*Biocontrol News and Information* ***38***(4), 21N–29N
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# General News

## Could Biological Control Protect Darwin's Finches from an Invasive Parasite?

*Philornis downsi* is bird-parasitic nest fly that is native to mainland South America and invaded the Galapagos Islands sometime prior to 1964. Female *P. downsi* lay eggs into bird nests and the resulting larvae feed on the blood of developing nestlings. A number of bird species are attacked – including mainly passerines – but in the native range mortality of nestlings is quite low owing to low prevalence of parasitism (% of nests with *P. downsi*) and low abundance of *P. downsi* per nest. In Galapagos, however, both prevalence and per-nest parasite abundance are much higher, and this has resulted in high levels of mortality in some passerines endemic in Galapagos – notably in many of the species of Darwin's finches.[1,2] The result is that some species of rare Darwin's finches, and populations of more common species, are at a high risk of extinction.[3–5]

The idea of exploring the possibility of introducing specialized parasitoids as a means of protecting the finches was endorsed at a workshop on *P. downsi* that was organized by the Charles Darwin Foundation and the Galapagos National Park Directorate and held in Puerto Ayora, Galapagos in 2012. Initial exploration for potential agents was done in Trinidad and Tobago based upon previous research on *Philornis* spp., and these studies revealed a *Philornis* parasitoid that was new to science: *Brachymeria philornisae*.[6] While this species is likely to be specialized on *Philornis* flies, no laboratory studies have been done to test this hypothesis.

Further work on *Philornis* parasitoids was done in mainland Ecuador near the port city of Guayaquil. This area was targeted for two reasons: first, Guayaquil is the source of almost all boat and air traffic to Galapagos and thus a likely source of invading *P. downsi*.[7] Second, western Ecuador has a climate that is quite similar to the Galapagos Islands in that it is characterized by a strong seasonality with a rainy season during January–May and a dry season during the remaining months. Nesting of birds known to be hosts to *P. downsi* occurs only during the rainy season both in western Ecuador and in Galapagos. Thus, *P. downsi* parasitoids found in western Ecuador could be expected to have a shared history with population(s) of *P. downsi* that invaded Galapagos and also be pre-adapted to a seasonal climate found in Galapagos. Two field sites were used for exploration – one at the Bosque Protector Cerro Blanco in Guayas province and the other at the Reserva Ecológica Loma Alta in Santa Elena province. *Philornis downsi* as well as two other species of *Philornis* were found attacking various bird species at these sites.[8]

Investigations at the sites revealed five parasitoid species attacking *Philornis* species.[9] The parasitoids were (in order of decreasing abundance) *Conura annulifera* (Hymenoptera: Chalcididae), *Trichopria* sp. (Hymenoptera: Diapriidae), *Exoristobia* sp. (Hymenoptera: Encyrtidae), *Spalangia cameroni* (Hymenoptera: Pteromalidae) and *Brachymeria* sp. (Hymenoptera: Chalcididae) ([8,9] and I. Ramirez and G.E. Heimpel, unpublished data). All of these parasitoids emerged from *Philornis* pupae and overall rates of parasitism were relatively low, never exceeding 20%.

Laboratory investigations on host specificity were done in a quarantine laboratory at the University of Minnesota, USA, for three of the species reared from *Philornis* pupae in western Ecuador: *Exoristobia* sp, *Trichopria* sp. and *Conura annulifera*. While the *Exoristobia* species exhibited a very broad host range and was thus excluded from further consideration as a potential biological control agent, the *Trichopria* species and *C. annulifera* exhibited specificity to the genus *Philornis* ([8] and M. Bulgarella and G.E. Heimpel, unpublished data). Most work was concentrated on *C. annulifera*, for which rearing records from the literature already suggested specialization on *Philornis*. In these trials, *C. annulifera* females were exposed to pupae of *P. downsi*, five other muscomorphan dipterans, three lepidopterans and one hymenopteran. Parasitism was detected only in *P. downsi* and there was no indication that any of the other hosts were stung at all.[8] These data, in conjunction with reports from the literature and our own field rearing results, support the hypothesis that *C. annulifera* is a specialist parasitoid on flies in the genus *Philornis*.

While the results outlined above suggest that a release of *C. annulifera* in Galapagos would be ecologically safe, extra caution needs to be taken given the high-level endemism at this UNESCO World Heritage Site.[10] Historical records indicate the presence of 18 species of endemic muscomorphan flies in Galapagos, none of which are in the genus *Philornis*. These flies are at the highest theoretical risk of attack by *C. annulifera* (R.A. Boulton and G.E. Heimpel, submitted ms) but nothing is known about the ecology of most of the species or whether they have been or are being competitively displaced by the many species of introduced flies in Galapagos. Current research is focused on locating these species, identifying their feeding niche and developing methods to use them in host-range testing with *C. annulifera* in a quarantine setting in Galapagos. Information from these studies as well as further biological studies with the parasitoid will be needed before a recommendation can be made whether or not to release *C. annulifera* in the Galapagos Islands as means of suppressing populations of *P. downsi*.

