Biocontrol News and Information **30**(4), 67N–87N
pestscience.com

General News

IOBC Reports to FAO on Access and Benefit Sharing

In October 2008, IOBC (International Organization for Biological Control) established its Global Commission on Biological Control and Access and Benefit Sharing, with the mission to provide scientific advice to oversee and advise on the design and implementation of an access and benefit sharing (ABS) regime that ensures practical and effective arrangements for the collection and use of biological control agents (BCAs) which are acceptable to all parties[1] [also see *BNI* 30(1) (March 2008), p. 1]. This mission will be realized by:

- Increasing scientific knowledge in the area of biological control and ABS
- Documenting the potential for negative consequences of adopting strict regulations about ABS of BCAs
- Transferring the knowledge concerning the question of ABS to the scientific community, stakeholders and international parties
- Developing linkages/agreements with international partners: CBD (Convention on Biological Diversity), FAO (Food and Agriculture Organization of the United Nations), CABI, ANBP (Association of National Biocontrol Producers, USA), IBMA (International Biocontrol Manufacturers Association) and CGIAR (Consultative Group on International Agricultural Research)
- Promoting the development and application of new international conventions on biological control and ABS which respect the CBD

Shortly after the establishment of the IOBC Commission, the Commission on Genetic Resources for Food and Agriculture (CGRFA) of FAO approached IOBC with the request to write a report on 'The use and exchange of biological control agents for food and agriculture'[2]. The report was to summarize the past and current situation regarding the practice of biological control in relation to the use and exchange of BCAs and ABS. IOBC gladly accepted this task and its Commission on Biological Control and Access and Benefit Sharing held a meeting in March 2009 to discuss the approach for writing this report and to summarize the current situations with regard to ABS and biological control for the various world regions. CABI (Matthew Cock) was commissioned to draft the report and to collect information on classical biological control. IOBC (Joop van Lenteren) collected and summarized information on augmentative biological control. The IOBC Commission members collected information on current regulations and perceptions concerning exploration for natural enemies and helped draft some 30 case studies selected to illustrate a variety of points relevant to ABS, ranging from the difficulties that ABS already represents, to practical examples of situations where application of ABS is not straightforward, to successes and the implications for ABS sharing. In June 2009, the report, which is unique in its overview of the current state of affairs in biological control, was sent to FAO for review and the final version was published by FAO on 16 October 2009. The (edited) executive summary of the report is presented below. A pdf file of the report can be downloaded:
Web: ftp://ftp.fao.org/docrep/fao/meeting/017/ak569e.pdf

The main conclusions of the report were presented by Jacques Brodeur, as President of IOBC Global, during a special meeting preceding the 12th Regular Meeting of CGRFA in Rome, Italy, in October 2009. Part of the 12th Regular Meeting was attended by Joop van Lenteren (for IOBC) to follow the latest developments in ABS regulations and to explain the concerns of the biological control community with regards to a monetary sharing ABS regulation. He observed that country representatives frequently had not realized (a) how widely biological control was applied, (b) that in classical biological control no direct profits were accrued by the biological control community performing the work, (c) how little money was involved in commercial biological control, and (d) how dependent biological control workers are on exotic natural enemies. Several participants requested more information and documentation about biological control. During the plenary session of the meetings in Rome, it became clear that representatives of the various world regions still have differing opinions about future ABS regulations. As at 20 October 2009, about 30 countries have ABS regulations in place, but these are often rather general and do not specifically consider BCAs. CGRFA is currently negotiating options to address the special features of genetic resources for food and agriculture (including BCAs) within the international architecture of ABS. The CGRFA sees two alternatives: (1) Exclude genetic resources for food and agriculture from the international regime on ABS, or (2) Include them appropriately in an international ABS regime.

The IOBC report to FAO minimized political statements, to focus on a factual summary. The Commission on Biological Control and Access and Benefit Sharing thought it was essential to present these issues to the biological control community, as an important part of this community is still unaware or just beginning to understand the possible implications of ABS. Therefore, the Commission wrote a forum article for the journal *BioControl*[3]. This paper deliberately takes a more political stance and takes an advocacy role on behalf of the IOBC community. We would like to stress the importance of the final sentences of this paper: "Finally, we urge biological control leaders in each country to join forces and get in touch with the ABS contact point for their country

Are we on your mailing list?

Biocontrol News and Information is always pleased to receive news of research, conferences, new products or patents, changes in personnel, collaborative agreements or any other information of interest to other readers. If your organization sends out press releases or newsletters, please let us have a copy. In addition, the editors welcome proposals for review topics.

as soon as possible, and raise the issues surrounding the practice of biological control and ABS, using local examples when appropriate, so their national delegates to the ABS discussions in 2010 are appropriately informed. Only if the biological control community of practice gets involved in the discussions now, can they expect their needs to be taken into consideration."

The IOBC Commission will continue its work with the drafting of a document describing best practices for ABS in relation to biological control including guidelines for joint research that are equitable, but not restrictive.

Summary of the Report

The report sets out to summarize the past and current situation regarding the practice of biological control in relation to the use and exchange of genetic resources relevant for BCAs. It considers the two main categories of biological control: classical and augmentative.

Allowing access to BCAs for use in another country imposes no risk of liability to the source country. Local scientific knowledge about habitats, fauna and flora, can be helpful for locating suitable sites for surveys and collections. Biological control is a research-based activity that requires access to genetic resources but that is not expected to generate large monetary returns. It is not the practice in the biological control sector to patent biological control organisms.

The Research Process and Opportunities for Benefit Sharing

Preliminary surveys for the target pest and its natural enemies will often need to be carried out in several countries. These surveys offer limited opportunities for financial benefit sharing, but benefit the source country through provision of training in survey methods, joint surveys, capacity building and information generated to better understand biodiversity. Specimens of pests and natural enemies would normally need to be exported for identification and taxonomic studies.

Detailed studies on natural enemies to assess their potential as BCAs must in part be carried out in the source country, while host-specificity studies involving plants or animals not naturally occurring in the source country would best be carried out in quarantine in the target country or in a third country. It is this stage of a biological control programme that provides great scope for collaboration, shared research and capacity building. In comparison, there is relatively little scope for routinely sharing research with the source country during the BCA release stage.

In source countries, local partners are essential to carry out biological control surveys and research. When added to the moral obligation in the spirit of ABS, there is a compelling case for local partnerships. Some of these local partners will become the leaders in developing biological control options for their country in the future.

The Implementers

Two main groups of producers are involved in augmentative biological control: commercial and centralized. The former are independent companies who produce and sell BCAs to users. Such companies have mostly operated in developed countries, but new ones are increasingly common globally, particularly supporting cash crop production in middle-income countries. The centralized production units are government- or industry-owned and produce natural enemies for a particular niche, normally large-scale agriculture or forestry, which are either provided free or sold to users. In the case of classical biological control, those who implement it are normally national agencies or programmes. Classical biological control in developing countries is often carried out with the financial support of international development agencies and technical support of implementation agencies.

The Benefits to Users and Their Customers

In the context of agriculture and forestry, the main beneficiaries of classical biological control are the farmers who have their pest problems reduced without necessarily actively using BCAs, which by spreading and reproducing naturally contribute to the public good. The reduced crop losses from pests lead to improved food security and improved livelihoods. Farmers in all parts of the world have benefited from this. Consumers also benefit from reduced use of pesticides, and hence lower pesticide residues in food. Thus, classical biological control is in the domain of public good, as the benefits reach all who grow and benefit from the crop, without requiring them to make any intervention. The use of augmentative and classical biological control enables producers to reduce pesticide use and residues to meet the high standards of profitable northern export markets, resulting in job creation amongst the growers and a very significant influx of foreign exchange in developing countries.

To make augmentative biological control products available in developing countries it is necessary to establish mass-production facilities, which creates job opportunities. Also important is the creation or retention of jobs in agricultural production systems dependent upon augmentative or classical biological control.

Biological control also addresses invasive alien species that are problems in agriculture, forestry and the environment. Biological control is an effective tool to tackle alien pest problems. Furthermore, biological control is environmentally friendly and does generally not lead to a reduction of biodiversity, which is often observed when chemical pesticides are used.

The Extent of Use of Biological Control

At least 7000 introductions of BCAs involving almost 2700 BCA species have been made. The most widely used BCAs have been introduced into more than 50 countries. BCAs from 119 different countries have been introduced into 146 different countries. Highincome countries have implemented classical biological control the most and have also been the main source of BCAs. Low-income countries have contributed slightly more BCAs than they have received.

In augmentative biological control, more than 170 species of natural enemies are produced and sold, but some 30 species make up more than 90% of the market worldwide. There is a trend in augmentative biological control to first look for indigenous natural enemies when a new, even exotic, pest develops.

Once a BCA has been used successfully in one country, the opportunity has often been taken to repeat that success in other countries through redistribution of the BCA. Developing countries have benefited from access to such tested BCAs because research and implementation was carried out by developed countries. For example, the work of developed countries with subtropical and tropical regions, e.g. Australia and the USA, has directly benefited developing countries in the tropics and subtropics. Usually BCAs for redistribution have been re-collected in the target country rather than the original source country.

Control of Genetic Resources and Opportunities for Profit

In the case of classical biological control, a national or international research institute usually carries out the research, but once established, a BCA ceases to be under its control. The agent breeds and ideally contributes effectively to management of the target pest. The BCA will disperse to the geographic range limits to which it is suited, often including other countries. The classical biological control ethos is to establish a free-of-charge public good. The sector has traditionally made no use of intellectual property rights to regulate access to, or use of, classical BCAs. All knowledge generated is put into the public domain, and other countries are encouraged to take advantage of this new BCA. Benefits to farmers, consumers, and the local economy, do not return to the research institute or development agency in monetary form.

In the case of augmentative biological control, a company might survey for a useful new BCA to control a particular pest. They research it and develop rearing, distribution and release methods at their own expense. The augmentative biological control company then sells it to growers or other customers, generating profits for the company. Farmers who paid for the BCA benefit from effective pest control and improved yields, growing food without pesticides with implications for their own health, and the price they can obtain for their produce. The customers who buy the food are able to get healthy food at an acceptable price. It is not the practice in the augmentative biological control sector to use patents for BCAs, so anyone can collect and use the agents from nature. Augmentative biological control companies may establish patents on rearing processes, but more usually handle this by keeping the relevant know-how secret.

Worldwide, some 30 larger commercial producers of augmentative BCAs are active, of which 20 are located in Europe. In addition to the larger producers, some 100 small commercial producers are active, employing fewer than five people. The total market for augmentative biological control natural enemies at end-user level in 2008 was estimated at about US$100–135 million. With an average net profit margin of around 3–5%, the total commercial augmentative biological control industry profit is under US$15 million per year. Augmentative biological control is a small activity undertaken by small and medium-sized enterprises and with modest profits.

Regulation of Introduction of Biological Control Agents

Over the last 20 years, the introduction of BCAs has increasingly followed international or national legislation. ISPM3 (International Standards for Phytosanitary Measures No. 3) of the IPPC (International Plant Protection Convention) sets out the responsibilities of the different players, but does not address the issue of ABS.

Since the earliest days of biological control, there has been a community of practice based on free multilateral exchange of BCAs, rather than bilateral exchange or defined benefit sharing agreements. Countries are both providers and users of BCAs. It has usually made good practical sense to collaborate with a research organization in a (potential) source country, and as the need for more detailed risk and environmental impact assessment studies has grown, the need for collaborative research in the source country has grown. Conversely, there is a general trend for access to genetic resources, including BCAs, to become increasingly restrictive, for a variety of reasons, including ABS regulations and, in the case of biological control, phytosanitary legislation. The existing multilateral free exchange ethos and effective global networking of biological control practitioners is a foundation that deserves special consideration with regards to ABS.

