduce soil salinity and the water table, thus increasing the potential of the land[5]. As outlined above, similar processes operating in different locations can have negative consequences. Other reported benefits of *Prosopis* include those associated with nitrogen fixation, although the degree to which this benefit is felt at a landscape level is unclear.

Reasons for the Invasiveness of Prosopis juliflora in Ethiopia – the Case of the Amibara District

Prosopis juliflora has become highly invasive in Ethiopia in a relatively short period of time. This could be for a combination of reasons including the agroecology of the environment into which *Prosopis* has been introduced, the intrinsic invasiveness of the species, the biology of the particular genotype of *P. juliflora* introduced, policy and institutional issues and a range of other socioeconomic factors. These possible influences are discussed below in relation to the Amibara District, the putative first site of introduction of *Prosopis*, and the area in which much of Ethiopia's *Prosopis*-related research has been undertaken to date.

Degraded Rangelands

Like most of the rangeland in the semi-arid areas of Ethiopia, that in the Amibara District is extremely overgrazed. Highly variable rainfall, many generations of continuous grazing, population pressure and cultures that measure their wealth in terms of numbers of cattle possessed, are among the factors responsible for this degradation. *Prosopis* is well adapted to invade degraded areas for a variety of reasons including the following: its high germination rate under a wide range of temperature and moisture conditions, increased seed germination after being eaten and dispersed by mammals, rapid root system development, abundant production of seeds with extreme longevity and high viability, marked drought tolerance, grazing-resistant foliage, and capacity of young plants to sprout/coppice and regenerate following stem and root damage.

Increasing *Prosopis* densities have resulted in growing rodent populations feeding on *Prosopis* pods. Rodents, in turn, contribute to a drastic reduction in the densities of desirable grass species[1], further facilitating *Prosopis* invasion.

Vectors

Livestock (mainly cattle, camel and goats) are in most cases free and wide ranging. Together with wild animals (e.g. warthogs and porcupines), they are the major dispersal agents for *Prosopis*. Long distance dispersal is achieved through the movements of nomadic pastoralists. Other dispersal pathways include irrigation and flood waters.

The Prosopis juliflora Line Introduced to Ethiopia

In common with many *Prosopis* introductions into Africa and Asia, the Ethiopian population of *P. juliflora* has subsequently shown a number of undesirable traits that have limited its acceptance and use, therefore accentuating its invasiveness. Some of these traits have also directly enhanced the plant's invasiveness, including: its short stature and spreading and multi-stemmed growth habit resulting in its ability to coppice at high density producing dense, impenetrable thickets that impose physical barriers to human and livestock movement; the ability of damaged surface lateral roots to rapidly develop sucker growth; the unpalatability of *Prosopis* leaves to camels, goats and cattle; the long, strong and sharp thorns that damage the hooves and skin of domestic animals such as camels and goats; and the low digestibility of the unprocessed pods and leaves.

Lack of Knowledge of Utilization Possibilities

A lack of knowledge about how to best utilize *Prosopis* in Ethiopia has further accentuated its invasiveness[6]. As outlined, the tree is used for fuel, charcoal making and construction purposes but these uses could be considerably expanded. Other activities, such as pod processing for flour and for animal feed are practically non-existent.

Legislation and Policy

There are gaps, overlaps and inconsistencies in existing policies, regulations, strategies and institutional arrangements concerning invasive species in Ethiopia. For example, *Prosopis* is acknowledged as a threat to biodiversity resources under the Ethiopia Forestry Research Strategy, while *Prosopis* planting is being recommended as a means of controlling desertification under the National Plan to Combat Desertification[7]. Prohibitions on the cutting of trees for charcoal production in the Afar Regional State apply to both native species and *Prosopis*.

Cultural Norms

The making of charcoal is against the norms of the Afar people, one of the main groups impacted by the spread of *Prosopis* in Ethiopia. It is usually the highlanders who make charcoal in the Afar National Regional State. The charcoal makers frequently cut not only *Prosopis* but also valuable native trees that are meant to be conserved[3], further increasing the opportunities for *Prosopis* to expand its range.

