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General News

Economic Benefits of Ragwort Biological Control in New Zealand

Five agents have been introduced to New Zealand during a 90-year biological control programme against ragwort (*Jacobaea vulgaris*). An analysis by Landcare Research, reported in its *What's New in Biological of Weeds?* newsletter, shows that successful biological control by one of these, the flea beetle *Longitarsus jacobaeae*, has returned a benefit–cost ratio of 14:1 on dairy farms alone over this period.

Ragwort was first recorded in New Zealand from Dunedin, South Island in the 1870s, probably arriving as a seed contaminant. Like many other weeds in the Asteraceae, copious seed production and competitive vegetative growth along with an ability to thrive in disturbed habitats contributed to its invasive success. By the 1920s it was one of New Zealand's most serious weeds, infesting vast tracts of pastoral land where its toxicity to horses and cattle added to the problem for dairy farmers.

It became one of the first weed biological control targets in the country, with the first biocontrol agents – cinnabar moth (*Tyria jacobaeae*) and ragwort seedfly (*Botanophila jacobaeae*) – introduced in the 1920s–1930s. Although both established, their distributions have remained limited, the seedfly is ineffective at reducing seed production and the cinnabar moth does not achieve damaging populations every year. So biological control remained inadequate until a third agent, the ragwort flea beetle, was introduced in the 1980s.

The flea beetle had been eliminated from a shortlist of candidates for introduction to New Zealand in the 1930s because of perceived low impact. But this judgement was based on field observations and critically no quantitative studies were conducted. The idea of introducing the flea beetle was revisited in the 1980s following encouraging reports of its success against ragwort elsewhere. *Longitarsus jacobaeae* from Italy had been introduced to coastal western states of the USA against ragwort infestations in rangeland from 1968. It became the most effective biocontrol agent for ragwort in temperate coastal zones, reducing ragwort infestations by >90% at many sites. Material from this US population was subsequently introduced to Australia and later New Zealand.

The flea beetle was released in New Zealand in 1983 and by the early 1990s was beginning to make inroads into the ragwort problem. Apart from in high-rainfall areas, the weed has since declined to the extent that it has become a rare sight in many previously infested parts of the country, and often no other control measures are needed. However, Simon Fowler, who undertook the recent analysis, says that few quantitative data were collected so although it is clear that the flea beetle has had a big impact on ragwort, the financial benefits could only be speculated on.

To tackle the wetter areas where the flea beetle has been relatively ineffective, two lepidopteran biocontrol agents that had been successfully introduced to Tasmania from Spain – the ragwort plume moth (*Platyptilia isodactyla*) and the ragwort crown borer (*Cochylis atricapitana*) – were introduced in 2005 (see below). As part of the application to release these agents, a survey was conducted on 32 randomly selected dairy farms where the flea beetle had provided inadequate control on South Island's West Coast to determine the continuing cost of ragwort control. Fowler was able to use these data to complete a national benefit–cost analysis to extrapolate what the cost of ragwort control would be for dairy farms across the whole country in the absence of biological control by the flea beetle. He extrapolated costs of the ragwort biological control programme and mechanical/chemical control costs from detailed historical records and the above survey data, respectively, making appropriate adjustments for inflation, changes in the size of the dairy herd, the proportion of the dairy area where the flea beetle had impact, etc. He assumed that the decline in ragwort observed in other parts of New Zealand could be attributed to the presence of the flea beetle, and that where ragwort was suppressed it would be replaced with pasture and not some other invasive weed.

The results were a surprise, with benefits much higher than anticipated. For 2015 alone, savings in ragwort control on dairy farms in New Zealand from biological control by the flea beetle were predicted by Fowler's analysis at NZ$44 million – and this annual saving is ongoing and needs no further investment. He also estimated a benefit–cost ratio of 14:1 for ragwort biological control dating from the start of the programme in 1926: for every dollar that has been invested there has been a $14 return. Moreover, the costs in his analysis included only control costs, not costs of lost production or to farmers when stock are poisoned, and benefits did not take account of other sectors of the farming community, such as deer or sheep and beef farming, so total net benefits both for dairy farmers and for the New Zealand economy are even higher.

While the decision to reject the flea beetle on anecdotal, non-quantified evidence in the 1930s looks like a costly mistake (had it been introduced then, savings by now would have run to an estimated $8.6 billion at net present value), hindsight is a wonderful thing. Fowler points out that refining agent selection is now a key area for Landcare Research to ensure resources are not put into agents that have a low chance of success. He notes that considerable progress has been made on understanding why

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around three of every four agents released and established in the past failed to have any significant impacts on the target weeds.