New legislation has been and is being introduced in some countries regarding access to genetic resources. If legislation is not designed to accommodate biological control, it becomes a very difficult and challenging process, for both international researchers and their national collaborators. In the short term, this legislation will remain in place and have to be complied with. There is a risk that new international ABS legislation not tailored to the needs of the sector will add another layer of regulation to the research, which is likely to slow the process.

The arrival of a new invasive alien pest in a country can be devastating. In such cases, there is an argument that an emergency response may be needed before irreversible harm is done. That emergency response could be classical biological control. In such cases fast-track procedures for access to genetic resources should be anticipated and facilitated.

User Perspectives

The attitudes and views of biological control players reflect a mixture of positions regarding ABS. Much of the classical biological control community has been unaware of the potential of ABS to affect its activities, although the pragmatic need for a good local collaborator is recognized. However, there is now growing awareness of ABS policies and the need for continued exchange of BCAs so that biological control and the resultant public good will be guaranteed.

The implementers of classical biological control have long been aware that classical biological control does not bring them cash benefits. It is against the classical biological control ethos, which is based on government and donor financing to create a free-of-charge public good. Furthermore, there is no pathway or mechanism to collect monetary benefits from the beneficiaries, such as smallholder farmers. For this reason, forms of non-monetary benefit sharing are appropriate, based around shared research activities and capacity building.

On the other hand, the augmentative biological control community has been more aware of the issues, perhaps because augmentative biological control does generate some modest commercial profits. Larger augmentative biological control producers, such as members of IBMA and ANBP, are willing to consider benefit sharing in the form of knowledge sharing, training, provision of natural enemies, and other ways. In the event that a natural enemy obtained from a source country becomes a commercially successful BCA, some augmentative biological control producers foresee that payment of 'royalties' to the country of origin might be possible, but if the industry had to pay for each natural enemy collected, they would anticipate not being able to continue with this type of work. On balance, these producers believe that shared activities and capacity building would be a more realistic approach, given the relatively small profits and profit margins in the augmentative biological control industry.

Recommendations

ABS regulations should recognize the specific features of biological control:

- Countries providing BCAs are also themselves users of this technology
- Many BCAs are exchanged, but have little recoverable monetary value
- Organisms are not patented, so can be used by anyone at any time
- Classical biological control information and to a degree augmentative biological control information are publicly shared
- There are societal benefits for all, such as environmental and public health benefits, and reduction in pesticide use
- Biological control is widely used in both developing and developed countries, often using the same BCAs
- Most use of biological control relates to food and agriculture

In view of these specific positive features, the following recommendations are made:

1. Governments should build on the existing multilateral practice of exchange of natural enemies for biological control on a complementary and mutually reinforcing basis, which ensures fair and equitable sharing of the benefits of biological control worldwide.

2. ABS regulations should encourage further development of the biological control sector, by facilitating the multilateral exchange of BCAs.

3. Countries are encouraged to have a single point of contact to facilitate survey missions, provision of information, institutional linkages and taxonomic support, and provide advice on compliance with regulations for biological control, including ABS.

4. ABS in relation to biological control will normally be based on non-monetary benefit sharing, e.g. capacity building, shared research programmes and/or technology transfer, as already practised by many organizations and the augmentative biological control industry.

5. A document describing best practices for ABS in relation to biological control, including guidelines for joint research that are equitable but not restrictive, should be prepared and disseminated. Biological control organizations would be expected to follow these guidelines.

6. To improve transparency in the exchange of BCAs, mechanisms should be supported globally to establish and allow free access to database information on BCAs including source and target countries.

7. In the case of a humanitarian or an emergency situation for food security, governments should cooperate within FAO to fast track action in the exchange of BCAs.

[1]Brodeur, J. & van Lenteren J.C. (2008) IOBC Global Commission on Biological Control and Access and Benefit Sharing. IOBC Global Newsletter No. 84 (October 2008), pp. 5–7.
Web: www.unipa.it/iobc/view.php

[2]Cock, M.J.W., van Lenteren, J.C., Brodeur, J., Barratt, B.I.P., Bigler, F., Bolckmans, K., Cônsoli, F.L., Haas, F., Mason, P.G. & Parra, J.R.P. (2009) The use and exchange of biological control agents for food and agriculture. FAO Commission on Genetic Resources for Food and Agriculture, Background Study Paper No. 49, 94 pp.
Web: ftp://ftp.fao.org/docrep/fao/meeting/017/ak569e.pdf

[3]Cock, M.J.W., van Lenteren, J.C., Brodeur, J., Barratt, B.I.P., Bigler, F., Bolckmans, K., Cônsoli, F.L., Haas, F., Mason, P.G. & Parra, J.R.P. (2009 in press) Do new access and benefit sharing procedures under the Convention on Biological Diversity threaten the future of biological control? *BioControl*.
Web: www.springer.com/life+sci/entomology/journal/10526

By: Joop C. van Lenteren and Matthew J.W. Cock (on behalf of the IOBC Commission on Biological Control and Access and Benefit Sharing).
October 2009.

Can Lace Bug Stitch Up Woolly Nightshade?

The first biocontrol agent for woolly nightshade (*Solanum mauritianum*) in New Zealand has been approved for release. The tingid lace bug *Gargaphia decoris* is, like woolly nightshade, native to northeastern Argentina and southern Brazil. It was released as a biocontrol agent in South Africa in 1999, and in 2007 there were reports of it causing large-scale defoliation to the weed in invaded pine plantations in the northeastern region of the country.

Woolly nightshade is naturalized widely in some islands of the Atlantic, Pacific and Indian oceans, and in India and southern African countries (where it is known as bugweed). In New Zealand, it is a serious invasive environmental and pasture weed in the North Island. It is a prolific seed producer, and these are spread by birds and long-lived in the seed bank making control a long-term proposition. Its large leaves form dense canopies. In forest margins and light gaps within forests, the weed limits the regeneration of native vegetation by shading and allelopathic effects. It invades grazing land and is thought to be toxic to stock. Handling the leaves also causes skin and respiratory tract irritation and nausea in humans.

Although herbicides can provide control of woolly nightshade, it is too widespread in some areas of the North Island to make this option practical. Environment Bay of Plenty Chairman John Cronin says that managing woolly nightshade has been the region's most costly weed control programme: the Bay of Plenty regional council has spent NZ$2 million over the past 18 years in a bid to control it.

In developing a biological control programme for the weed in New Zealand, scientists looked to South Africa. Preliminary trials suggested the lace bug had considerable potential: 2–4 weeks sustained feeding had reduced leaf, stem and root biomass in potted plants by about a third. But then it seemed reluctant to establish and little population build up was observed in the first years after releases. One localized outbreak at a few sites in the Sabie area of Mpumalanga Province was reported in April 2007, with large numbers of nymphs and adults causing extensive and even complete defoliation, total absence of flowering and fruiting, and even mortality of seedlings and larger trees; resprouting growth of surviving plants was also attacked. Unfortunately, the burgeoning lace bug populations were destroyed by rampant plantation fires in the area in July 2007 and no further outbreaks, either in this area or elsewhere in the country, have since been reported.

The decision to investigate the lace bug for New Zealand was taken after considering the results in South Africa and comparing the situation in New Zealand. The stuttering start after the lace bug was released in South Africa was ascribed at least in part to predation from the many generalist insect predators found on woolly nightshade in South Africa; in contrast, woolly nightshade in New Zealand supports little in the way of an insect fauna (although the aggressive Argentine ant, *Linepithema humile*, occurs at a few sites). Of more concern was the difference in climate, and whether the lace bug would be suited to New Zealand's cooler temperatures, but the lace bug population in South Africa has been shown to be cold tolerant, and to prefer shady sites – so it may prove well suited to New Zealand's infested forest environments.

There are three *Solanum* species native to New Zealand, plus a number of important *Solanum* crops, so demonstrating the host-specificity of *G. decoris* was critical. Drawing on existing expertise with this weed and the lace bug, Terry Olckers and Candice Borea of the University of KwaZulu-Natal in South Africa carried out host-specificity testing with selected cultivated and New Zealand native *Solanum* species. The laboratory and open-field trials showed that none of the three native New Zealand *Solanum* species (the two poroporo species, *S. laciniatum* and *S. aviculare*, and the small-flowered nightshade, *S. americanum*) are acceptable to *G. decoris* as hosts. When it came to other *Solanum* species, however, *G decoris* showed an ability (albeit limited) to exploit a cultivated *Solanum* crop. While most cultivated *Solanum* species, including potato, tomato and tamarillo, were not accepted as hosts, some aubergine/eggplant (*S. melongena*) cultivars did support feeding, development and oviposition under no-choice conditions. Comprehensive testing was needed to build a convincing case that the lace bug would not pose a danger to non-target *Solanum* species in New Zealand. However, careful consideration of *G. decoris'* behaviour in its native and introduced range, together with the results of open-field trials and a risk assessment based on multiple measures of insect performance led to the conclusion that while some minor attack on eggplant is possible it is unlikely to be a major issue.

Releasing biocontrol agents in New Zealand has also to take account of cultural issues. Environment Bay of Plenty commissioned an independent cultural impact assessment report as part of the process of considering *G. decoris*.

The application to introduce the insect to New Zealand was submitted to ERMA (the Environmental Risk Management Authority) by Environment Bay of Plenty regional council as a representative of the national Biocontrol Collective, which is made up of regional councils, unitary authorities and the Department of Conservation, working together with Landcare Research. During the submission and hearing process, the decision-making committee considered all the potential effects of the lace bug on the environment, human health and safety, the economy, society and community and Maori culture and values. Overall it decided that the benefits of the release of the lace bug outweighed any adverse effects.

ERMA's decision to allow the lace bug to be imported into New Zealand as a biological control agent for woolly nightshade was welcomed by Environment Bay of Plenty. Its Senior Pest Plant Officer, John Mather, expressed the hope that the lace bug would be a major help in reducing the density of woolly nightshade infestations in forestry and scrubland.

If all goes well, it will provide a good start. Large plants with large root reserves, like woolly nightshade, can tolerate a significant amount of defoliation – as indicated by the plant's ability to regenerate from cut stumps after mechanical clearance. So the lace bug is likely to need help, if further sufficiently specific agents can be found. In South Africa a flowerbud-feeding weevil, *Anthonomus santacruzi*, which has the ability to reduce fruit set and hence long-range seed dispersal, is currently being mass-reared and released, and New Zealand's collaborators there are similarly assessing whether it might be suitable for New Zealand. It is still too early to confirm establishment in the field in South Africa, but host-specificity results so far suggest that the weevil should be considered for release in New Zealand.

Meanwhile, Landcare Research is hoping to import a lace bug colony from South Africa early in 2010 and undertake mass rearing over the winter with the aim of making the first releases in spring 2010.

Further Information

ERMA: www.ermanz.govt.nz

Olckers, T. & Borea, C.K. (2009) Assessing the risks of releasing a sap-sucking lace bug, *Gargaphia decoris* , against the invasive tree *Solanum mauritianum* in New Zealand. *BioControl* **54**(1), 143–154.

Olckers, T. (2009) *Solanum mauritianum* Scopoli (Solanaceae). In: Muniappan, R., Reddy, G.V.P & Raman, A. (eds) *Biological Control of Tropical Weeds using Arthropods*. Cambridge University Press, pp. 408–422.

Anon. (2007) A bug for bugweed? *What's New in Biological Control of Weeds* No. 42 (November 2007), pp. 1–2.

Contact: Lynley Hayes, Landcare Research,
PO Box 40, Lincoln 7640, New Zealand.
Email: HayesL@landcareresearch.co.nz
Fax: +64 3 321 9998

John Mather, Environment Bay of Plenty,
Tauranga, New Zealand.
Email: John.Mather@envbop.govt.nz
Web: www.envbop.govt.nz

New Biocontrol Agent for Canadian Leek and Garlic Growers' Fight Against Leek Moth

The parasitic wasp *Diadromus pulchellus* was recently approved by the Canadian Food Inspection Agency for release in Canada for biological control of the leek moth, *Acrolepiopsis assectella*. This biological control agent attacks and kills leek moth pupae, reducing overall adult emergence and infestation of *Allium* crops, particularly leek and garlic.