Shortage of Labour

It is easy to assume that labour-intensive solutions have the potential to successfully manage invasive plant populations such as *Prosopis* in Ethiopia. With an average family size of eight in the *Prosopis*-affected areas of the Amibara District, for example, labour would appear to be an abundant resource. However, in the Afar pastoralist communities, males in their late teens, twenties and early thirties look after the livestock. This takes up a great deal of time. In addition, there are frequent conflicts between the Afar and Somali people over rangeland. This often leaves only women, children and the elderly in the homesteads. Individuals in these groups are not usually strong enough to clear *Prosopis*-infested land[3].

Solutions to the Prosopis Problem in Ethiopia

Most *Prosopis* management actions to date have been initiated by individual operators (such as the control efforts in commercial estates and along major irrigation canals outlined above) or at the community level. An example of the latter approach is that adopted by the Afar people from Angelele, a part of the Amibara District where *Prosopis* is present but at very low densities. Having observed the damage done to neighbouring areas, the people of Angelele have undertaken a *Prosopis* prevention campaign. By-laws that require every individual to uproot a seedling of *Prosopis* immediately they see it have been passed. Another means of avoiding importing *Prosopis* is to control the movement of livestock from *Prosopis*-infested areas. The community is determined not to buy livestock from such areas and they would prefer to sell their animals at a low price rather than return with them from the local market, which is located in a highly infested area[3].

Actions such as these, if adopted on a large scale and in a concerted manner, offer possibilities for limiting the spread of *Prosopis*. In addition, management measures are also needed in areas that are currently severely infested by *Prosopis*.

EIAR has produced a proposal for a pilot programme for the management of *Prosopis* in the Amibara District, with the objectives of: preventing its introduction into currently weed-free areas; eradicating it from less infested areas; and minimizing the impact of the species in highly infested areas[8]. The programme is to be conducted under the UNEP/GEF (United National Environment Programme/Global Environment Facility) project 'Removing Barriers to Invasive Plant Management in Africa'. EIAR is the National Executing Agency, with CABI the principal International Executing Agency, supported by IUCN (The World Conservation Union). The project is being undertaken in four countries in Africa: Ethiopia, Ghana, Uganda and Zambia. The goal (development objective) of the project is 'to conserve globally significant ecosystem, species and genetic diversity in Africa' and its purpose (immediate objective) is to remove barriers to the management of invasive species through effective implementation of the Convention on Biological Diversity (CBD) Article 8(h) in four countries in Africa. This will be achieved through the implementation of interlinked activities under four project components relating to: (i) enabling policy and institutional environment, (ii) information and awareness raising, (iii) invasive species prevention and management, and (iv) capacity building. The EIAR proposal will be used as a basis for the production of a detailed *Prosopis* management plan for Amibara in 2006. The plan, formulated in consultation with stakeholders at local and national level, will be implemented under the UNEP/GEF project, which will run from 2006 to 2010.

Under the EIAR proposal, those areas suitable for *Prosopis* would be classified as *Prosopis*-free areas (zone 1), areas with low level *Prosopis* infestation (zone 2) and areas with high levels of *Prosopis* (zone 3). Activities undertaken in zones 1 and 2 would relate to awareness raising, the establishment of community based rules and regulations (along the lines of those currently being implemented in Angelele), regular surveillance and the eradication of new infestations and the application of preventive measures.

Activities undertaken in zone 3 would include intensive control and restoration activities in addition to the measures undertaken in the other zones. The major challenge will be to make such activities sustainable. Sustainability can only be maintained if clearance costs can be met. Labour costs for the initial clearance of *Prosopis* alone from infested land in Amibara were between US$175 and US$233 per hectare in 2004[3]. This would translate into an estimated cost of US$2.6–3.5 million for a single clearance of the *Prosopis*-infested land in Amibara. Although such abstractions are simplistic they serve to illustrate the fact that if clearance costs are to be sustainable, they must be met, at least in part, through increased utilization of *Prosopis* for income-generating activities. EIAR are proposing that options for control by utilization are piloted in the UNEP/GEF project. Options could include the use of *Prosopis* for charcoal, fuelwood and briquettes, furniture, timber and plywood production, and the collection and processing of pods for food and fodder.

Biological control has a potential role to play in an integrated management package for *Prosopis* in

Ethiopia. However, the release of agents against *Prosopis* is likely to be some years away because of the legislative environment, potential conflicts of interest and limited national capacity in biological control.