Dairy farms across the country are still incurring some $20 million in costs of ragwort control annually, however, largely (as noted above) in higher-rainfall areas. The West Coast Ragwort Control Trust (WCRCT), who Landcare Research assisted to introduce the two new agents in 2005, obtained funding for an additional community project from 2005 onwards to mass-rear and distribute the biocontrol agents to West Coast farmers. While the crown borer proved difficult to rear and failed to establish from some small releases, some 9000 plume moths were reared by the WCRCT and distributed to Coast farmers and established well.

The plume moth has been recorded in Europe from marsh ragwort (*Jacobaea aquatica*), which, as the name suggests, thrives in wet environments. As it also has 2–3 generations a year, a single moth can lay around 100 eggs, and attack by as few as 2–3 larvae may kill a seedling plant, it seems a good prospect for combatting ragwort in New Zealand's wetter areas. Through the efforts of the WCRCT project, the plume moth has established at 85% of release sites. Monitoring conducted by the WCRCT and by Landcare Research indicates that populations of the plume moth are becoming widespread on the Coast. Landcare Research has found that ragwort is now far less common than during pre-release surveys. The plume moth has begun to reduce ragwort populations in some areas throughout the Coast where the flea beetle was having little impact. A few farmers were only having to spot-spray instead of boom-spraying or using helicopters. Good results with the plume moth are reported from other parts of New Zealand, so there is hope that the economic success of ragwort biocontrol may be extended to all of New Zealand's dairy farmers.

Sources: Fowler, S. (2015) Ragwort biocontrol pays off. *What's New in Biological Control of Weeds?* 74 (November), 2–3. Landcare Research New Zealand Ltd 2015.
Anon. (2013) West Coast ragwort control – a successful community project. *What's New in Biological Control of Weeds?* 66 (November), 2–3.
Landcare Research New Zealand Ltd 2013.
Web: www.landcareresearch.co.nz/publications/newsletters/biological-control-of-weeds

Winston, R.L., Schwarzländer, M., Hinz, H.L., Day, M.D., Cock, M.J.W. and Julien, M.H. (eds) (2014) *Biological Control of Weeds: a World Catalogue of Agents and Their Target Weeds*, 5th edn. USDA Forest Service, Forest Health Technology Enterprise Team, Morgantown, West Virginia, USA.
Web: www.ibiocontrol.org/catalog/

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Trichogramma-based IPM to Boost Rice Production in the Greater Mekong Subregion

A project funded by the European Commission through EuropeAid* has introduced thousands of smallholder rice farmers in the Greater Mekong Subregion (GMS) to an integrated pest management (IPM) strategy that has, as its cornerstone, large-scale deployment of *Trichogramma* egg parasitoids to control the major insect pests of the crop.

The Mekong is Asia's longest river, flowing 4300 km from its source on the Tibetan plateau, through southwestern China and Southeast Asia, to its delta in southern Vietnam. Rice is the dominant crop along the river and increased productivity is crucial for food security and economic development. It is the most important source of food for the people in the GMS, provides work and income for 80% of the population, and generates a substantial part of the GDP of the constituent countries. Despite significant improvements in rice production in the past 15 years, productivity in the subregion remains low. The crop is prone to weed infestations, diseases and insect pests, which often reduce yields by 20% or more. The use of broad-spectrum pesticides has increased and nowadays a vast quantity is used in rice fields because farmers have little training or knowledge about other, more sustainable pest control practices. Far from solving farmers' problems, pesticide overuse, particularly insecticides, has exacerbated the situation through the development of insecticide resistance and outbreaks of secondary pests such as plant hoppers. Inappropriate use of broad-spectrum insecticides is also a threat to the health of rice farmers and consumers – and the environment, including the river itself. So it was appropriate for this project to work across the GMS.

The project has brought together local partners in three target countries in the GMS – China (Guangxi and Yunnan provinces in the southwest of the country), Lao People's Democratic Republic (PDR) and Myanmar – with staff from the International Rice Research Institute based in the Philippines, Tianyi Biological Control Company Ltd (Hengshui, Hebei, China), CABI in Switzerland, China and Malaysia, and the Institute of Plant Protection of the Chinese Academy of Agricultural Sciences (IPP–CAAS), operating out of the Ministry of Agriculture–CABI Joint Laboratory based in Beijing. The project has focused on sustainably increasing rice production in the target regions through research, capacity building and implementation of biocontrol-based IPM that is effective now and also resilient to climate change. The central role of insect parasitoids in the IPM strategy means that it is only likely to be successful on an area-wide basis – i.e. isolated farmers deploying *Trichogramma* are unlikely to reduce pest population pressure – which means that a village-scale approach was adopted, while the specific needs of low-income, smallholder rice farmers are being addressed by combining traditional and modern practices in the strategy.