Leek moth, accidentally introduced into the Ottawa region in Canada, was first reported in 1993 and has since spread down the Ottawa valley into eastern Ontario and southwestern Quebec. In 2008 it was reported from Prince Edward Island. Leek moth is having an increasing impact on *Allium* production in Ontario and Quebec. The year 2009 saw the most significant damage yet in garlic crops: leek moth were abundant in up to 100% of the bulbs, making entire crops unmarketable. The presence of this pest in Canada has led to severe trade restrictions being imposed on fresh *Allium* products exported to the USA. Given that the value of these exports in 2006 exceeded Can$40 million, such restrictions are having an impact on producers.

In 2003, an integrated pest management programme was initiated to investigate sustainable approaches to managing this exotic pest. As is commonly observed with invasive alien species, early surveys in *Allium* crops in the Ottawa region revealed very low attack rates by indigenous generalist parasitoids on leek moth, suggesting that the leek moth's separation from Europe also released it of its European natural enemies. There did not appear to be any North American parasitoids that attacked leek moth sufficiently to regulate the pest's population. In contrast, a number of leek moth parasitoids were known from the European scientific literature. Hence, a classical biological control approach held promise.

A research team composed of scientists and staff from Agriculture and Agri-Food Canada (AAFC), CABI Europe – Switzerland (CABI E-CH), the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), and Carleton University, with financial support from AAFC's Pest Management Centre, took on the challenge to provide growers with tools for combating the leek moth. CABI E-CH took the lead for the biological control component of the project, conducting research to discover and evaluate the impact and safety of potential agents.

Studies were conducted in Europe to determine mortality factors of leek moth and to discover and assess potential agents for biological control. Following two summers (2004–2005) of field surveys in central Europe and based on the available literature on leek moth parasitoids, the pupal parasitoid *D. pulchellus* was selected for an in-depth study of its suitability for classical biological control of leek moth in Canada.

Investigations on the host range of *D. pulchellus* were carried out in 2006–2008 in Europe and in containment in Canada. Laboratory experiments tested the suitability of 12 non-target host species for the candidate agent. The test species selected satisfied one of more of the following criteria: (1) Phylogenetic affinity to target pest, (2) Ecological similarity to target, (3) Safeguard species (i.e. beneficial or rare), (4) Morphological similarity to target and (5) Known host of another *Diadromus* sp. parasitoid. Additional non-targets had been considered for testing but were ruled out based on early results. Of the non-target species tested, only three species belonging to the families Acrolepiidae and Plutellidae were attacked by *D. pulchellus*. Like leek moth, these non-targets had stiff, non-sticky cocoons. *Diadromus pulchellus* is known to be attracted by volatile sulphur compounds, which are characteristic of *Allium* and Brassicaceae plants. Nonetheless, there are no known field records of this parasitoid from any host other than leek moth. Furthermore, recent evidence from field trials suggest that *D. pulchellus* is probably very selective of the habitat in which it forages, since it avoided cabbage plants infested with a suitable non-target host despite the extremely close proximity of these plants to leek fields.

A petition for release of *D. pulchellus* was submitted to the Canadian Food Inspection Agency in May 2009 and approval was given in September 2009. Release is planned for spring 2010 and a post-release monitoring project will be implemented. The host specificity of *D. pulchellus* and its capacity to parasitize a significant proportion of available hosts is expected to have a substantial impact on leek moth in Canada.

By: Peter Mason[a], Wade Jenner[b], Ulli Kuhlmann[b] & Naomi Cappuccino[c]

[a]Agriculture and Agri-Food Canada, Research Centre, 960 Carling Avenue, Ottawa, Ontario, K1A 0C6 Canada.
Email: Peter.Mason@agr.gc.ca

[b]CABI Europe – Switzerland, Rue des Grillons 1, CH-2800 Delémont, Switzerland.
Email: W.Jenner@cabi.org / U.Kuhlmann@cabi.org

[c]Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, K1S 5B6 Canada.
Email: naomi_cappuccino@carleton.ca

Australia Takes Prickly Acacia Biocontrol Search to India

A project co-funded by MLA (Meat & Livestock Australia) and the Queensland Government is putting new life into the search for biocontrol agents for prickly acacia (*Acacia nilotica*), a Weed of National Significance in Australia. Prickly acacia was introduced into Australia in the early part of the twentieth century as a fodder and shade tree. It is now regarded as one of the country's worst weeds because of its potential for spread and economic and environmental impacts. It infests some six million hectares of arid and semi-arid land in Queensland, but could potentially infest vast tracts of grassland and woodland across Australia's arid northern region. The current economic impact of the weed on Queensland's livestock industry is estimated at Au$10 million annually. Even at medium densities, it halves the primary productivity of grasslands, interferes with stock mustering and restricts stock access to water. The cost of control measures, which generally rely on mechanical approaches, considerably outweighs its benefits as a shade tree and drought fodder.

Previous surveys for biocontrol agents, conducted during the 1980s and 1990s in Pakistan, Kenya and South Africa, led to the introduction of six insect agents, but only two of these have become established and they have so far had no measurable economic impact[1]. The prickly acacia populations in Australia have been identified as *A. nilotica* subsp. *indica* originating from India[2], which fuelled a new hunt for natural enemies in the area of origin of the Australian weed. Matching the climatic conditions of areas in western Queensland where prickly acacia is invasive with regions in India indicated that a majority of the areas in India are climatically suitable, with Rajasthan State the most suitable region for exploration[3]. On the basis of a visit in 2004 to several research institutions in Rajasthan, Chhattisgarh, Karnataka, Kerala and Tamil Nadu states in India, the Institute for Forest Genetics and Tree Breeding (IFGTB) at Coimbatore, Tamil Nadu, and the Arid Forest Research Institute (AFRI) at Jodhpur, Rajasthan, were identified as potential collaborators for surveys in India.

The new project, which began in September 2007, is led by Dr K. Dhileepan (Biosecurity Queensland) in collaboration with the two Indian research institutes, IFGTB conducting surveys in Tamil Nadu and Karnataka states in southern India, and AFRI conducting surveys in Rajasthan and Gujarat states in northwest India. Dr A. Balu is leading the research team based at IFGTB, which includes two entomologists and a plant pathologist. The team based at AFRI, which includes two senior plant pathologists, two entomologists and a plant pathologist, is led by Dr Syed Irfan Ahmed.

Prickly acacia is grown widely in India, serving a variety of purposes, but it also occurs naturally, along with several other subspecies of *A. nilotica* and other *Acacia* species. However, information on insects and plant pathogens associated with *A. nilotica* in India has been gathered from the perspective of itemizing forestry and nursery pests, and no systematic surveys have been made so far to catalogue insects and plant pathogens associated with *A. nilotica* there. As part of this project, suitable survey sites were identified in northwest and southern India. In southern India, survey sites are predominantly forestry plantations in tank beds, with isolated plants also found on roadsides and bunds (banks) in agricultural land. In northwest India, survey sites include both natural groves and forestry plantations. The surveys included various subspecies native to India: subspecies *indica* and *tomentosa* in Tamil Nadu, subspecies *indica* and *cupressiformis* in Rajasthan and Karnataka, and subspecies *indica* and *hemispherica* in Gujarat.

During the surveys in northwest and southern India so far (2008–09), more than 60 insect species and 25 diseases were recorded on all the subspecies. The search for natural enemies is focusing on areas that are climatically similar to arid western Queensland, where problems with prickly acacia are particularly severe. As Dhileepan explains, species capable of surviving in the hot, arid climate of the areas they are surveying in India would be most likely to survive in western Queensland, while exploring two geographically distant regions in India improves the chances of collecting a large number of species.

There are logistical difficulties as well as biological ones to be overcome: identification is proving difficult because taxonomic expertise is scarce and moving specimens internationally is difficult. Nonetheless, although many of the collected species have yet to be identified, four potential biocontrol agents (one rust fungus and three insects) have already been prioritized for further study to assess their suitability and safety for introduction to Australia. These studies will be conducted at the outset in India, and will focus on testing the potential agents against *Acacia* taxa native to Australia, using plant material supplied from Australia. In addition, Dhileepan is helping Indian staff in refining monitoring and sampling techniques, to assess which natural enemies are most damaging to prickly acacia in its native range, and prioritize suitable agents for detailed host-specificity tests. He says that simulated herbivory studies have indicated that prickly acacia is susceptible to herbivory, and hence a suitable target for biocontrol[4]. On the basis of this study, a shoot-tip herbivore in combination with a multivoltine leaf herbivore will be prioritized as biological control agents for further host-specificity tests.

This systematic approach to native-range surveys, one that incorporates plant genotype matching and climate similarity as filters, in conjunction with agent prioritization based on plant response to herbivory will enhance the selection, testing and release of effective biocontrol agents for prickly acacia in Australia.

[1]Dhileepan, K. (2009) *Acacia nilotica* ssp. *indica*. In: Muniappan, R., Reddy, D.V.P. & Raman, A. (eds) *Biological Control of Tropical Weeds using Arthropods*. Cambridge University Press, UK, pp. 17–37.

[2]Wardill, T.J., Graham, G.C., Manners, A., *et al.* (2005) The importance of species identity in the biocontrol process: identifying the subspecies of *Acacia nilotica* (Leguminosae: Mimosoideae) by genetic distance and the implications for biological control. *Journal of Biogeography* **32**, 2145–2159.

[3]Dhileepan, K., Wilmot, K.A.D.W. & Raghu, S. (2006) A systematic approach to biological control agent exploration and selection for prickly acacia (*Acacia nilotica* ssp. *indica*). *Australian Journal of Entomology* **45**, 302–306.

[4]Dhileepan, K., Lockett, C.J., Robinson, M. & Pukallus, K. (2009) Prioritising potential guild of specialist herbivores as biological control agents for prickly acacia through simulated herbivory. *Annals of Applied Biology* **154**, 97–105.

Contact: Dr K. Dhileepan, Alan Fletcher Research Station, Biosecurity Queensland, Department of Employment, Economic Development and Innovation, Sherwood, Queensland 4075, Australia.
Email: K.Dhileepan@deedi.qld.gov.au
Web: www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/4790_14152_ENA_HTML.htm

Australia Tiptoes into Cape Tulip Biocontrol

Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Department of Agriculture and Food Western Australia (DAFWA) are collaborating to try and outwit one of southern Australia's worst agricultural weeds, starting with a one-year feasibility study to assess the most promising agent identified so far.

Cape tulips (*Moraea* spp.) were imported as ornamentals to Australia from South Africa in the mid 1800s. By the early 1900s, both one-leaf Cape tulip (*M. flaccida*) and two-leaf Cape tulip (*M. miniata*) were established weeds of pastures in all of Australia's southern states, with the most extensive infestations found in parts of Victoria, South Australia and Western Australia. Historically they are weeds of rangelands; they are unpalatable and poisonous to livestock. Recently, however, they have been increasing their invasion of native habitats and have the potential to become weeds of conservation importance too.

Current control options for Cape tulips include herbicides and cultivation. These measures are often not justified for economic reasons and access to waterlogged areas, where these weeds often occur, can be difficult. However, Cape tulips have few close relatives among the Australian native flora and there are no related crops grown in the country, which makes them promising candidates for classical biological control. Staff from CSIRO have previously looked for potential biological control agents in the weeds' area of origin, the Western Cape Province of South Africa, and assessed risks associated with introducing them.

In 1999–2001, survey work in South Africa identified weevils feeding on Cape tulip corms and *Urodon* weevils feeding on its seeds. The most promising potential agent, though, was a rust fungus, *Puccinia moraeae*, which affects the leaves. It appeared to cause significant damage to plants in their native habitat and has not been recorded from species outside the genus *Moraea*. Little is known of the biology of this rust, however.