Ethiopia has yet to undertake a classical biological control release[9], although the country's weed management community has long appreciated the potential value of biological control as a part of an integrated management programme for certain invasive species[10]. A proclamation on the importation of biological control agents into Ethiopia was drafted in 2000, though it has yet to be formally approved by government[7]. In spite of this, a limited number of proposals for the importation of biological control agents for research purposes have recently been accepted by the authorities in Ethiopia. These approvals are for species for which conflicts of interest are minimal (e.g. the importation of *Pauesia juniperorum* against the cypress aphid *Cinara cupressivora*). The procedure for the granting of an equivalent approval for a *Prosopis* biological control agent is likely to be a highly complex process. In addition, current capacity and facilities for the rearing and host range testing of biological control agents in Ethiopia is limited. It is likely that the work related to the currently approved requests and those in the pipeline will utilize all national capacity in Ethiopia for the next few years.

Discussion

The impact of *Prosopis* on the pastoral communities of eastern Ethiopia represents a catastrophe for a country that has suffered more than its fair share of disasters in recent decades. Like most such disasters, this one was avoidable. Although undertaken with the best of intentions, it is clear with the benefit of hindsight that the introduction of *P. juliflora* to Ethiopia was ill considered. The lack of consideration given to either the germplasm being introduced, or the ecological, socioeconomic and cultural context into which it was introduced, was commonplace 30 years ago. Such mistakes should not be repeated. Mandatory risk analyses for all proposed introductions of 'miracle trees' would go some way towards making sure that history does not continue to repeat itself.

A thorough risk analysis, while helping in minimizing the risk associated with new species introduction, does nothing to deal with the negative consequences of previous introductions. Once a species has been introduced, we must seek ways in which positive net outcomes can be optimized. In the case of *Prosopis* in Ethiopia, strident calls for eradication are likely to go down well with the affected communities in the short term. However, within a few years, community support is likely to diminish if it is clear that the promises of eradication cannot be kept, and this will almost certainly be the case. More realistic is an integrated management programme that investigates all possible means to manage *Prosopis*. Such a programme will not be sustainable unless a significant proportion of the removal costs of *Prosopis* can be met through its utilization. This is a challenge to the invasive species community, many of whom are accustomed to seeing only the negative aspects of species such as *Prosopis juliflora*.

[1]Zewdie K., Lemma, Y. & Kikus, O. (2005) *Prosopis juliflora*: potentials and problems. *Arem* **6**, 1–9.

[2]Sertse, D. & Pasiecznik, N.M. (2005) *Controlling the spread of* Prosopis *in Ethiopia by its utilisation.* HDRA, Coventry, UK.

[3]EARO (2004a) *Socio-economic impact and baseline control conditions for parthenium, prosopis and water hyacinth at pilot sites in Ethiopia.* Report submitted to the CAB International Africa Regional Centre under the PDF-B phase of the UNEP/GEF project: Removing Barriers to Invasive Plant Management in Africa. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia.

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[10]Gebremedhin, T. & Parker, C. (1987) The potential for biological control of weeds in Ethiopia. In: *Problems and priorities for weed science in Ethiopia.* Proceedings of the First Ethiopian Weed Science Workshop, Addis Ababa, Ethiopia.

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Community-based Management of Invasive *Prosopis juliflora* in Egypt

This article by Usama F. Ghazaly (Elba protectorate ranger, Egypt) is reproduced with permission from the January 2006 issue of the GISP (Global Invasive Species Programme – www.gisp.org) newsletter[1].

Prosopis juliflora is the most serious invader in the southeast corner of Egypt. Introduced to the area by the local community of the Halaib region in the 1980s for agroforestry and charcoaling purposes, it subsequently spread rapidly, especially after a period of heavy rain in 1996. The success of *Prosopis* species as invaders is largely attributable to the massive number of seeds produced – about 60 million per hectare per year according to some references – and water plays a major role in their dispersal, particularly during floods.

On a more local scale, livestock also disperse the seeds after feeding on the pods. In this case, however, camels moving along the border between Egypt and Sudan helped spread the seeds over more than 1000 km^2. Within this area there are three main *Prosopis* populations, but most of the invaders are concentrated in the Halaib region.

The area of invasion falls within Egypt's largest and most important protected area, the Elba Protected Area (PA), which encompasses some 35,600 km^2. It contains an enormous variety of habitats and landscape features, ranging from coral reefs to mountain habitats, and supports a rich flora and fauna. There are at least 27 species of mammals, 38 species of reptiles and amphibians, and some 60 species of breeding bird. Furthermore, the region is situated on internationally important migration routes for soaring birds, in particular for birds of prey.