The first part of the project focused on developing the rice IPM strategy, and identifying an appropriate biocontrol agent for the major insect pests. Project staff surveyed for rice pests and their natural enemies, and conducted participatory rural appraisals, talking mainly to farmers but also other community stakeholders in the target regions. These activities allowed them to produce a comprehensive overview of rice pests and local management practices in each region. They identified the most important pests as three crambid moths: two stem borers (*Scirpophaga incertulas* and *Chilo suppressalis*) and a leaf roller (*Cnaphalocrocis medinalis*). Laboratory studies on host acceptance of these species together with research on survival and parasitism rates in the field identified the most promising biocontrol agent as a specific strain of the egg parasitoid *Trichogramma chilonis* for areas where *Chilo suppressalis* is the dominating pest, and *T. japonicum* for areas where *S. incertulas* is causing most problems. Farmers need heat-tolerant strains that are efficient at the high temperatures prevalent in the target region and able to cope with even higher ones expected under conditions of climate change, so experiments were conducted under varying temperatures to allow the selection of *Trichogramma* strains with this trait. Information was also collected during field studies to help develop a sound release strategy in terms of the number of release points and the number of *Trichogramma* necessary to control the target pests. In addition, field and laboratory research was conducted to evaluate the extent to which *Trichogramma* was likely to be negatively affected by application of insecticides targeting plant hoppers.

The acquired knowledge and research findings were synthesized into an IPM strategy, tailored for each cropping system and region, with the inundative releases of the *Trichogramma* wasps during the critical tillering stage of rice growth at its centre. The project also produced an IPM technical guideline for rice for each region, which specifies various IPM measures, including *Trichogramma*, for controlling rice pests, and puts strict limits on the use of – particularly broad-spectrum – pesticides. Other measures suggested in the guideline include improved and more balanced fertilization schemes, alternate drying and wetting of the crop area, pheromone trapping of stem borer adults, use of tolerant rice varieties and growing flowering strips (such as sesame) on the larger bunds to encourage natural enemies and pollinators.

Clearly, the success of the IPM strategy depends on a reliable and timely supply of very large numbers of *Trichogramma* egg parasitoids. Thus a major objective of the project was to establish *Trichogramma* rearing facilities (TRFs) in the three countries involved. *Trichogramma* rearing depends in turn on rearing large numbers of a suitable host species. Applying a cost–benefit approach, the rice moth (*Corcyra cephalonica*) reared on a rice bran-based diet was selected as the most efficient production system. For both the host and the biocontrol agent, strict quality control procedures were outlined, focusing (for *Trichogramma*) on parasitism rate, emergence rate and sex ratio. During the second half of the project, production facility and equipment designs were adapted and built to meet the specific needs in each target region, and constructed using local, low-cost materials. Where possible, existing buildings were used and renovated to serve as a TRF. The *Trichogramma* eggs are made available to farmers as an easy-to-use product: as cards, from each of which c. 1000 *Trichogramma* wasps emerge. The farmers hang the cards on rice plants in their fields. Per hectare, 100 cards are deployed, and thus 100,000 wasps released, and three releases are scheduled per season, focusing on the tillering stage. Each TRF is expected to reach a target of 500–700 ha of rice fields protected by the wasps. To ensure the sustainability of operations, staff engaged to run the TRFs have been trained in all aspects of production, while the project team has compiled a *Trichogramma* production guide, slightly adapted for each target region. By mid-2015, 11 of 12 planned TRFs had been completed while the final one in Myanmar will become operational in spring 2016. Despite successful establishment of these TRFs in the target regions, it became obvious, particularly for Lao PDR and Myanmar, that the production and delivery of biocontrol agents was problematic, basically because it is a completely new concept to these countries. The production collapsed a few times at the beginning, so relatively low amounts of material were produced until the end of 2015. In contrast, up to 85 g of *Corcyra* eggs were produced daily in each of the TRFs situated in Yunnan and Guangxi provinces, China.

The ultimate test of success of the project is its uptake by the rice farmers for whom it was conceived. Setting up demonstration plots provides an ideal way for farmers to see the strategy in practice and get hands-on training, and the rice farmers involved in this project have been able to gain experience in implementing the IPM strategy and collecting data through demonstration plots. From these demonstration plots, slightly higher yields were achieved, with notably reduced pesticide use and an overall higher cost efficiency. This small increase in yield appears to be due to the improved pest management based on *Trichogramma*, but as there were no differences in fertilizer use between IPM and control fields, further yield increases are achievable under the IPM strategy. Overall, pest density was not that different between IPM and conventional plots but markedly more natural enemies were observed in the IPM fields, particularly towards the end of the season. In addition to the demonstration plots, several thousand farmers were trained on rice IPM in classroom and field sessions. Feedback from farmers has been very positive and a frequently heard comment, particularly from Chinese rice growers, was that they would be willing to pay for *Trichogramma*, as long as they are not more expensive than pesticides. Finally, a number of national agricultural research and extension institutions have shown interest in adopting the *Trichogramma*-based IPM approach and the Plant Protection Station in Guilin, Guangxi Province, China, for example, plans to initiate its own rearing facility this year.