The one-year project funded by DAFWA, now underway, is looking at the feasibility of using the rust as a biological control agent for Cape tulips. Selected rust isolates are being tested at the CSIRO Black Mountain Containment Facility in Canberra to see how effective they are on Australian populations of Cape tulips. The isolates will also be tested on a few closely related, non-target plant species to provide preliminary information on the susceptibility of key non-target species to the rust, which will help to decide whether the rust should undergo future comprehensive host-specificity testing.

Contact: Louise Morin, CSIRO Entomology,
GPO Box 1700, Canberra, ACT 2601, Australia.
Email: Louise.Morin@csiro.au

Encounters with an Alien: a European Perspective

The harlequin ladybird, *Harmonia axyridis*, was introduced into continental Europe in the 1980s as a classical biological agent of scale insects and aphids. It was never intentionally introduced into Britain, but arrived in the southeastern county of Essex in

2004. The spread of this non-native species across Britain has been spectacular; approximately 100 km per year[1]. The harlequin ladybird is particularly abundant in the southeast of England, but there are many records from central and northern England, Wales and also a few records from Scotland, as far north as Orkney. The UK Ladybird Survey has been monitoring *H. axyridis* since it arrived in Britain through an online public participation survey: www.ladybird-survey.org. The survey has received more than 30,000 records of this species, and particularly notable are the very large numbers of the beetle which are commonly reported in the autumn each year, when this species enters buildings to locate suitable overwintering sites. The autumn of 2009 is no exception; the survey received approximately 800 records a week during October. The pattern of rapid spread and high abundance of *H. axyridis* has also been documented across northern and central Europe[2]. *Harmonia axyridis* has been recorded as established in (order relates to approximate time of establishment): France (first report), Germany, Belgium, Netherlands, Switzerland, Luxembourg, England, Czech Republic, Italy, Austria, Denmark, Norway, Poland, Wales, Liechtenstein, Scotland, Hungary, Slovakia and Bulgaria (last report). Interestingly this species is not so successful in southern European countries[3].

The harlequin ladybird is both a human nuisance in the autumn, as it occupies premises in high numbers, and also threatens native biodiversity through competition and predation. However, research to quantify the extent of the threat is urgently required, and collaborative effort is essential to further understanding of this conspicuous invader. In recognition of this, an IOBC/WPRS (International Organization for Biological Control/Western Palaearctic Regional Section) Study Group was established to encourage collaborations on this species and other exotic biological control agents.

The role of *H. axyridis* as an intraguild predator has been the focus of a number of studies[4–6]. Ware and Majerus[4] demonstrated the potential of *H. axyridis* to act as an aggressive, unidirectional intraguild predator of many coccinellids. The role of intraguild and extraguild prey densities was assessed in a study considering the intraguild interactions between *H. axyridis* and a native ladybird, *Coccinella undecimpunctata*[7]. These authors concluded that intraguild predation of *C. undecimpunctata* by *H. axyridis* was promoted through exploitation of shared prey. Further research examines the interactions between *H. axyridis* and non-coccinellid members of the aphidophagous guild[6] (also Wells unpublished data). Roy *et al.*[6] examined interactions between *H. axyridis* and the aphid-specific pathogenic fungus *Pandora neoaphidis*, showing that *H. axyridis* consumed infected cadavers. In the 2008 special issue of *BioControl*[8], the intraguild interactions between *H. axyridis* and other aphidophagous organisms were reviewed[9]. Much of the evidence involves rigorously controlled laboratory experiments. The challenge now is to examine the role of *H. axyridis* as an intraguild predator in the field.

Systematic field surveys are indicating the niche overlap of *H. axyridis* with a number of herbaceous and arboreal insect species. Furthermore, anecdotal and photographic evidence from contributors to the UK Ladybird Survey further indicate the potential for antagonistic interactions (members of the public have recorded *H. axyridis* consuming larvae of many species, from ladybirds to lacewings and even Lepidoptera larvae). A three-year project (collaboration between the Centre for Ecology & Hydrology, University of Oxford and Rothamsted Research) has begun to link these field observations using an ecological modelling approach, including habitat and climate parameters. It is hoped that this may begin to address questions relating to the extent of interactions and make predictions for the future.

The natural enemy escape hypothesis is a theory that is invoked to explain the rapid (and uninterrupted) spread of an alien invader. The alien arrives in a region which represents natural enemy free space, i.e. it escapes the top-down regulation of predators, parasites and pathogens. The arrival of *H. axyridis* in Europe provides an opportunity to examine this concept.

Coccinellids are attacked by a suite of natural enemies[10–14], including: predators (such as the predatory mirid bug *Deraeocoris ruber*); a hymenopteran braconid parasitoid (*Dinocampus coccinellae*); dipteran parasitoids (such as the phorid *Phalacrotophora fasciata*); a mite (*Coccipolipus hippodamiae*); various male-killing bacteria (*Wolbachia, Spiroplasma, Rickettsia*); and insect pathogenic fungi (such as *Hesperomyces virescens* and *Beauveria bassiana*).

Experimental work has assessed the potential of two ladybird natural enemies as mortality agents of *Harmonia axyridis*: the parasitoid wasp *D. coccinellae*[15] and the fungal pathogen *B. bassiana*[16]. In both cases, *H. axyridis* was less susceptible than native species of ladybird. Indeed, *B. bassiana* was highly pathogenic to the native ladybirds *Coccinella septempunctata* and *Adalia bipunctata*, but not to *H. axyridis*. Despite these findings, it is difficult to envisage that an insect at such high density will remain free of natural enemies within in its invaded range; populations of *H. axyridis* in Europe represent a large resource pool for natural enemies. Therefore, it is predicted that natural enemies, particularly parasites and pathogens, will begin to adapt to utilizing *H. axyridis*. In 2009, a low proportion (less than 0.5%) of field-collected individuals of *H. axyridis* provided the first evidence of parasites and pathogens utilizing *H. axyridis* in the invaded range[17] (also Ware unpublished data; Handley-Lawson unpublished data). In Britain, a small number of *H. axyridis* pupae, collected from field sites, yielded phorids, and *D. coccinellae* emerged from a couple of adults. In Denmark, the focus has been on pathogenic fungi, and extensive field sampling has provided exciting results: larvae, pupae and adults were found to be infected by *Isaria farinosa*, *B. bassiana* and species of *Lecanicillium*[17]. Furthermore, these authors noted approximately 18% winter mortality due to fungal infection at one location. At the recent meeting of the IOBC Study Group 'Benefits and Risks of Exotic Biological Control Agents'[see Conference Reports, this issue] it was decided to coordinate research on natural enemies across Europe particularly in relation to sharing field observations. Work to detect intraguild predation by *H. axyridis* in the field using molecular techniques, is also being coordinated through the study group.

In conclusion, *H. axyridis* is often reported as an invasive non-native species with far reaching ecological impacts, and there is no doubt that it has the potential to threaten biodiversity[18]. However, it is critical that empirical evidence is gathered to enable us to have a thorough understanding of the extent of any effects this non-native invasive species will have on other species, particularly those within the aphidophagous guild. Furthermore, we have a unique opportunity to monitor this alien through public participation and to study this species within a community context through extensive biological recording in the field. This, coupled with intensive and systematic field and laboratory studies, in the collaborative spirit of the IOBC Study Group, will ensure that we unravel the dynamics of this invasive species.

Acknowledgements

The Joint Nature Conservation Committee (JNCC) co-funds the Biological Records Centre (Centre for Ecology & Hydrology) which hosts the UK Ladybird Survey. Defra (Department for Environment, Food and Rural Affairs), through the NBN (National Biodiversity Network) Trust, funded the initiation of the online recording for the UK Ladybird Survey. The IOBC/WPRS have generously supported European activity on *Harmonia axyridis* through the Study Group 'Benefits and Risks of Exotic Biological Control Agents'.

[1]Brown, P.M.J., Roy, H.E., Rothery, P., *et al.* (2008) *Harmonia axyridis* in Great Britain: analysis of the spread and distribution of a non-native coccinellid. *BioControl* **53**, 55–68

[2]Brown, P.M.J., Adriaens, T., Bathon, H., *et al.* (2008) *Harmonia axyridis* in Europe: spread and distribution of a non-native coccinellid. *BioControl* **53**, 5–22.

[3]Soares, A., Borges, I., Borges, P.A.V., *et al.* (2008) *Harmonia axyridis*: what will stop the invader? *BioControl* **53**, 127–145.

[4]Ware, R.L. & Majerus, M.E.N. (2008) Intraguild predation of immature stages of British and Japanese coccinellids by the invasive ladybird *Harmonia axyridis*. *BioControl* **53**, 169–188.

[5]Ware, R.L., Ramon-Portugal, F., Magro, A., *et al.* (2008) Chemical protection of *Calvia quatuordecimguttata* eggs against intraguild predation by the invasive ladybird *Harmonia axyridis*. *BioControl* **53**, 189–200

[6]Roy, H.E., Baverstock, J., Ware, R.L., *et al.* (2008) Intraguild predation of the aphid pathogenic fungus *Pandora neoaphidis* by the invasive coccinellid *Harmonia axyridis*. *Ecological Entomology* **33**, 1–8.

[7]Nóia M., Borges I. & Soares A. (2008) Intraguild predation between the aphidophagous ladybird beetles *Harmonia axyridis* and *Coccinella undecimpunctata* (Coleoptera: Coccinellidae): The role of intra and extraguild prey densities. *Biological Control* **46**, 140–146.

[8]Roy, H.E. & Wajnberg, E. (2008) From biological control to invasion: the ladybird, *Harmonia axyridis*, as a model species. *BioControl* **53**, 1–4.

[9]Pell J.K., Baverstock, J., Roy, H.E., *et al.* (2008) Intraguild predation involving *Harmonia axyridis*: a review of current knowledge and future perspectives. *BioControl* **53**, 147–168.

[10]Majerus M.E.N. (1994) *Ladybirds*. Harper Collins, London, UK, 367 pp.

[11]Hodek I. & Honìk A. (eds) (1996) *Ecology of Coccinellidae*. Kluwer, Dordrecht, Netherlands, 484 pp.

[12]Roy, H.E., Brown, P. & Majerus, M.E.N. (2006) *Harmonia axyridis*: a successful biocontrol agent or an invasive threat? In: Eilenberg, J. & Hokkanen H. (eds.) *An Ecological and Societal Approach to Biological Control*. Kluwer, Dordrecht, Netherlands.

[13]Kenis, M., Roy, H.E., Zindel, R. & Majerus, M.E.N. (2008) Current and potential management strategies against *Harmonia axyridis*. *BioControl* **53**, 235–252.

[14]Roy, H.E. & Cottrell, T. (2008) Forgotten natural enemies: interactions between coccinellids and insect-parasitic fungi. *European Journal of Entomology* **105**, 391–398.

[15]Koyama S. & Majerus M.E.N. (2008) Interactions between the parasitoid wasp *Dinocampus coccinellae* and two species of coccinellid from Japan and Britain. *BioControl* **53**, 253–264.

[16]Roy, H.E., Brown, P.M.J., Rothery, P., *et al.* (2008) Interactions between the fungal pathogen *Beauveria bassiana* and three species of ladybird: *Harmonia axyridis*, *Coccinella septempunctata* and *Adalia bipunctata*. *BioControl* **53**, 265–276

[17]Steenberg, T. & Harding, S. (2009) Entomopathogenic fungi recorded from the harlequin ladybird, *Harmonia axyridis*. *Journal of Invertebrate Pathology* **102**, 88–89.

[18]Majerus M.E.N., Strawson V. & Roy H.E. (2006) The potential impacts of the arrival of the Harlequin ladybird, *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae), in Britain. *Ecological Entomology* **31**, 207–215.