One of the most prominent features of the area is Gebel Elba (Elba Mountain). Due its closeness to the sea and its interception of moisture-laden northeast winds, Gebel Elba enjoys a higher precipitation than other Red Sea Mountains. The summit is a 'mist oasis' where much of the precipitation is contributed in the form of dew, mist and clouds, creating a unique and rare ecosystem not found anywhere else in the country. Indeed, Gebel Elba is a 'biodiversity hotspot', with a biological diversity unparalleled in any other terrestrial environment in Egypt. The relative abundance of moisture supports a diverse flora of some 458 plant species – almost 25% of plant species recorded for the entire country. Many Afrotropical elements have their northern limits at Gebel Elba, and the dense cover of acacias and other scrubs represents the only natural woodland in Egypt.

Prosopis poses a threat to the Elba PA's biodiversity, and negatively impacts ecosystem functioning and catchment hydrology. It has also had a secondary effect in that the dense thickets have displaced livestock, resulting in more intense grazing pressure in other parts of the protected area. The species has spread into all habitats, from salt marshes on the Red Sea coast in the east to desert plains in the west, and makes up about 40% of the plant community in the Halaib area.

A monitoring programme for *Prosopis* was completed in 2004, after which the Elba PA's rangers embarked on a control programme with the participation of the local community. To date, only mechanical methods have been used, the trees being felled and the rest of the stem and roots burned. Follow-up work is conducted and GIS techniques are used for continuous monitoring of the area of invasion. These control efforts are seen as a temporary solution, which will at least help conserve natural resources until the best way of exploiting this species within a sustainable and integrated management approach has been identified.

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www.gisp.org/publications/newsletter/GISPnewsletter5.pdf

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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. Once again, there is biopesticide news to report.

Mycoherbicide Hope For Hydrilla Biocontrol

Hydrilla (*Hydrilla verticillata*) is a submersed aquatic plant introduced to Florida in the 1950s via the aquarium trade, but it has now become one of the worst water weeds of lakes, rivers, canals and other water systems across the southern USA and in Atlantic and Pacific coast states. Its dense mats often dominate water bodies, and can clog drainage and water-intake systems, impede boating and degrade fish and wildlife habitat. A mycoherbicide, currently in the development stage, may provide another option in an integrated control strategy for the weed.

The history of attempts at hydrilla's biological control stretches back some 35 years and involves surveys in many parts of the weed's purported native Old World and Australian distributions (its centre of origin remains uncertain, and there may have been multiple introductions into the USA through the aquarium trade). A number of introductions have been made of *Bagous* spp. tuber weevils from Pakistan (which did not establish) and *Hydrellia* spp. leaf-mining ephydrid flies from Australia (which did), but the weed remains problematic.

Herbicide spraying is currently the main means of hydrilla control, but few herbicides are registered for this use. Prolonged use of one of the most effective, fluridone, has led to the development of resistant hydrilla strains, which increases treatment costs and impacts performance.

The need for new approaches to integrate with chemical control led to an assessment of the potential of pathogens. Judy Shearer (US Army Corps of Engineers [USACE], Army Engineer Research and Development Center [ERDC], Vicksburg, Mississippi) identified *Mycoleptodiscus terrestris* as a promising candidate for an inundative approach. The fungus is commonly isolated from hydrilla and another aquatic weed, Eurasian watermilfoil (*Myriophyllum spicatum*) throughout the USA and was also found on watermilfoil during surveys in China.

Since 2000 she and Mark Jackson (US Department of Agriculture – Agricultural Research Service [USDA-ARS], National Center for Agricultural Utilization Research [NCAUR], Peoria, Illinois) have collaborated on developing a strain of the fungus from Texas. They developed a defined laboratory medium and techniques for growing and harvesting the fungus. A unique feature of their medium was that it caused the fungus to produce microsclerotia (survival structures comprising minute, filamentous clumps) in broth culture.

Microsclerotia allow a fungus to survive adverse conditions, and can potentially increase the shelf life of a product as they enable the fungus to withstand the rigors of drying and prolonged storage better than spores. The *M. terrestris* microsclerotia can be harvested and dried to about 5% moisture level. Shearer and Jackson also found that when the microsclerotia were rehydrated they germinated within 24 hours and produced asexual spores within 3 days, although the fungus does not sporulate on standard laboratory media. When dusted onto potted hydrilla in aquarium trials, the microsclerotia reduced plant above-ground growth by 99%. The product is also compatible with fluridone at low doses, and the combination treatment was more effective than the fungus or the herbicide used alone.