*The project 'Agricultural innovation for smallholder farmers in the Greater Mekong Subregion to improve food security, in the context of impact and adaptation to climate change and in favour of economic development' is a 5.5-year project (February 2011 – July 2016), funded by EuropeAid within the Global Programme on Agricultural Research for Development.

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See also:
www.cabi.org/projects/project/33074

www.ippcaas.cn/Html/2013_03_27/2585_47965_2013_03_27_54037.html

www.cabi.org/Uploads/projectsdb/documents/33074/Rice%20congress%20bangkok%202014.pdf

James Stewart Kelleher, 1924–2015

James Stewart Kelleher, 91, died peacefully on 24 November 2015 in Ottawa, Canada surrounded by his family and caregivers.[1] Jim was born on 6 November 1924, in Canora, Saskatchewan. His early years were spent in Brandon, Manitoba, where he completed high school before serving in the Royal Canadian Navy during World War II. Jim received his BSc in biology from the University of Brandon, his MSc from the University of Iowa and his PhD from the University of Minnesota. Jim was a humble man of quick wit and always willing to help family, friends and colleagues when it was needed. He was also an active member of the Catholic community wherever he lived.

Jim's 43 year professional career as an entomologist with Agriculture Canada (now Agriculture and Agri-Food Canada) began in 1948, first at Belleville and then Ottawa. His work focused on the use of biological control rather than pesticides to manage pest insects, long before there was much concern about the negative effects of pesticide use. His work was international in scope, including a strong relationship with CABI, and he enjoyed meeting new people and experiencing new cultures. Jim managed the National Arthropod Quarantine Facility in Ottawa from 1972 until his retirement in 1991, receiving and processing shipments of biocontrol agents from abroad. He co-edited (with M. A. Hulme) the third volume (1984) of the CABI published *Biological Control Programmes in Canada* series, which summarized biological control research by Canadian scientists for the period 1969–1980. Jim was a friend to many and he is fondly remembered by his colleagues in Canada and abroad.

Jim is survived by three daughters; Mary Jane (Colin Leech) of Ottawa, Joyce (Dusty Williams) of Black Diamond, and Angela (Dave McIntyre) of West Vancouver; one granddaughter, Jessica (Greg) Dacyk and two great-granddaughters Logan and Hollyn all of Clear Prairie, Alberta; two sisters Mae Cotter, Twyla (Al) Warwaruk; two brothers Jack (Marion) and Pat (Joan); and many other relatives.[1]

[1]www.legacy.com/obituaries/ottawacitizen/obituary.aspx?pid=176799152#sthash.btIp-Jmcs.dpuf

By: Peter Mason.

IPM Innovation Lab Ten-Year Report

A special report from the Innovation Lab for IPM at Virginia Tech in the USA, which is funded by the US Agency for International Development, reviews ten years' work (1994–2014) and highlights some of its achievements.[1]

The lab implements participatory farmer-focused research and training that can be adopted and adapted for horticultural crops and other food production systems in developing countries. It worked with a large range of US and in-country agencies and partners in 23 countries during the decade. Initiatives with particular relevance to biological control include classical biological control of papaya mealybug (*Paracoccus marginatus*) in India, the first planned introduction of a biocontrol agent to Ethiopia (*Zygogramma bicolorata* against *Parthenium hysterophorus*), and the use of local bacterial biocontrol agents against witches' broom disease of cacao (*Moniliophthora cacao*) in Ecuador and *Trichoderma* to protect vegetables in several countries. Integrated pest management (IPM) is of course at the centre of the lab's activities. Besides developing IPM strategies for pests and diseases, it has supported famers to implement IPM in a variety of ways by tackling areas such as training, diagnostics, by-product use, partnerships including private partnerships, and gender issues. A particular highlight over the past decade has been the lab's support for raising awareness and development of IPM measures for the leaf miner *Tuta absoluta* as the pest has spread through Mediterranean countries to Africa and Asia.

[1] Rich, M. and Izlar, K. (2015) *Feed the Future Innovation Lab for IPM: a Decade of Innovation.* Virginia Tech, Blacksburg, Virginia, USA, 24 pp.
Web: www.oired.vt.edu/ipmil

Invasive Fruit Fly Review

A review in the *Journal of Pest Science*[1] summarizes knowledge and current and potential management options for *Drosophila suzukii*. This highly polyphagous Asian fruit fly has attacked fruit crops in North America and Europe following its arrival on both continents in 2008, and more recently in South America. Unusual weather events have also seen it emerge as an occasional pest in China in its home range. It is recognized as a global threat to economically important fruit crops. Unlike many species in the genus, *D. suzukii* lays eggs inside ripening fruit; damage is caused by larval feeding and secondary infections. Current control relies primarily on insecticides; the authors describe the limitations to this and suggest how it could be made more effective and sustainable as part of integrated pest management. Cultural management, including sanitation, shorter harvest intervals, use of nets and mass trapping, as an alternative in some crops is discussed. Knowledge about natural enemies is summarized, and the potential for conservation, augmentative and classical biological control to control *D. suzukii* is discussed. Its many wild hosts mean an area-wide approach will be needed for effective control, and biological control could play a key role in this.