By: Helen E. Roy[a], Peter M.J. Brown[b] & Remy L. Ware[c]

[a]Centre for Ecology & Hydrology, Wallingford, OX10 8EF, UK.

[b]Anglia Ruskin University, Cambridge, CB1 5PT, UK.

[c]University of Cambridge, Cambridge, CB2 1RD, UK.

Additional Genetic Data Support Native Range Hypothesis for the Invasive Beech Scale, *Cryptococcus fagisuga*

Since the end of the nineteenth century, beech bark disease has caused an epidemic of mortality in American beech (*Fagus grandifolia*). Newly infected stands can suffer an initial mortality of 50% or greater, and even trees that are not killed outright often become severely damaged, resulting in a significant economic loss of native lumber as well as dramatic changes in forest community composition[1]. An invasive scale insect, *Cryptococcus fagisuga*, and two associated fungal plant pathogens, *Nectria coccinea* var. *faginata* and *Nectria galligena*, cause this disease. Both the scale and the principal pathogen (*N. coccinea* var. *faginata*) are invasive species in the USA. The scale is believed to have entered Canada, in Nova Scotia, in about 1890 on seedling beech trees brought to the Halifax Public Garden, most likely from Europe, where the scale has been known since 1832.

Biological control of the scale insect has been considered as a potential method of limiting the damage caused by beech bark disease. Knowledge of an invasive species' native range may give insight into where coevolved natural enemies associated with the pest might exist, but it can be hard to figure out where an insect is originally from. Clues can include: where the host plant evolved, where the insect species' closest relatives occur, and where the insect species shows the greatest genetic diversity. A recent phylogeographic study conducted by Gwiazdowski *et al.*[2] searched for the native range of *C. fagisuga* using historical records, field surveys, and molecular phylogenetics based on mitochondrial DNA (mtDNA). Based on phylogeographic data and the approach that the native range is likely to be where the pest species shows the greatest genetic diversity, that work suggested that natural enemies are best sought on oriental beech (*F. orientalis*) within an area that included northeastern Greece, the Black Sea drainage basin, the Caucasus Mountains, and northern Iran.

Following the publication of Gwiazdowski *et al.*, samples of *C. fagisuga* were collected from Armenia; mtDNA sequence data were collected from three individual Armenian insects and included in a phylogenetic parsimony analysis using the original methods and sequence data from the publication. Gwiazdowski *et al.* reported 15 unique haplotypes among 174 samples collected from North America, Europe and Iran. Intriguingly, each of the three Armenian sequences is a unique haplotype. Following the haplotype designation in Gwiazdowski *et al.*, these haplotype numbers and their GenBank accession numbers are respectively identified as H16 – GQ398378, H17 – GQ398379, and H18 – GQ398380. The sequences H16 and H17 differ from each other by only one base pair, and both of them are approximately 2.5% divergent from H18, differing by 14 base pairs. When these three new haplotypes are added to the 15 haplotypes of the original study, and the analysis is repeated, the result is three most-parsimonious trees that are directly comparable to those in the original study. Haplotypes H16 and H17 are placed in a clade with closely related (1–2 base pairs different) haplotypes from Georgia and Turkey. H18 is placed in a clade with haplotypes found in Belgium, Bulgaria and Switzerland, along with two extremely widespread and numerous European and American haplotypes. The genetic variation of these three new unique sequences from Armenia provides further evidence corroborating the pattern of high haplotype diversity of *C. fagisuga* in southeastern Europe[2], and suggests that this region holds a good deal more unsampled diversity in this species. The phylogenetic position of the sequences from Armenia provides additional support for the hypothesis of Gwiazdowski *et al.* that southeastern Europe and southwestern Asia may be the area of origin of *C. fagisuga* and may yet be a fruitful area in which to find coevolved predators and parasitoids that might serve as biological control agents in North America against the invasive scale insect vector of beech bark disease.

The authors of this article wish to thank Marc Kenis for collecting the *C. fagisuga* specimens from Armenia and for his role in initiating this project and for his continuing help and advice.

[1]Houston, D.R. (1994) Major new tree disease epidemics – beech bark disease. *Annual Review of Phytopathology* **32**: 75–87.

[2]Gwiazdowski, R.A., Van Driesche, R.G., Desnoyers, A., *et al.* (2006) Possible geographic origin of beech scale, *Cryptococcus fagisuga* (Hemiptera: Eriococcidae), an invasive pest in North America. *Biological Control* **39**(1), 9–18.

By: Rodger Gwiazdowski[a,c](rodger@psis.umass.edu), Lindsey Cushing[b] & Dr Benjamin B. Normark[c] (bnormark@ent.umass.edu).

[a]Graduate Program in Organismic and Evolutionary Biology, University of Massachusetts, Amherst, MA, USA.

[b]Undergraduate Program in Biology, University of Massachusetts, Amherst, MA, USA.

[c]Department of Plant, Soil, and Insect Sciences, University of Massachusetts, Amherst, MA, USA.

Sting in the Tail of Fire Ant Venom

Fire ant venom is one reason for fearing these introduced pests in the southern USA, but a recently published study indicates that the venom can be the source of the fire ant's downfall.

The imported fire ants *Solenopsis richteri* and *S. invicta* were accidentally introduced into the USA from South America in the first part of the twentieth century, and currently infest some 129.5 million hectares in 13 southern US states and Puerto Rico. They cost the country in the order of US$7 million annually in terms of control and repair costs and medical care. The observation that fire ant populations were 5–10 times higher in the invaded range than in their native range led to a classical biological control programme, coordinated from centres in Florida (US Department of Agriculture – Agricultural Research Service) and Texas (Texas A&M University).

Under the biological control programme, four species of decapitating phorid flies (*Pseudacteon* spp.) have been imported from the fire ants' native range in Argentina. The female of these solitary host-specific parasitoids lays an egg in the abdomen of a worker fire ant. The larva develops in the body cavity, then migrates to the head to pupate; during this process it secretes an enzyme that separates the fire ant head from its abdomen – a behaviour that has captured the public's interest and helped raise the profile of the biological control programme.

The parasitic flies have established at most release sites in the USA and are spreading at a rate of 10–20 km per year, but their effects on fire ant populations are proving variable. Research has been directed towards working out why this is so and whether anything can be done to improve impact where it is poor. Their behaviour and biology have been carefully studied in the home and introduced ranges but until recently little was known about host-location behaviour. It was presumed that the phorids had evolved to use one or more chemicals produced for communication purposes by the fire ant itself (semiochemicals). However, much behaviour in social insects is mediated by chemicals and fire ants have an array of glands for this purpose; which of these was responsible for the chemicals that attract the fire ants' natural enemies was unknown. It was thought likely that the worker ant alarm pheromone was the phorids' chemical cue, but there was no direct evidence for this.

In 2007, a team led by Henry Fadamiro at Auburn University, Alabama, confirmed through behavioural studies and electroantennogram (EAG) bioassays that, as expected, location of worker fire ants by phorids was based on detection of host semiochemicals. Unexpectedly, though, they found evidence to implicate fire ant venom alkaloids in the mechanism. Worker fire ant venom is manufactured in a gland in the abdomen, stored in a venom sac, and dispensed via a sting apparatus. Now the team has reported on the results of a study designed to confirm which glands and chemicals mediate the host-location response, and to elucidate what role venom alkaloids play as attractants for phorid flies[1].

In this study, the team first investigated EAG responses in *P. tricuspis* to extracts of *S. invicta* worker body parts and glands. They found that extracts of the whole head and (to a lesser extent) mandibles, and extracts of the whole abdomen and the venom gland/sac elicited EAG responses.

Next, focusing on the role of the venom gland, they used silica gel column chromatography to separate and purify chemical fractions obtained from whole-body extracts, and used EAG bioassay to identify the biologically active fractions. They obtained EAG responses with just two of the five fractions: *cis*- and *trans*-alkaloids; a cuticular hydrocarbon fraction did not elicit a response. Earlier this year the team published the chemical characteristics of the alkaloid fractions from venom, identifying them as *cis*- and *trans*-alkaloids and also identified some of constituent chemicals (see refs in [1]).

The third element of this study was behavioural. By exposing both male and female fire ants to the different fractions in an olfactometer bioassay, the team demonstrated that both sexes were attracted by physiologically active (i.e. very low) concentrations of the *cis*- and *trans*-alkaloid fractions – but not by the cuticular hydrocarbon fraction.

Taken together these three sets of results provide compelling evidence for the role of fire ant venom alkaloids in host location by phorid parasitoids.

The results of the behavioural experiment have two other interesting facets: attractivity of the *cis*- and *trans*-alkaloid fractions to both female and male fire ants, and a difference between the attractivity to females of the *cis* and *trans* fractions at physiologically active concentrations: the first suggests that males may have evolved to use fire ant venom to locate females in place of a sex pheromone; the second suggests a mechanism for females of these host-specific parasitoids to differentiate between *Solenopsis* species (it has previously been shown that the composition of alkaloids varies slightly between species).

A role for the fire ant alarm pheromone in host location by phorids has not been ruled, however – nor has a role for non-chemical cues such as visual stimuli. The first experiment (above) recorded EAG responses to head and mandibular extracts; the mandibles have been reported elsewhere to be a source of alarm pheromone in fire ants. The authors of this paper suggest that fire ant alarm pheromone and venom may either act synergistically, or the highly volatile alarm pheromone may act as a long-distance attractant, and the less-volatile venom as a short-range host-location cue.

The team will continue to study this, and also what role visual cues might play. Knowledge of how phorid flies locate their hosts could facilitate the design of attractant traps which would allow phorid populations to be monitored more effectively, and this could ultimately contribute to improvements in fire ant control.

[1]Chen, L., Sharma, K.R. & Fadamiro, H.Y. (2009) Fire ant venom alkaloids act as key attractants for the parasitic phorid fly, *Pseudacteon tricuspis* (Diptera: Phoridae). *Naturwissenschaften*. Published online 28 August 2009. DOI: 10.1007/s00114-009-0598-6.

Contact: Henry Fadamiro, Department of Entomology & Plant Pathology, Auburn, AL 36849, USA.
Email: fadamhy@acesag.auburn.edu
Fax: +1 334 844 5005
Web: www.ag.auburn.edu/enpl/faculty/fadamirolab/

Call for New US Arthropod Biocontrol Database

The authors of a recent paper in *Biocontrol Science & Technology* propose and describe a new database system for classical biological control of arthropods in the USA[1].

The documentation of biological control agents targeting arthropods in the USA – as is the case elsewhere – has historically been subject to less regulation than weed biological control releases. While a complete record of weed biocontrol agents releases in the USA facilitated retrospective analysis of weed biological control introductions, the record for arthropod agents is incomplete. This is a lacuna that needs to be plugged because, as the authors explain in their first sentence: "Quantification is essential to evaluating the success, obstacles and risks of any applied environmental science practice." Without complete records, it is difficult to substantiate claims about the benefits of arthropod biological control. The authors suggest that that solid documentation and economic analyses would help "bolster arguments for increased classical biological control funding."

The paper reviews publicly available databases to track environmental releases of biological control agents targeting arthropods in the USA, identifying the weaknesses of each in terms of providing a complete record of these releases.

- BIOCAT, created by David Greathead in 1995, is global in scope but covers only insect natural enemies, and not nematodes or pathogens. In addition, as Greathead noted in a subsequent co-authored paper, because BIOCAT depends on published records, it underestimates the total number of attempted introductions. Also, delays in the publication process tend to skew the reported date of introductions. (Warner *et al.*[1] looked at a version of BIOCAT updated to 2002.)

- The US Department of Agriculture – Agricultural Research Service (USDA-ARS) Biological Control Documentation Centre (BCDC), created the Release Of Biological Organisms (ROBO) in 1982. It proved impossible to extract information on field releases of novel biocontrol agents. The shortcomings were identified to be the result of data collection practice design, reporting data being voluntary, and inadequate resources for entering data and maintaining the system.