In May 2003, US Patent No. 6,569,807 was granted, which covers not only the fungus studied, but any fungus that produces microsclerotia in broth culture and can be used for aquatic plant control. In December 2005, USACE and USDA-ARS jointly signed a patent licence agreement with SePRO Corporation, Carmel, Indiana covering the formulation techniques. Mark Heilman of SePRO is now collaborating with the team to try and commercialize the fungus as a biological herbicide. A crucial step is the formulation of the fungus. Research at NCAUR is currently focused on evaluating polymer coatings for the microsclerotia and assessing whether any of them can enhance performance in aquatic environments. Once the best formulation is determined, the mycoherbicide will undergo larger-scale testing at ERDC and SePRO.

Sources: Suskitz, J. (2006) *Scientists mobilize fungus to fight hydrilla*. Press release.
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University of Florida Aquatic, Wetland and Invasive Plant Information Retrieval System
http://aquat1.ifas.ufl.edu

Leach, S. (2006) ERDC's Environmental Lab signs patent license agreement. *The Corps Environment* **7(2)**, April 2006.
http://hq.environmental.usace.army.mil/Corps_Environment/vol7_no2.pdf

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.

Rice Hispa Parasitoids

A guide to the common insect parasitoids of the rice hispa (*Dicladispa armigera*) in Bangladesh has been published[1]. The publication is one of the outputs of a 3-year research projected funded by the UK Department for International Development (DFID) on the ecology and management of the pest. This was a collaborative project including the Bangladesh Rice Research Institute (BRRI) and Department of Agricultural Extension (DAE), CABI, the Natural Resources Institute (NRI) and Imperial College London in the UK, and the International Rice Research Institute (IRRI) in the Philippines.

The guide provides an illustrated key to five species of parasitoids identified during the project as playing an important role in reducing populations of the beetle, which is a serious threat to rice production in the country. The parasitoids include four primary parasites of eggs or larvae and one probable obligate hyperparasioid. Notes on characters for recognition, biology, synonyms and distribution are also given for each species.

[1]Polaszek, A. (2005) *Identification guide to the common insect parasitoids of the rice hispa in Bangladesh*. BRRI, Gazipur, 10 pp.

Contact: Entomology Division, Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh.

Leafminer Factsheet

A factsheet on the invasive alien pest species of leafminers (*Liriomyza* spp.) is now available on the Global Potato News website at: www.potatonews.com/leafminers/australia.asp

Also, published papers/reports on leafminers and their parasitoids are sought to update the global information database CD-ROM.

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California Biocontrol Conference

The Fifth California Conference on Biological Control (CCBC V) is being held on 25–27 July 2006 in Riverside, California. It will start with a pre-conference gathering to discuss regulatory issues with USDA-APHIS pertaining to the importation and movement of natural enemies in the USA and legislation modifications to accommodate biological control in the post 9-11 anti-terrorism era, followed by two days of sessions covering the following topics:

- Citrus and biological control. Yesterday, today and tomorrow
- Risk assessment and weed biological control
- Urban forestry – a tribute to Dr Donald Dahlsten
- Biological control in the urban environment

Web: http://nature.berkeley.edu/biocon/

South American Whitefly Manual

'The biology and management of the whitefly *Trialeurodes vaporariorum* in string and field beans: a technical manual' is now available for agronomists and technicians in Latin America. Likewise, three primers on this worldwide persistent pest, written for farmers in Bolivia, Ecuador and Colombia, have also just been published.

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USDA National Agricultural Library

The National Agricultural Library (NAL) has established an online digital repository providing convenient public access to the full text of selected US Department of Agriculture (USDA) publications. NAL is part of the Agricultural Research Service (ARS), USDA's chief scientific research agency. The NAL Digital Repository (NALDR) contains a wide variety of publications that have been digitized. See: http://naldr.nal.usda.gov/

A quick search on 'biological control' turned up a publication on fungus diseases of grasshoppers in the USDA Yearbook for 1901, and another on San José scale in the 1902 volume.