[1] Haye, T., Girod, P., Cuthbertson, A.G.S., Wang, X.G., Daane, K.M., Hoelmer, K.A., Baroffio, C., Zhang, J.P. and Desneux, N. (2016) Current SWD IPM tactics and their practical implementation in fruit crops across different regions around the world. *Journal of Pest Science*. DOI: 10.1007/s10340-016-0737-8.

Communicating about Carp Biological Control in Australia

A virus that has decimated carp populations in other parts of the world is being considered as a potential biocontrol agent for invasive European carp (*Cyprinus carpio*) in the Murray-Darling basin of southeast Australia. Having an open dialogue is seen as key to gaining public acceptance. A CSIRO blog article on potential use of the virus in Australia dealt with four ‘common questions’ relating to necessity of control, efficacy and specificity/safety of the potential agent, and fate of the dead fish. The blog attracted further questions from the public, and answers to these were posted on the site five days later. Some covered technical details not covered in the original blog (e.g. the virus’s mechanism of action and transmission). Further explanation was also given for topics dealt with in the original blog, for example why scientists were sure the virus would not infect other species, why they consider it unlikely to mutate and then jump to another species, and whether infected fish would be safe to eat. This approach to re-addressing answers to ‘frequently asked questions’ introduces a spontaneity to what can be a rather formulaic way of communicating information.

Source: McColl, K (2016) Using herpes virus to eradicate feral fish? Carp diem! *(and)* Leigh, C. and Pyers, E. (2016) Update: a carp’s tale – you ask, we answer.
Web: https://blog.csiro.au/reclaiming-our-rivers-from-feral-carp/

Australia Consults on Rabbit Control

A new strain of rabbit haemorrhagic disease virus (RHDV) could contribute to improved control of rabbits in Australia as biological control is recognized to be an important element in the national strategy.

A new draft national rabbit management plan and background document were released in October 2015 by the Australian Ministry of the Environment, open for comment until mid-March 2016. Biological control remains one of the identified control measures, although the plan notes that it should not be relied on as a sole measure. Importantly, the plan accepts the long timescale for new biological control tools to be developed, and highlights the need for strategic research and development for new biological control options. It also calls for surveillance and monitoring to assess the impact of (all) control measures in the field to inform management planning. The background document outlines the three key Invasive Animals Cooperative Research Centre (CRC) research initiatives under its rabbit programme: RHD Boost, RHD Accelerator and Bio-prospecting.

Rabbit numbers have increased as resistance grows to the Czech strain RHDV v351, which was introduced in 1996. The RHD Boost initiative has been evaluating naturally occurring overseas RHDV strains in a search for ones that are highly lethal, have the potential to overcome this growing immunity, and could provide effective control in cooler, wetter areas where it has been lacking; the problem in these areas is that a benign, endemic strain, RCV-A1, partially protects rabbits from RHDV v351.

So far a strain from the Republic of Korea (RHDV K5) has shown the most promise, and testing has demonstrated that it infects only the European rabbit. In December 2015, the Australian Pesticides and Veterinary Medicines Authority (APVMA) released a draft decision to register this new strain of RHDV to boost biological control in Australia. APVMA is conducting a comprehensive public consultation before finalizing any decision to coordinate the national release of the virus. Any release of the new strain will be implemented by the Invasive Animals CRC, with oversight by the Invasive Plants and Animals Committee, and funding for this has been assured by the Australian government. The National Biosecurity Committee has said that national release of RHDV K5 could take place in spring 2016 or autumn 2017 depending on the outcomes of approvals, consultation and further scientific advice.

Further information

Draft varied threat abatement plan for competition and land degradation by rabbits.
Web: www.environment.gov.au/biodiversity/threatened/threat-abatement-plans/rabbits-2015

Rabbit haemorrhagic disease virus, 08Q712 strain in the product RHDV K5.
Web: http://apvma.gov.au/node/19481

Cooke, B.D. (2014) *Australia's War against Rabbits. The Story of Rabbit Haemorrhagic Disease.* CSIRO Publishing, Collingwood, 222 pp.