- Lists of novel arthropod biocontrol agents released have only been published for Hawaii and Florida. The lists (first produced in 1988 and 1993, respectively) are necessarily retrospective, although the Hawaii list has been updated three times since, most recently by the Hawaii State Department of Agriculture in 2007, and the Florida one once, also in 2007. California, which was included in more detailed analysis, did not have a published list.

- Quarantine facilities are a checkpoint for novel species entering the USA, with USDA historically requiring an entry permit of any organism being introduced from overseas into quarantine, and being released from quarantine for further laboratory study and release. But these efforts were focused on purity of cultures, e.g. screening out hyperparasitoids, rather than maintaining a record of what was introduced and monitoring what happened post-release.

By tracking releases in the publicly available databases, it became clear that three states, Hawaii, Florida and California, dominated in terms of numbers of releases over the period 1962 to 2005, and were looked at in more detail. Warner *et al.* were able to use the published lists to investigate Hawaii and Florida further; for California, they obtained a record of federal and state permits for arthropod introductions from the California Department of Food and Agriculture. The data indicate a clear decline in rates of introduction since 1982 or 1994, depending on the source. Comparison with BIOCAT suggested the Hawaii list is reliable but that the Florida and California records are not; unsuccessful attempts to establish biocontrol agents in Florida have gone unrecorded in the literature and therefore BIOCAT, while releases in California have been published and listed in BIOCAT but not recorded by the state. The authors conclude that existing systems offer incomplete or inconsistent data for evaluation for a variety of reasons. Besides the gaps in records of releases, a major concern was that, because they were created before non-target impacts of arthropod biocontrol agents became an issue, they are not designed to store useful data on this now critical topic.

The authors propose a new database to make arthropod biological control data available to a wider audience, and outline in detail how this could be designed. They argue that while the need for a comprehensive database is driven by regulatory needs and issues, it could also facilitate economic and other types of impact evaluation of release programmes, which would help communicate understanding of the value and potential benefits of classical biological control of arthropods.

Warner *et al.* suggest that pre-release data could include the systematics and biology of the natural enemy species proposed for release, together with documentation of the material intended for release: collection data, intended target species, and information on hosts. Post-release field data could include release site locations, post-release monitoring data and effects on non-targets, together with analyses of economic and pesticide-reduction impacts. Supporting documentation could include the environmental assessment, and refereed and other publications.

[1]Warner, K.D., Getz, C, Maurano, S. & Powers, K. (2009) An analysis of historical trends in classical biological control of arthropods suggests need for a new centralized database in the USA. *Biocontrol, Science & Technology* iFirst (online 16 June 2009).
Web: http://webpages.scu.edu/ftp/kwarner/agecobc.htm

Killifish Critique

The following note was received from Peter Neuenschwander, a member of the BNI *Editorial Advisory Board, following the publication of the news item 'Fish in waiting for malarial mosquitoes in Tanzania' in the June 2009 issue of* BNI.

I am troubled by the suggestion on using *Nothobranchius* against mosquitoes as presented in *BNI* volume 30, issue 2, pp. 29N–30N. Fishes are contentious biological control agents because of their unspecific feeding habits. In this particular case, the problematic non-target impact does not only cover freshwater arthropods and amphibians (as if that were not bad enough!); but most importantly other killifishes. *Nothobranchius guentheri* is only one of hundreds of species of this group of families, which have several centres of evolution with hotspots of speciation. The article gives the impression that this killifish has a novel biology. Many of these species indeed lay eggs that necessarily need to dry out before developing further; for others this is a facultative trait, and others do not allow eggs to dry out. A check with Google reveals 34 million entries for killifishes, indicating how well studied these organisms are. To further distribute *N. guentheri* where it already occurs would be one thing; but to distribute it where it does not naturally occur would endanger fish biodiversity to an unacceptable degree. Despite the alluring biology of these fishes, which at first glance suggests that their impact can be controlled, we, the biocontrol practitioners, should not forget that we have decided on various occasions that biocontrol with vertebrates should be avoided. Have we not learnt our lessons, which are retold over and over again by our detractors?

Further Information

Axelrod H., Burgess W., Pronek N. & Walls J. (1985) *Atlas of Freshwater Aquarium Fishes*, 2nd edition. TFH Publication, 782 pp.

Neuenschwander, P., Borgemeister, C. & Langewald, J. (2003) *Biological Control in IPM Systems in Africa*. CABI Publishing, Wallingford, UK, 414 pp.

Seegers, L. (1997) *Killifishes of the World, Old World Killis II*. Aqualog Verlag, Rodgau, Germany, Vol. 8, 112 pp.

Wajnberg, E., Scott, J.K. & Quimby, P.C. (2001) *Evaluating Indirect Ecological Effects of Biological Control*. CABI Publishing, Wallingford, UK, 261 pp.

IPM Systems

This section covers integrated pest management (IPM) including biological control and biopesticides, and techniques that are compatible with the use of biological control or minimize negative impact on natural enemies.

Demand Grows for African DBM Biopesticide

Scientists at the International Institute of Tropical Agriculture (IITA) in Benin have developed an effective biopesticide for diamondback moth, *Plutella xylostella*, (DBM) using a local isolate of the fungus *Beauveria bassiana*. DBM is the main pest of smallholder and commercial cabbage in West Africa, capable of affecting farmers' incomes and the market price of the crop. Having seen it demonstrated in field trials, farmer demand for the product is currently exceeding supply.

Raymond Ahinon, head of the Crop Department of the Songhai Center – a facility that specializes in training, production, and research-for-development of sustainable agricultural practices – in Porto Novo, Benin, says that prospects for cabbage production have been transformed. This centre, which has been using *B. bassiana* on its cabbage farms for some time, has found that it keeps the pest under control.

Cabbage and the related crop, kale, are regarded as high-value cash crops in West Africa, with farmers saying they give higher returns than other vegetable crops such as carrot and lettuce. However, thousands of farmers in West Africa abandoned cabbage production because of DBM damage on their farms. Market prices for African cabbage consequently jumped because of dwindling supply.

The situation was made worse by the high costs associated with synthetic pesticide use – the farmers' only recourse against DBM. Ignace Godonou (IITA Benin) says that the most commonly used pesticides are bifenthrin and deltamethrin, and that some 19 applications of them are needed to control DBM during the three months leading up to harvest: the cost is prohibitive for most farmers. In addition, farmers have found pesticides less and less effective against DBM as the pest has developed resistance to a wide range of synthetic insecticides.

Farmers have also been using botanical pesticides, mostly extracts of seeds of the neem tree (*Azadirachta indica*), against DBM and a wide range of other arthropod pests, but the success of this approach has been limited.

Godonou says that the development of *B. bassiana*, as part of an IPM approach, offers a cost-effective solution for the sustainable control of DBM. He and co-workers screened eight isolates of the entomopathogenic fungi *B. bassiana* and *Metarhizium anisopliae* indigenous to Benin for virulence against DBM larvae. One of the *B. bassiana* isolates (Bba5653) caused 94% mortality of the larvae, significantly higher than with any of the other isolates. Using 1 kg conidia powder (CP) per hectare in a water-based or emulsion formulation, cabbage yield was some three times more than with bifenthrin treatment or an untreated control. Reducing the CP to 0.75 and 0.5 kg/ha did not significantly reduce DBM mortality.[1]

Godonou says that the biopesticide can remain active in the field for several months after initial application, and "will end the rigor of repetitions and high costs and risks associated with the use of synthetic chemical pesticides." A co-author of the study, Cyprien Atcha-Ahowé (IITA Benin) describes how field trials with *B. bassiana* have sparked high demand, but adds: "Many of the farmers who abandoned cabbage cultivation because of DBM but who want to go back are requesting *B. bassiana*, but the problem is the availability of the product."

Like the locust biopesticide Green Muscle®, which was picked up by the private sector, Godonou is hopeful that *B. bassiana* will go down the same route and eventually be adopted by vegetable farmers across the continent.

[1]Godonou, I., James, B., Atcha-Ahowé, C., Vodouhè, S., Kooyman, C., Ahanchédé, A. & Korie, S. (2009) Potential of *Beauveria bassiana* and *Metarhizium anisopliae* isolates from Benin to control *Plutella xylostella* L. (Lepidoptera: Plutellidae). *Crop Protection* **28**, 220–224.

Contact: Dr Ignace Godonou, IITA Benin.
Email: i.godonou@cgiar.org
Fax: +229 21 350556.

Breakthrough Technology for Metarhizium

Scientists at the University of Florida and the company Evolugate (Gainesville, Florida, USA) have reported in *BMC Biotechnology* the experimental evolution of thermotolerant variants of *Metarhizium anisopliae* using a new continuous culture device that works through a natural selection–adaptation strategy[1]. The authors of the paper describe the new technology, the Evolugator™, as "a critical breakthrough for industrial mycology" and say that it potentially allows fungal strains to be developed "for virtually any application."

The research with *M. anisopliae* strain ARSEF2575 (US Department of Agriculture – Agricultural Research Service Insect Pathogenic Fungus Collection, Ithaca, New York), which was conducted as a proof-of-principle regarding the novel Evolugator™ technology, adapted the strain, which has a normal upper thermal limit for growth of 32°C, to grow at 37°C.

The use of *M. anisopliae* as a bioinsecticide has been limited by a number of factors, but one of these is its intolerance to higher temperatures, and – because some insect hosts can elevate body temperature especially when diseased, either as part of an immune response or by basking in sunlight (known as 'behavioural fever') – this issue can become critical during biological control application. In addition, high ambient temperatures in subtropical and tropical climates can hamper the effectiveness of *Metarhzium*.

According to the authors, previously developed methods of continuous culture (i.e. serial dilution and chemostats) are either manually intensive, or carry with them a high risk of contamination, or select for traits that allow microbes to evade selective pressures rather than adapt to them. The Evolugator™ uses continuous flexible tubing as a culture chamber and is fully automated so experimental evolution can be run indefinitely. Both tubing and medium are changed with every cycle of dilution, but without any exposure to external contamination. The net result is that cells can be cultured continuously for very long periods of time, allowing for the selection of complicated traits that cannot be achieved in the short timespan possible using existing techniques.

Over a four-month time period, 22 cycles of growth and dilution were used to select two thermotolerant variants of *M. anisopliae*. These variants were isolated and assessed for growth and pathogenicity. Both displayed robust growth at 36.5°C, which inhibits growth in the parent strain, and one was able to grow at 37°C. Insect bioassays using the grasshopper *Melanoplus sanguinipes* confirmed that the two thermotolerant variants had retained entomopathogenic capacity, albeit with complex alterations in parameters such as infectivity and virulence.

Evolugate plans to promote and market the use of the new technology for the production of novel bioinsecticides under a newly created division, Entovia.

[1]de Crecy, E., Jaronski, J., Lyons, B., Lyons, T.J. & Keyhani, N.O. (2009) Directed evolution of a filamentous fungus for thermotolerance. *BMC Biotechnology* **9**, 74.
Web: www.biomedcentral.com/1472-6750/9/74

Contact: Nemat O. Keyhani, University of Florida, Dept. of Microbiology and Cell Science, Bldg. 981, Museum Rd., Gainesville, FL 32611, USA.
Email: keyhani@ufl.edu
Fax: +1 352 392 5922

All about Azadirachtin

The review 'Azadirachtin, a scientific gold mine' by E. David Morgan[1] packs a wealth of information drawn from 40 years' research on this compound into ten pages. The author also explores why a compound that has apparently outstanding potential for insect pest control has not been more widely used or commercialized. The paper therefore makes useful reading for researchers involved in the practical development and use of neem extracts for pest control.

Azadirachtin is a plant-derived chemical, in the limonoid group of triterpenoids, extracted from *Azadirachta indica,* the neem tree. The 176 references in the review (marred only by the journal's policy of not including titles of papers) demonstrate the large number of previous reviews on aspects related to the chemistry and antifeedant/insecticidal effects of the compound, which reflect the scientific interest and amount of research it has generated. As the author says, "The neem tree must be one of the most intensively studied sources of natural products." However, he points out, there is an imbalance between this large body of research and the use to which it has been put.