Conference Report

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

US Fifth National IPM Symposium

Over 650 people gathered in the Gateway City of St. Louis to share innovations that lead to a safer food supply, enhanced human health, and an improved environment. The Fifth National IPM Symposium, 'Delivering on a Promise' was held on 4–6 April 2006. With 23 countries represented, the theme of the event examined the historical, biological, technological, economic, and social facets of IPM in order to look inward and see if IPM has been meeting the expectations of goals set forth in the past.

Nine plenary session presentations addressed an historical overview of IPM, the future of IPM, results with collaboration, consumer insights on pesticides, incorporation and adoption of IPM by international production and distribution companies, the concept of precautionary pest management, and IPM in a globalized world. Thirty mini-symposia focused on IPM in soyabeans, cotton, greenhouses and urban settings, water and air quality, biological control, and education. International partnerships, outreach, and IPM in ornamentals, vegetables, turf, and urban environments were the general topics of 36 workshops. Pesticides, extension education, and specific IPM cases were discussed in nine roundtable sessions. Over 170 posters displayed a diversity of ongoing projects worldwide in North America, Central America, and the Pacific region.

A key event at the Symposium included the presentation of the first ever National IPM Achievement Awards. There were 25 award nominations from four countries, and all of them demonstrated effective IPM practices and programmes that deliver economic, health and environmental benefits. The National IPM Achievement Award winners are:

Glades Crop Care, Inc., Jupiter, Florida

Glades Crop Care has provided scouting and consulting services for over 30 years in the southeastern USA and the Caribbean Basin. Above and beyond crop consulting services, Glades Crop Care has conducted independent and collaborative research in all areas of pest management on some of the most intense and quality conscious crops. Glades received the IPM Achievement Award because they are always innovative while building new partnerships

in the private and government sectors. Glades Crop Care is a recognized leader in IPM, from their implementation of standard IPM practices to developing their own solutions to integrate management approaches to limit high risk pesticides through the reliance on biological intensive IPM.
Web: www.gladescropcare.com/

Hawaii Area-Wide Fruit Fly Integrated Pest Management Program (HAW-FLYPM)

This programme includes representatives from the US Department of Agriculture, University of Hawaii, and the Hawaii Department of Agriculture. The HAW-FLYPM Program pioneered IPM techniques for the area-wide control of four fruit fly species using pilot locations on three of Hawaii's farming islands. The programme uses a '1-2-3' approach consisting of population monitoring and traps, field sanitation, and protein bait sprays. The HAW-FLYPM Program also integrates the use of population suppression (male annihilation, sterile release, and biocontrol strategies), education and training for both residential homeowners and farm growers. This core team of project leaders from the state and federal governments created and implemented a comprehensive pest management programme which is environmentally acceptable, biologically based, and sustainable for the control of four different fruit flies. The group has had an immediate and far-reaching impact on Hawaii's agricultural community using technologies that are easily transferable to other regions.
Web: www.fruitfly.hawaii.edu/

Integrated Pest Management Program, City and County of San Francisco, California

The City of San Francisco's IPM Program has pioneered aggressive and creative strategies to reduce pesticide use through deployment of a suite of innovative pest management strategies in city parks, buildings, the port, airport and municipal golf courses over the last 10 years. Both Chris Geiger and Deanna Simon have pioneered a number of innovations for IPM that has reduced the city's total pesticide use by more than 70% as of March 2006. Implementation is conducted through regular trainings and workshops, a newsletter, monthly meetings of the end-user group, and collaborative partnerships with universities, non-profit organizations, and industry and government entities. The IPM Program for the City and the County of San Francisco has proven itself a leader among municipal IPM programmes throughout the USA.
Web: www.sfenvironment.com/aboutus/innovative/ipm/

Dr Marc Lame, Indiana University's School of Public and Environmental Affairs

Dr Lame has been a leader in school IPM for over a decade. His work, known as the Monroe IPM Model, has been implemented in schools in Indiana, Florida, Ohio, Alabama, Washington, Arizona and, most recently, Utah. The Monroe Model boasts 70 to 90% reductions in both pests and pesticide applications with no increase in long term costs. The Monroe Model is currently expanding into child care facilities in Indiana and Arizona. Dr Lame's dedication to school IPM issues runs deep; he wrote 'A Worm in the Teacher's Apple: Protecting America's School Children from Pests and Pesticides', which illustrates the national problem of pesticide dependence and outlines effective alternatives to the 'exterminator' approach to pest management.
Web: www.iu.edu/~speaweb/faculty/mlame.php