Hyperparasitism and Microbial Pathogens

The authors of an open-access mini-review[1] argue that the diversity and dynamics of micro-hyperparasites are important but somewhat neglected components of host–pathogen systems, and may be an important element to consider in several fields including biological control. They draw from literature on a number of key systems to argue that hyperparasites may be implicated in observed patterns of pathogen virulence and disease dynamics.

[1] Parratt, S.R. and Laine, A.L. (2016) The role of hyperparasitism in microbial pathogen ecology and evolution. *ISME Journal*. Online 19 January 2016; doi:10.1038/ismej.2015.247.
Web: www.nature.com/ismej/journal/vaop/ncurrent/full/ismej2015247a.html

Conference Reports

European Workshop on Biocontrol Agent Regulation and Use

Some 75 stakeholders and experts from 25 countries with a mutual interest in the regulation of all types of biological control met in Budapest, Hungary on 23–24 November 2015 for a two-day meeting entitled ‘Joint Workshop on the Evaluation and Regulation of the use of Biological Control Agents in the EPPO Region’.

In the EPPO (European and Mediterranean Plant Protection Organization) region, the import and release of organisms in new areas is subject to a wide range of regulations, including those aimed at plant pests, invasive species, marketing of pesticides and protection of habitats. However, few of these are specifically drafted with biological control agents (BCAs) in mind. Interpretation of the regulations is highly variable by individual countries, resulting in a wide range of different practice around EPPO member countries.

The meeting was organized jointly by EPPO, the EU Cooperation in Science and Technology (COST) project ‘Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER), the International Organization for Biological Control (IOBC), the International Biocontrol Manufacturers Association (IBMA), CABI and the Hungarian Ministry of Agriculture.

The workshop arose from an earlier stakeholder workshop ‘Regulating Classical Biological Control of Invasive Plants across Europe’, held under the auspices of SMARTER in Brussels in January 2015, to offer support for policy-makers dealing with invasive alien species and biological control in Europe and attended by representatives of the European Commission (DG Santé, DG Environment), the European Food Safety Association (EFSA), EPPO, IOBC and national authorities as well as scientists. Based on the discussions held during that meeting, a petitioning and evaluation process was proposed for the release of weed BCAs that would separate activities and stakeholder roles into phases prior to and after submission of a request for field release to the national authorities. It was proposed that EPPO and IOBC might play an active role during the petitioning phase, while EFSA might be involved in the evaluation phase post-submission. It was emphasized that the petitioning and evaluation process should be embedded in a communication strategy that would include information exchange among national competent authorities and between national and European stakeholders.

The Budapest workshop built on some of the recommendations made in Brussels but took a broader approach by integrating the regulation of all types of biological control. Following an introduction by representatives from each of the organizing partners and EFSA, Day 1 focused on the regulations applied in seven EPPO countries and took a look at international cooperation as well as individual case studies. Most informative was a presentation by Dr Peter Mason on the situation in North America, a region from which a lot could be learnt by Europe. The day concluded with a session on weed biocontrol, covering the releases of an insect and a fungus in the UK against Japanese knotweed (*Fallopia japonica*) and Himalayan balsam (*Impatiens glandulifera*), respectively, as well as the very recent release of a bud galling wasp against *Acacia longifolia* and the associated procedures, including in the latter case the EFSA opinion on the application.[1] This session was followed up by a short group discussion on regulatory issues regarding the release of non-indigenous BCAs of plants.

The second day began with a similar session on biological control of insect pests in both the field and glasshouse environments including presentations on the use of an exotic parasitoid to control the chestnut gall-wasp (*Dryocosmus kuriphilus*) in several European countries, and the effective use of integrated pest management based on mirids against the leaf-mining moth *Tuta absoluta* in Spain. A brief breakout session on regulatory issues revealed the very complex landscape in Europe thanks to the national implementation of various pieces of EU legislation by 28 different countries.

The most challenging workshop activity was the collective assessment of four case studies: (i) an indigenous nematode for commercial augmentative control of *T. absoluta*, (ii) an exotic predatory mite for the control of *Drosophila suzukii*, (iii) an exotic parasitoid for the classical control of *Agrilus planipennis* and (iv) an exotic fungus for the augmentative control of *Ambrosia artemisiifolia*. The workshop split into four groups, with each considering three of the four case studies by focusing on a series of questions: Which legislation applies? Which international or regional standards are relevant? What additional information is needed to make a decision? In what format should that information be provided and by whom? Who carries out the analysis and using what methodology? Who evaluates the analysis? Who should make the decision and who should be consulted?

A broad range of conclusions were drawn at the end of the workshop, which are listed on the EPPO website (see below). The wide range of regulations with a potential bearing on biological control and the highly variable interpretation of these regulations by individual countries has resulted in a wide range of different practices around EPPO member countries. Inappropriate implementation of these regulations risks losing the benefits of well-applied biological control for crop protection or reducing environmental impacts of invasive species, e.g. in the frame of National Action Plans under the EU Sustainable Use Directive (SUD).[2] There is limited evidence of real problems from use of properly authorized BCAs, and BCAs have in general a good safety record over a long period.