There is a lot of chemistry in this review, with accounts of research into the complex structure and equally complicated synthesis of azadirachtin, as well as its extraction and analysis. Although azadirachtin is the most abundant and biologically active of the triterpenoids in neem extracts, more than 150 others have been found, and the paper touches on the structure and significance of some of these. The author outlines the current limited knowledge of how azadirachtin is biosynthesized in the plant, and notes that much has yet to be explained about the compound's mode of action and structure–activity relationships.

Neem is native to South Asia, where its insecticidal/repellent properties have long been known, including the antifeedant properties of its leaves against desert locust, *Schistocerca gregaria*. However, as the literature reviewed in this paper indicates, neem extracts exhibit insecticidal properties against a very broad range of insects, and at far lower doses than those producing antifeedant effects. It is now planted in many parts of the semi-arid tropics, and is often used as a source of azadirachtin or crude neem extract, but also has value as a rapidly growing tree that is tolerant of harsh conditions, suitable for windbreaks, combating desertification and as a source of firewood. The trees begin to bear fruit at 3–5 years old and at maturity can produce up to 50 kg of dried seed annually.

Azadirachtin is found in all parts of the neem tree, but highest concentrations are found and most effectively extracted from seeds. The amount that can be extracted varies, which the author suggests is at least partly due to the precise extraction process. The impact of environmental, soil and seasonal factors on seed azadirachtin content is also unknown.

Morgan says that variable results from experimental use of neem extracts have occurred partly because the term 'neem extract' is very imprecise: it might mean an extract of leaves, or of seeds, or the seed oil, and so on; these will have quite different contents and are in no way equivalent. It is often unclear precisely what compounds have been tested, and how much. Nonetheless, although testing ill-defined extracts is not helpful in developing the technology, in the longer term the use of a mixture of compounds is beneficial in preventing development of resistance in the target pest. Morgan explains that he coined the term 'azadirex' "for the insecticidally active extract of neem seeds, however obtained, containing azadirachtin as its principal active component, with other biologically active limonoids."

Like many natural pesticides, regulatory hurdles have hindered the commercialization of neem products [and this has also been the subject of an anti-biopiracy campaign]. However, the author makes an interesting comparison between azadirex and another much more successfully commercialized plant-derived insecticide, pyrethrum, identifying from this "some of the advantages and disadvantages of azadirex in production and use."

In early commercialization efforts, the author suggests, too little attention was paid to the stability of the product to light, temperature and pH, which meant results were variable and potential users discouraged. Nowadays far more importance is attached to formulation of biological pesticides in general. There is potential for improving the stability of azadirachtin products (e.g. with UV screens) and its formulation (e.g. one possible avenue is forming complexes with certain sugars to increase water solubility).

The author identifies the high cost of raw material and therefore the final price, as well as licensing fees, as continuing obstacles to commercializing neem-based products. He suggests the high cost of commercial neem production might be tackled via mechanical harvesting, or finding commercial outlets for neem by-products.

Although poor uptake of neem-based control measures has been ascribed to apparent unreliability, as well as supply problems, Morgan suggests an additional and quite different reason: cheap and easy availability of crude neem seed extracts – coupled with slower action against pests than more expensive synthetic pesticides – made farmers undervalue the 'homemade' neem-based product in early farm-based initiatives. With farmers facing growing restrictions on use of synthetic chemicals, a new window of opportunity may have opened for developing and promoting neem-based technology.

[1]Morgan, E.D. (2009) Azadirachtin, a scientific gold mine. *Bioorganic & Medicinal Chemistry* **17**, 4096–4105.
Web: www.elsevier.com/locate/bmc

This article is adapted from an article that appeared first in *GRO-Cocoa* No 16 (December 2009), pp. 6–7.
Web:
www.cabi.org/default.aspx?site=170&page=1888

Announcements

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

New Zealand Biocontrol Agent Database

A database containing information on the biological control agents that have been introduced to New Zealand to help manage weed and invertebrate pests is now available online[1].

The database 'Biological Control Agents Introduced to New Zealand' (BCANZ) has been prepared by the research team of Outcome-Based Investment (OBI) Better Border Biosecurity (B3), funded by the New Zealand Foundation for Research, Science and Technology (FRST).

In October 2009 the database contained records for 721 introductions of 518 biological control agents against 126 targets (25 weeds and 101 invertebrates); the information is being constantly updated. The database can be searched by biocontrol agent either by decade of introduction or alphabetically, or by target pest. Records include information on the target pest(s), the origin of the agent, numbers introduced and release sites, establishment status, and target and non-target impacts, together with any available references.

[1]Ferguson, C.M., Moeed, A., Barratt, B. & Kean, J.M. (2007) BCANZ – Biological Control Agents Introduced to New Zealand.
Web: www.b3nz.org/bcanz

IOBC/WPRS Working Group Celebrates Birthday

The 50th Anniversary of the IOBC/WPRS WG (International Organization for Biological Control/ Western Palaearctic Regional Section Working Group) 'Integrated Protection of Fruit Crops' fell in February 2009, and to celebrate this, an historic review[1] of the first 25 years of the WG has been written, which can be downloaded from the IOBC/ WPRS website. The review includes over one hundred references of various kinds. The authors describe how fruit entomologists have been the pioneers within WPRS in terms of developing integrated plant protection (IPP) and integrated production (IP) and their introduction into practice. They summarize important events, identifying the key characteristics, challenges and turning points of successive eras. A short section (by Jerry Cross) on the future perspectives of the WG indicates that there is plenty still to say about the last 25 years.

[1]Boller, E.F., Minks, A.K., Cross, J.V. & van Lenteren, J.C. (2009) February 2009: The Working Group "Integrated Protection of Fruit Crops" is celebrating its 50th Anniversary.
Web: www.iobc-wprs.org/

Integrated Protection of Fruit Crops Meetings

Two meetings of the IOBC/WPRS WG 'Integrated Protection of Fruit Crops'are scheduled for 2010.

On 15–17 September 2010 in the Tremiti Islands, Italy, a joint meeting of the 'Pome Fruit Arthropods' Sub-Group and the 'Stone Fruits' Sub-Group takes the form of a workshop on sustainable protection of fruit crops in the Mediterranean area.

On 20–23 September 2010 in Budapest, Hungary, the Sub-Group 'Soft Fruits' is holding a workshop on integrated soft fruit production.

Information: www.iobc-wprs.org/events/index.html

Invasive Species Guidelines for the Pacific

The Pacific Invasives Partnership (PIP) has published 'Guidelines for Invasive Species Management in the Pacific'. Copies of the guidelines are available free to anyone working on invasive species in the region. These guidelines, together with National Biodiversity Strategies and Action Plans (NBSAPs) and national/territorial Invasive Species Action Plans, will be used for guidance by PIP members.

PIP was created a year ago with the merging of the combined Pacific Invasives Initiative (PII) and Pacific Invasives Learning Network (PILN) partnership with the Invasive Species Working Group of the Roundtable for Nature Conservation in the Pacific Islands. PIP now acts as the single coordinating body for invasive species action in the Pacific.

The guidelines were launched at PIP's first meeting in July 2009 and were adopted as its guiding framework. PIP members also agreed on mechanisms to ensure that their organizations' programmes reflect the priorities of Pacific island countries and territories, and developed an Action Plan to support implementation of the guidelines.

Contact SPREP.
Email: irc@sprep.org
Web: www.sprep.org/att/publication/000699_RISSFinalLR.pdf.

ENDURE IPM Training Leaflet on Experience Groups

ENDURE (European Network for the Durable Exploitation of Crop Protection Strategies) has issued the first in a series of leaflets in a 'Training in Integrated Pest Management' series. The series is drawing on ENDURE partners' expertise and is pooling their experiences to outline proven techniques useful for advisers and extension services across the European Union.

The ENDURE Network of Excellence includes 300 researchers from 18 organizations in ten countries and is funded by the European Commission (2007–2010). Its objectives are to build a lasting crop protection community of research, provide end-users with a broader range of short-term solutions to specific problems, develop a holistic approach to sustainable pest management, and take stock of and inform plant protection policy changes.

The first leaflet is entitled 'Using experience groups to share knowledge and reduce pesticide use' and is by Rolf Thostrup Poulsen and Poul Henning Petersen from the Danish Agricultural Advisory Service (DAAS). The leaflet draws on Denmark's longstanding use of experience groups, which were first developed in the early 1980s and later played an important part in helping Danish farmers meet government targets to reduce pesticide use while remaining profitable. Now, with 428 registered experience groups totalling more than 3000 members in the country, they cover the majority of agricultural sectors. DAAS says membership of experience groups offers some key advantages:

- The uncertainty the farmers feel can be removed by sharing them with colleagues and the adviser
- Advice is presented regularly during the growing season when weeds, pests and diseases have to be treated
- It is more efficient to advise seven farmers once rather than seven farmers individually

- The farmer experiences how strategies work out at similar farms
- Farmers challenge each other to solve problems in the best possible way
- The cost of an adviser can be split between members of the group

The eight-page leaflet outlines the best ways to proceed, from creating an experience group through to generating commitment, setting goals, timetabling and maintaining motivation.

Source: Anon (2009) First IPM training leaflet now available. ENDURE Newsletter No. 5, September/October 2009.
Web: www.endure-network.eu//about_endure/all_the_news

IPaWN: the International Parthenium Weed Network

IPaWN, the International Parthenium Weed Network, has been created to bring together expert volunteers devoted to creating awareness about the parthenium weed (*Parthenium hysterophorus*) threat, and to sharing information on how to reduce its adverse impacts upon agro-ecosystems, the environment and human health.

The new network is an initiative of the Tropical and Sub-tropical Weed Research Unit (TSWRU), The University of Queensland, Australia. In 2009 and with research involvement in three continents, TSWRU developed information packages on the weed which were sent out to more than 20 countries that have or are at threat of having the weed. The overwhelming positive response to this initiative meant the value of setting up an international network became obvious.

IPaWN was set up with the mission of coordinating and disseminating information regarding the global invasion of parthenium weed, its diverse impacts on agro-ecosystems, the environment and human health, and its management. Its goal is to create an online community to support international collaboration on the parthenium weed problem and its management.

The objectives of the network are:

- To facilitate the exchange of information about parthenium weed and its management
- To link different regional working groups, institutions and other stakeholders with an interest in parthenium weed and its management
- To document new outbreaks of the weed and to recommend strategies to reduce further spread in those regions
- To identify topics deserving of new research and to provide access to online resources such as identification kits, best management practice documents, etc.

Meetings of IPaWN are likely to be timetabled to coincide with major international conferences such as those of the International Weed Science Society, the Asian Pacific Weed Science Society and the International Parthenium Weed Management Conferences.

Parthenium Newsletter

The Australian Parthenium Weed Research Group plan to produce 'International Parthenium News', a newsletter to be published at the University of Queensland, Australia. Contributions for the first issue in 2009 are now invited.

Contacts: Dr Steve Adkins (Chair) & Asad Shabbir (Network Co-ordinator), IPaWN, The University of Queensland, Australia.
Emails: s.adkins@uq.edu.au / asad@uq.edu.au

IOBC Pathogens Meeting Focuses on Climate Change

The 11th meeting of the IOBC/WPRS (International Organization for Biological Control/Western Palaearctic Regional Section) Working Group 'Biological Control of Fungal and Bacterial Plant Pathogens' has the theme 'Climate change: challenge or threat to biocontrol'. The meeting is being held in Graz, Austria, on 7–11 June 2010.

The organizers say that although the emphasis will be on climatic influence on biocontrol, and priority will be given to this in oral presentations, all contributions relating to biocontrol of diseases are welcome.