Wisconsin Potato and Vegetable Growers Association

This organization has been an industry leader in promoting IPM adoption at both the national and local level for close to 10 years. The philosophy of the Wisconsin Potato and Vegetable Growers Association (WPVGA) is to invest in research, collaborate with diverse partners and most importantly create grower incentives for IPM adoption. Through their innovative partnering with university researchers and the non-profit sector, WPVGA became the first in their industry to establish certification standards. The association developed the nation's first eco-brand for potatoes (Healthy Crown), which endorses the use of IPM methods and wise land management for the benefit of wildlife. In so doing, the WPVGA has created a meritorious market incentive programme and established IPM standards which are modelled by other commodities and companies. Their leadership is evident in their willingness to adopt novel approaches and test new tactics to advance IPM.
Web: www.wisconsinpotatoes.com

Posters and PowerPoint presentations given at the symposium may be viewed at the symposium's website (www.ipmcenters.org/ipmsymposiumv/). Plans are already underway for another IPM Symposium in 2009.

By: Ronald D. Cave, Indian River Research & Education Center, Ft. Pierce, Florida.

REBECA'S First Round

Two workshops were held in April 2006 under the new European Union (EU) FP6 Specific Support to Policies Project 'REBECA' (also see General News, this issue). Further information can be found on the website: www.rebeca-net.de/.

Macrobials

The First Macrobials Workshop, organized by the Macrobial Workpackage Leader Prof. Jeff Bale (University of Birmingham, UK), was held on 4–6 April 2006 in Wageningen, The Netherlands. A total of 27 participants from various sectors within several EU countries including industry, regulatory authorities and science provided a spread of knowledge and experience relating to the use of BCAs and their regulation and safety.

This series of workshops will discuss risk assessment for macrobial biological control agents (BCAs). The aims of the REBECA project are to accelerate the market introduction of environmentally safe BCAs within EU member countries by reducing costs of their risk assessment and registration while maintaining the level of safety to their producers and users as well as consumers of agricultural products.

Current regulations for import and release of macrobial BCAs vary widely between member countries of the EU, with some countries imposing strict regulations and others having none at all. Several documents detailing guidelines as to how a country should regulate imports and releases of native and non-native BCAs have been published in recent years but these procedures have not been universally adopted. Many biocontrol industries fear that the suggested regulations are impractical and too costly. The REBECA project therefore aims to analyse guidelines proposed in recent years, compare these to regulations that are successfully in place in other countries (Canada, USA, New Zealand, Australia) and propose a set of harmonized and simplified guidelines that can be implemented on an EU-wide scale.

Presentations and discussions covered several key topics. Firstly, the risks and benefits of macrobial BCAs were identified. Risks were categorized according to their impact, likelihood and need for regulation. Two presentations gave a summary on recent developments in regulatory guidelines and the current regulatory system in Europe. A presentation was also given on the industrial experience of EU regulation. Methods currently used for risk assessment were presented, in particular those used to assess establishment, host range and dispersal. A summary of the costs involved in conducting a full risk assessment of a classical BCA was provided after which there were discussions about how and by whom these funds might be provided in the future. Finally, the EPPO (European and Mediterranean Plant Protection Organization) 'positive list' of BCAs currently available on the EU market was discussed.

There was a common agreement amongst participants that regulations must not restrict the market registration of new BCAs and, as such, that the risk assessment methodologies emerging from the REBECA workshops must be cheap, quick and simple to carry out. A proposed, relatively simple, environmental risk assessment system[1] was discussed as a potential model system. Under such a scheme, a classical biological control candidate would have to be tested for its host range. However, an inundative biological control candidate may be able to bypass most of the testing procedures if it is initially determined that the agent is unable to establish in the area of introduction. This 'quick-scan' approach would be advantageous in that the costs of risk assessment could be significantly reduced. Only polyphagous exotic agents proposed for inundative release would have to be examined further for their dispersal capability as well as the direct and indirect effects that dispersal might lead to. This model system may need to be refined later on within the project when the subject of reducing the costs involved in conducting risk assessment are discussed further.

A follow up is expected over the next few weeks, and at the latest by September 2006 when the next REBECA Macrobials Workshop is to be held.