Technically there is a strong case for an eco-regional approach to regulation (e.g. [3]) because BCAs may spread across national borders. EU member states have not yet introduced tailored regulations for BCAs at EU level despite opportunities to do so (e.g. recent amendments to regulations aimed at plant pests, invasive species and marketing of pesticides); also, EPPO member countries have previously decided against establishing a 'First Release Expert Group' at EPPO level; and IBMA have recommended against regulating at EU level. There is, though, scope for 'soft harmonization' at EU or EPPO level through more guidance and establishment of an independent expert review mechanism.

EPPO also published a number of recommendations that are based on the discussions held at the workshop. For example, it was recommended that guidance is needed on which regulations should be applied in which cases (e.g. the scenarios presented at this workshop) and that EPPO, IOBC and the EU (SUD Steering Group) could have a role in this. More harmonization should be achieved through recognition and use of existing EPPO guidance, additional guidance where needed, sharing of information on applicable regulations and on specific applications for releases (subject to the need for commercial confidentiality) between regulators in neighbouring countries, and development of a form of 'mutual recognition' between countries with similar conditions. Common definitions of terms such as 'indigenous' would further facilitate harmonization of regulations and practice in the EPPO region.

Furthermore, it was recommended that national authorities should be encouraged to establish effective coordinating mechanisms to ensure a coherent response to requests to use and release BCAs (e.g. between authorities responsible for environment, agriculture and health regulation). Also, information should be exchanged between national authorities on candidate BCAs under consideration for release and the spread and impacts of BCAs that have been released (with or without authorization).

An independent expert review group for applications at European level should be explored again, building on EFSA's experience at reviewing the evidence on release of a non-native biocontrol agent against an invasive acacia in Portugal. Decisions on import and release of BCAs should be made in the context of a background level of introductions of new organisms to the EPPO region and their spread within the region. Not all of that spread of organisms can be avoided – particularly within the EPPO region across land borders.

Potential use of biological control should be included in contingency planning for arrival of new pests in the EPPO region, so that some of the information needs and regulatory hurdles can be addressed in advance. The Euphresco network (www.euphresco.org/) offers a possible way in which research on biological control options could be coordinated between countries before a new pest has spread widely across the EPPO region.

Finally, it was recommended that analysis of a proposed release should include the environmental, economic and social benefits as well as risks including (i) benefits from reduced environmental damage by the target pest, (ii) benefits from reduced use of other control options, and (iii) other benefits, e.g. human health benefits from control of allergenic plants.

The conclusions and recommendations from the workshop were referred to the decision-making bodies of the different participating organizations for further consideration. They were considered by a meeting of the joint EPPO/IOBC Panel on Biological Control Agents, which was held at the same venue immediately after the workshop, and a number of actions are underway already to start implementing the recommendations.

In all it was a very well organized and timely meeting with a very good balance of researchers, regulators and industry representatives all with the goal of facilitating the safe use of biocontrol agents and negotiating a way through an often complex and challenging overlapping regulatory framework. For further information and pdfs of the case studies and presentations given at the workshop, and its conclusions and recommendations, please visit: http://archives.eppo.int/MEETINGS/2015_conferences/biocontrol.htm#concl

[1] EFSA Panel on Plant Health (PLH) (2015) Risk to plant health in the EU territory of the intentional release of the bud-galling wasp *Trichilogaster acaciaelongifoliae* for the control of the invasive alien plant *Acacia longifolia*. *EFSA Journal* 13(4): 4079, 48 pp.

[2] EU (2009) Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticide. *Official Journal of the European Union* L 309, 71–86.

[3] Cock, M.J.W., Kuhlmann, U., Schaffner, U., Bigler, F. and Babendreier, D. (2006) The usefulness of the ecoregion concept for safer import of invertebrate biological control agents. In: Bigler, F., Babendreier, D. and Kuhlmann, U. (eds) *Environmental Impact of Invertebrates for Biological Control of Arthropods: Methods and Risk Assessment*. CABI Publishing, Wallingford, UK, pp. 202–221.

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Biological Control at the APWSS Meeting in Hyderabad

The silver jubilee (25th) Asian-Pacific Weed Science Society (APWSS) conference on the theme 'Weed Science for Sustainable Agriculture, Environment and Biodiversity' was held on 13–16 October 2015 at the

Professor Jayshankar Telangana State Agricultural University (PJTSAU) in Hyderabad, India. It proved to be the largest so far in this series of meetings with 690 participants. It was organized by the Indian Society of Weed Science (ISWS) in collaboration with APWSS, the Indian Council of Agricultural Research (ICAR), the Directorate of Weed Research (DWR) and PJTSAU. While the largest number of participants understandably came from India, 25 countries were represented in all, mostly within the region but also from Africa, Europe and North America, and 46 participants represented global industry. The mornings of the meeting were devoted to celebratory and plenary sessions, while the afternoons were organized as parallel technical sessions addressing specialized topics.