Contact: Ilaria Pertot, Fondazione Edmund Mach, S. Michele all'Adige (TN), Italy.
Email: Ilaria.Pertot@iasma.it
Web: http://tinyurl.com/yel8urr

Coccinellids in Biological Control

An issue of the journal *Biological Control* has been devoted to 'Trophic ecology of the Coccinellidae'. Volume 51, Issue 2 (November 2009) is edited by Jonathan G. Lundgren and Donald C. Weber. Content includes:

- Assessing the trophic ecology of the Coccinellidae: Their roles as predators and as prey (D. C. Weber & J. G. Lundgren)
- The evolution of food preferences in Coccinellidae (J. A. Giorgi, N. J. Vandenberg, J. V. McHugh, *et al.*)
- Scale insects, mealybugs, whiteflies and psyllids (Hemiptera, Sternorrhyncha) as prey of ladybirds (I. Hodek & A. Honěk)
- Aphidophagy by Coccinellidae: application of biological control in agroecosystems (J. J. Obrycki, J. D. Harwood, T. J. Kring & R. J. O'Neil)
- Lady beetles as predators of insects other than Hemiptera (E. W. Evans)
- Coccinellidae as predators of mites: Stethorini in biological control (D. J. Biddinger, D. C. Weber & L. A. Hull)

- Mycophagy in Coccinellidae: review and synthesis (A. M. Sutherland & M. P. Parrella)
- Nutritional aspects of non-prey foods in the life histories of predaceous Coccinellidae (J. G. Lundgren)
- Natural enemies of the Coccinellidae: parasites, pathogens, and parasitoids (E.W. Riddick, T.E. Cottrell & K.A. Kidd)
- Lady beetle oviposition behavior in response to the trophic environment (M. P. Seagraves)
- Coccinellids in diverse communities: Which niche fits? (W. E. Snyder)

Web: www.sciencedirect.com/science/issue/6716-2009-999489997-1516148

Updated BCPC Biocontrol Manual

The BCPC (British Crop Production Council) Congress, which is taking place in Glasgow this November after a hiatus last year, sees the launch of the fourth edition of *The Manual of Biocontrol Agents,* as well as the new editions of *The Pesticide Manual* and *The e-Pesticide Manual*.

The latest *Manual of Biocontrol Agents*, edited by Len Copping, has been expanded to include over 70 new entries and now contains details of 452 biocontrol agents used in over 2000 commercial products.

Contact: BCPC Publications Sales, 7 Omni Business Centre, Omega Park, Alton, Hampshire, GU34 2QD UK.
Email: publications@bcpc.org
Web: www.bcpc.org/bookshop

Conference Reports

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

EMAPi 10: 'Effective Intervention through Enhanced Collaboration'

The Tenth Conference on the Ecology and Management of Alien Plant Invasions (EMAPi) underlined the expansion from its traditional regions in Europe and North America. EMAPi 10 was held in South Africa, 17 years after the conference series' establishment. This, the second consecutive EMAPi meeting in the southern hemisphere, underlines how it has now established its place on the world stage.

EMAPi meetings began in Loughborough University in the UK in 1992. The following year continued with EMAPi 2 in the Czech Republic (1993). Since then, EMAPi conferences were held every two years across North America and Europe (Arizona, Germany, Sardinia, the UK, Florida and Poland), until EMAPi 9, which was held in Australia in 2007. As EMAPi conferences have become influential in shaping the research agenda for the study of plant invasions worldwide, their growing status has led to the number of participants increasing substantially. Not only the conferences themselves have built up the reputation of EMAPi, but also the proceedings published as edited books or special issues of journals. The initial focus of EMAPi on Europe quickly extended to North America and other parts of the world which later led to EMAPi becoming truly global in its reach, making unique worldwide connections between managers and researchers.

The tenth conference in the EMAPi series was held in Stellenbosch, South Africa, on 23–27 August 2009 and was hosted by the now world-renowned working group on invasive species: the DST-NRF (Department of Science and Technology – National Research Foundation) Centre for Invasion Biology (CIB) at Stellenbosch University (www.sun.ac.za/cib). The meeting attracted 240 delegates from at least 29 countries, with presentations on topics from Antarctic to Greenland. Special sessions and workshops were organized to stimulate better communication within research and management groups on specific topics. These include pine invasions, invasions in mountain ecosystems, protected areas and invasive species, and more general themes such as risk assessment methods, experiences on the management of invasive plants, policy regulations and funding of eradication and monitoring campaigns. Seven plenary presentations on subjects ranging from a scientific review of the biology of alien species and invasion patterns, to management and policy matters, were given by leading figures from around the world: Marcel Rejmánek, Mark Burgman, Spencer Barrett, Sue Milton, Peter Dye, Petr Pyšek, and CABI's own Arne Witt. Arne was invited to give a plenary presentation, which he titled 'Alien plant invasions in sub-Saharan Africa – status, prognosis, and key challenges'. With numerous well-illustrated examples, Arne emphasized the impacts of plant invasions on food security, biodiversity, transport, water resources and human health.

A number of sessions focused on burning issues at the coal face of invasive plant management, with a session dedicated to integrated management. This included a presentation on integrated pest management and biological control of water hyacinth (*Eichhornia crassipes*), arguably one of the world's most troublesome aquatic plants. Another important avenue of research highlighted, although frequently given less attention, was on assessing the costs and benefits of the biological control research programme on invasive plants in South Africa. The benefit–cost ratios for the biocontrol programme assessed by Willem de Lange & Brian van Wilgen varied from R11 benefit for every R1 spent (for subtropical alien shrubs). However, at the other end of the scale, for biological control of perennial invasive Australian trees, a benefit of R863 for every R1 was realized. This indicates the substantial contribution that biological control agents can make to long-term control of invasive alien plants.

Last but not least is a warm invitation to all who are interested in biological invasions, scientists, managers and policymakers, and especially those who have not attended before, to the next EMAPi conference in Hungary in 2011. For details about the conference, contact Dr Zoltan Botta-Dukat (email: bdz@botanika.hu).

By: Llewellyn C. Foxcroft[a] & Jan Pergl[b]

[a]Conservation Services, South African National Parks, DST-NRF Centre for Invasion Biology, Stellenbosch University, South Africa.

[b]Department of Invasion Ecology, Institute of Botany, Academy of Sciences of the Czech Republic.

IOBC/WPRS Study Group 'Benefits and Risks Associated with Exotic Biological Control Agents'

The first meeting of the IOBC/WPRS (International Organization for Biological Control/Western Palaearctic Regional Section) Study Group 'Benefits and Risks Associated with Exotic Biological Control' was held on 6–9 September 2009 in Engelberg, Switzerland. This Study Group was founded in 2007 and its goals are to offer a forum for exchange of information and to stimulate contacts and cooperation between scientists working in the field of benefits and risks of exotic biological control agents. The first meeting of the group was organized by Marc Kenis and Dirk Babendreier (CABI Europe – Switzerland, Delémont), Alexandre Aebi (Agroscope Reckenholz-Tänikon, Zurich, Switzerland) and Helen Roy (Biological Records Centre, Centre for Ecology & Hydrology (CEH), Wallingford, UK), who is the convenor of the Study Group.

This first meeting was devoted to '*Harmonia axyridis* and other invasive ladybirds' and thus had a narrower focus than the general objectives of the group. However, *H. axyridis* is clearly a very relevant organism in the context of benefits and risks of exotic biological control agents and has attracted considerable attention in recent years. Altogether, 55 participants (mainly from across Europe but also from the USA, Japan and South Africa) attended the conference. After the welcome address, the first session was opened by Helen Roy who gave a keynote on 'Encounters with an alien: *Harmonia axyridis* in Europe'. Together with the ensuing talks, the first session gave a perfect overview of the current state of the invasion process of this exotic ladybird in Europe.

The second session was opened with a keynote by Professor Osawa from the University of Kyoto, Japan, on the ecology of *H. axyridis* in its native range while the keynote of the third session was on 'Invasive alien species in Europe: a review of patterns, trends and impact', given by David Roy from CEH. Subsequent presentations in these two sessions focused on the role of intraguild predation (IGP) in the population dynamics of *Harmonia* and other competing ladybirds. Evidence given throughout these sessions indicates that IGP occurs in this system under field conditions. Nevertheless, it was noted by some speakers that the prevalance of IGP might be limited in the field and consequently not significant to ladybird communities in terms of ecological function. Lively discussions demonstrated the relevance of this topic to the theme of the meeting but also how important and interesting the presented topics were for the entire audience at the meeting. Clearly, more quantitative data are required to enable a more complete understanding of IGP than is currently available and also to allow realistic calculations to be made on the risks for native ladybirds from the invasion of *H. axyridis*.

This IOBC meeting was also the platform for a tribute to the late Professor Mike Majerus (University of Cambridge). Mike Majerus was a very well known expert on ladybirds, and he sadly died earlier in 2009. It was fascinating to listen to the presentations of his co-workers and to learn about recent activities and scientific results obtained under his supervision. His enthusiasm for ladybirds, his scientific life and the impact Mike had and still has in the area of ladybird research was obvious during the passionate talks.

Ted Evans from Utah State University, USA, gave a keynote on the 'Dynamics and impact of *Coccinella septempunctata* as another invasive lady beetle in North America' in the fourth session of the meeting. Other talks provided exciting insights into the ecology of ladybirds, their status in different European countries and changes in distribution and abundance of native ladybirds since, and as a response to, the invasion of *H. axyridis* in Europe. In addition, a presentation was given on first records of *H. axyridis* in South Africa, indicating that the beetle is already distributed over large parts of the country. During this session, there were dynamic exchanges on the best methods to assess ladybird numbers and species. It is clearly envisaged that we should take this unique opportunity to harmonize methods as far as possible in order to allow for the comparison and joint analysis of data generated during surveys/ studies across Europe.

In the last session, Bill Hutchison from the University of Minnesota, USA, gave a keynote on the 'Pest status and management of *Harmonia axyridis* in North American vineyards'. Understandably, this is also of concern for European wine makers, although some important differences exist between US and European conditions, pointing towards less potential for problems with tainted wine in Europe. Other talks provided relevant and up-to-date findings on antagonistic organisms of *H. axyridis* (e.g. parasitic mites, parasitoids). This kind of knowledge could be useful for future attempts to control *H. axyridis*.

In addition to the talks presented, 17 posters were displayed at the venue during the meeting and these stimulated further discussions among participants. Finally, an idyllic afternoon field trip allowed the delegates to enjoy the scenic landscape of Engelberg and also encounter some alpine wildlife. This was possible thanks to Heike Kuhlmann who organized the technical aspects of the conference with perfection. Though *H. axyridis* has already been found in some alpine locations, only one specimen was found during this excursion – by the eight-year-old daughter of one of the delegates! Together with the authentic 'raclette dinner' at 1800 m above sea level taken after the hike, this excursion was highly appreciated by all participants especially as weather conditions were just perfect.

In summary, this IOBC meeting offered an opportunity for research scientists, invasion ecologists, biological control specialists and other interested colleagues to meet and discuss a wide range of aspects such as risk assessment in biological control, invasion ecology, spread, genetics of invasion, management of ladybirds, ecological impact on native fauna, agricultural impact, association with symbionts and tri-trophic interactions. It was also an excellent opportunity to develop and strengthen numerous collaborations and as such was a huge success. We thank all the participants who made this first meeting – with all the exceptional presentations, posters and discussions – so exciting!

The meeting ended with a fruitful discussion on future activities of the Study Group. The aim is to become an official WPRS Working Group and to expand activities beyond *H. axyridis* and invasive ladybirds. Therefore, I would like to use this opportunity to make all of you aware of this Study Group and invite you to make contact with the convenor, Helen Roy (hele@ceh.ac.uk), if you are interested in any of our activities and would like to join the group (see also the IOBC/WPRS website for more information: www.iobc-wprs.org).

By: Dirk Babendreier, CABI Europe – Switzerland.