[1]van Lenteren, J.C., Bale, J.S., Bigler, F., Hokkanen, H.M.T. & Loomans, A.J.M. (2006) Assessing risks of releasing exotic biological control agents of arthropod pests. *Annual Review of Entomology* **51**, 609–34.

By: Emma Hunt & Ulrich Kuhlmann, CABI.

Microbials

The First Microbials Workshop was held on 11–13 April 2006 in Innsbruck, Austria. Microbial-based products are very expensive to register within the EU because current regulations are based around requirements for chemical products. The relevant EU Directive (91/414/EEC) is very restrictive, because its comprehensive requirements mean that manufacturers have to spend very large sums of money to register products, which may have a small market. The workshop was organized to suggest regulations that related more to the biology of the organisms, so that they were relevant and quicker and cheaper to meet. This should facilitate more rapid registration and a greater number of (sometimes very niche) products coming onto the market.

The meeting had nearly 40 attendees, mostly scientists, manufacturers and several regulators, and was focused on BCA products although reference was made to classical introductions and the need to be able to fast-track these organisms based very much on their specificity. In relation to biopesticides, working groups on fungi, bacteria and viruses met, debated the major issues, and then determined what level of regulation would be appropriate for the hazards identified (for example, a completely new genus would require more detailed study than a *Metarhizium* isolate). It may not be very surprising that the fungal group, at least, suggested very radical reductions in the level of demands for registration.

The recommendations of the working groups were made available to the organizers who will ultimately report to the EU. Further meetings of this Working Group are also planned.

By: Dave Moore, CABI

New Books

Catalogue of Pathogen and Nematode Biocontrol Introductions

This volume[1]* is thought by the authors to be the most complete catalogue to date of classical biological control programmes that have used pathogens and nematodes to control arthropod pests. It covers programmes that meet the following criteria:

- The target pest was an insect or mite

- The species or strain of the microbial pathogen or nematode agent was exotic (non-native) in the area of release
- The goal (whether or not it was achieved) was the establishment of the pathogen or nematode and the long-term control of the target pest

Early widespread introductions of microbial species that later proved to be of questionable pathogenicity, and widespread unintentional introductions where contaminants were released instead of intended agents are *not* included.

The catalogue is presented as a series of five tables, one for each agent group (viruses, bacteria, fungi and oomycetes, microsporidia, and nematodes). The table content is organized taxonomically by target. Each entry includes information on the target pest group/species and its status (introduced, native, unknown), and on the biological control agent, including the year and country (occasionally region) of release, and its source country; a brief summary of the outcome of the release is also given in terms of establishment, control and persistence, and references are listed for each entry. A separate table of accidental introductions is included. Two charts outline the higher classification of the target pests and the microbial and nematode agents. Finally, a set of indexes covering scientific names of target pests, families of target pests, scientific names of agents, taxonomic groups of agents, countries/regions of release, and source countries allows information to be located easily.

The publication of this volume is an opportune moment to reflect that catalogues now exist for most of the main classical biological control agent and target groups, although gaps remain in biocontrol with and of non-insect arthropods, most notably mites. The catalogue of weed biological control agents, first compiled and edited by Mic Julien and published in 1982, is now in its fourth edition[2]. The BIOCAT database, biological control records of insect natural enemy introductions against insect pests worldwide, was compiled by David and Annette Greathead in 1992[3] and is updated annually from publications in *BNI*. This new catalogue of pathogens and nematodes introduced for insect and mite control makes a welcome and worthy addition to these and to the bookshelves of biocontrol researchers and practitioners.

[1]*Hajek, A.E., McManus, M.L. & Delalibera, I., Jr. (2005) *Catalogue of introductions of pathogens and nematodes for classical biological control of insects and mites.* USDA Forest Service, Morgantown, West Virginia, FHTET-2005-05, 59 pp.

[2]Julien, M.H. & Griffiths, M.W. (1998) *Biological control of weeds. A world catalogue of agents and their target weeds.* Fourth Edition. CAB International, Wallingford, UK, 223 pp.

[3]Greathead, D.J. & Greathead, A. (1992) Biological control of insect pests by insect parasitoids and predators: the BIOCAT database. *Biocontrol News and Information* **13**, 61N–68N.

*For copies of the pathogens and nematodes catalogue, contact: Richard Reardon, FHTET, USDA Forest Service, 180 Canfield St., Morgantown, WV 26505, USA.
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