The welcome address was given by Dr A. R. Sharma, Organizing Secretary and Director, ICAR-DWR, Jabalpur, while Dr N. T. Yaduraju, Convener of Conference and President of APWSS/ISWS presented a conference overview in his presidential address. Dr Steve Adkins, Immediate Past President, APWSS summarized nearly five decades of APWSS history. Dr B. S. Chauhan (University of Queensland, Australia) and Dr Puja Ray (Presidency University, Kolkata, India) were awarded the APWSS Young Scientist Award. The Conference was inaugurated by Prof. P. Appa Rao, Vice Chancellor, University of Hyderabad as chief guest and Dr D. Rama Rao, Director, National Academy of Agricultural Research, Hyderabad as guest of honour. Two of the 11 plenary presentations were of direct relevance to biological control: 'Weed control with microbial herbicides' by R. Charudattan, and 'Biology, ecology and management of the invasive parthenium weed (*Parthenium hysterophorus* L.)' by S. W. Adkins and co-authors.

There were five satellite symposia, including one focusing on 'Biological control – progress and future prospects in Asia-Pacific region' in which there were eight presentations. In 'Prospects for extending the success in the biological control of parthenium weed in Australia into the Asia-Pacific region', K. Dhileepan explained that four of the 11 biocontrol agents that have contributed to the considerable reduction of *P. hysterophorus* in Australia could be re-distributed to other counties in the region. He emphasized the need for climate matching of release sites and community engagement for rearing and release. Marion Seier's presentation on the 'Use of fungal pathogens as weed biocontrol agents in the Asia-Pacific region' highlighted successes in Australia and New Zealand with this approach, while noting that 'pathophobia' slows its adoption in many (but not all) countries in the region. Seier noted the success of *Puccinia spegazzinii* for control of *Mikania micrantha* in the region, and the use of Indian biodiversity to control Himalayan Balsam (*Impatiens glandulifera*) in the UK with a *Puccinia* rust. This presentation stimulated discussion about access and benefit sharing as well as technology transfer within the region.

Puja Ray presented a paper on 'Multi-trophic interactions in weed biocontrol – its role and future', explaining the often-overlooked importance of plant interactions with biocontrol agents and arguing that multi-trophic studies of weed biological control scenarios can aid restoration of healthy environments. The talk presented by N. Bakthavatsalam, 'Semiochemicals in classical biological control of weeds: challenges and opportunities' gave an interesting insight into the potential use of pheromones to monitor classical biocontrol agents with respect to their estimated population size, dispersal and seasonal incidence.

Sushilkumar reviewed 'Biological control of weeds in India: current status and prospects', highlighting the long history and success of the approach in the country and identifying current weed problems that would benefit from it. As noted above, India is a potential source of biocontrol agents for other countries, and this was addressed in two presentations. Dhileepan presented a paper titled 'Field host range and host specificity of *Dereodus denticollis* (Coleoptera: Curculionidae), a potential biological control agent for prickly acacia in Australia' by S. Murugesan and co-authors. He also presented a study by Syed Ahmed and co-authors, 'Impact of native herbivores on the survival and growth of prickly acacia in semi-arid regions of India', which looked at the effect of natural enemy exclusion on the performance of *Vachellia nilotica* subsp. *indica*, a serious weed of arid regions of Australia.

While shrubby and climbing weeds have a visually obvious impact in forests and plantations, grassy weeds can also do great damage. M. H. Rusli and co-authors described how a stable 'Powder formulation of *Phoma herbarum* as biological control of goose grass (*Eleusine indica*)' provided up to 80% control in nursery and field trials in oil palm plantations in Malaysia, suggesting it has high potential as a biocontrol option.

There were also 627 poster presentations organized around 20 themes, including 'Role of biological control in integrated weed management systems' and 'Alien invasive weeds and their management'.

A book release ceremony was held for a special publication to mark the silver jubilee of the APWSS conference series: *Weed Science in the Asia Pacific Region,* published by the APWSS and the ISWS. The conference was rounded off by a field visit to the research farm of the university, Indian Institute of Rice Research and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on 15 October 2015. An overview of the conference and vote of thanks was given by Dr A. R. Sharma during the closing ceremony.

The 26th APWSS Conference will be held in Kyoto, Japan on 19–22 September 2017 and the 27th APWSS Conference in Kuching, Malaysia in 2019.

The proceedings of the 25th APWSS are available online:
http://isws.org.in/apwss25th.aspx

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