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By: George E. Heimpel, Dept. of Entomology, University of Minnesota, St. Paul MN, USA. Email: heimp001@umn.edu

## How an Exotic Pasture Weevil in New Zealand Escaped Biological Control

Scientists in New Zealand have been investigating why the biological control of the invasive pasture weevil *Listronotus bonariensis* (Coleoptera: Curculionidae) in New Zealand by the introduced braconid *Microctonus hyperodae* (Hymenoptera: Braconidae) has declined. The latest research has involved the analysis of two decades of records that are providing increasing evidence that genetic adaptation is responsible.[1,2]

The Argentine stem weevil, *L. bonariensis*, was first reported in New Zealand in 1927 and later became a major pest of high-production exotic pasture throughout the country, reaching densities of up to 700/m$^2$. This contrasts with native tussock grassland where it has not become a pest and is considered unlikely to have overall impact in the future.[3] In 1991, the total cost of impact in pasture was estimated at NZ$78–251 million, making it the most important insect pest in the country at the time.[4] Thereafter, this impact was reduced by widespread adoption of endophyte-containing ryegrass cultivars, which are resistant to the weevil, combined with biological control through the introduction in 1991 of *M. hyperodae*. Maximum parasitism rates of 80–90% were recorded in the years after the weevil was introduced and there was suppression of damage (e.g. [5]).

Introduction and release methods for the parasitoid were developed to permit future analysis of establishment patterns of seven presumed 'ecotypes' from geographically distinct areas of Argentina, Chile, Uruguay and Brazil. Similar numbers of each ecotype were released at each project release site throughout New Zealand. The parasitoids are parthenogenetic, and the release cohorts were reared from between one and 33 imported lines, representing 132 founding females in total.[6] Some 99,000 parasitoids were released during the biological control project. Thereafter a further 613,000 individuals comprising balanced ecotype frequencies were supplied to land managers on a commercial basis. *Microctonus hyperodae* established in all release areas and is now considered to be present throughout New Zealand's pastures where the pest occurs.[5]-

In the past decade, obvious weevil-related pasture damage has re-emerged.[7] This was followed by a recent study reported in *PNAS*[1], which reviewed 21 years of nationally-collected field data and showed a 44% decline in parasitism compared with the 1990s levels. A number of reasons for this decline have been proposed including changed farming practice, new cultivars of forage, new strains of endophyte, metapopulation processes and climate change. However, none of these have appeared to be the reason and the focus has most recently been on the probable appearance of genetically based resistance.

Theoretically, genetic variation can allow pests to adapt to control agents, most probably through the selection of already-existing resistant alleles within a population. Notably however, while this has been recorded in microbial agents, there is very little published evidence for it in classical biological control systems. However, in New Zealand the situation is very unusual. The country has some 10.6 million hectares of improved pasture representing 40% of the total land area. More critically, 29% of this area is intensively managed and predominantly comprises just two species: perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*). The authors suggest that this agricultural intensification and area has led to a vast, connected, homogenous ecosystem with much reduced plant and natural enemy diversity (e.g. fewer spider and insectivorous bird species cf. similar systems in the UK) and a lack of refuges.[8] They argue that under these circumstances, selection pressure by a very effective biocontrol agent has been exceptionally high and this has led to pest resistance. Significantly they further contend that in this process the sexually reproducing pest had a major adaptive advantage over the parthenogenetic parasitoid, the latter being unable to change through the reassortment of alleles. Analysis of the data relating to this has revealed a striking pattern. The decline in parasitism began simultaneously across the country seven years after the biocontrol agent's first release in any particular location, and this reduction plateaued after about 12 years. Further, this held true for releases in sequential years, and was unaffected by habitat/climate or proximity of sites. The authors argue that the nationwide uniformity of the pattern points to a 'selective sweep' for any resistant genotypes in the pest population, with resistance becoming apparent after about 14 generations (two per year). The emergence and spread of resistant alleles and possibly novel mutations, would be expected to show clusters of resistance that then spread. Genetic analysis is being used to test these conclusions.

The actual mechanism for this resistance is not yet clear. Encapsulation has never been found in dissected weevils and accentuated pest evasion behaviour remains a real possibility. Interest is now focusing on whether insect-induced plant semiochemicals are involved in such evasive behaviour.[9]

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Contact: Stephen Goldson,
AgResearch Lincoln, Christchurch, New Zealand.
Email: stephen.goldson@agresearch.co.nz

Barbara Barratt, AgResearch Invermay,
Mosgiel, New Zealand.
Email: barbara.barratt@agresearch.co.nz

## Extending Biological Control of Giant Reed to the South Hemisphere

The misidentification of a potential biological control target in the Cook Islands has been turned into an opportunity to target the same weed in New Zealand. Two biocontrol agents of giant reed (*Arundo donax*) were imported into the Landcare Research quarantine in Auckland for testing on behalf of the Cook Islands, as part of a larger project for biological control of some invasive weeds in the country (see *BNI* 38(2), June 2017: www.cabi.org/bni/news). But closer examination of the purported giant reed infestations in Rarotonga revealed that most were actually elephant grass (*Pennisetum purpureum*)! Giant reed was found to be a rare and highly localized invader in the Cook Islands, such that biological control was deemed unnecessary. Giant reed is, however, an emerging invasive in New Zealand: it has naturalized from the west coast of the South Island to the Northland region of North Island, where the largest infestations are to be found. Given the range of localities where giant reed is already found in New Zealand it is clear that the plant has potential to spread much more widely, so rather than ditching the imported biocontrol agents once it became apparent that they would not be released in the Cook Islands, they were tested for potential release in New Zealand.[1]

Giant reed is a perennial bamboo-like, clump-forming grass that grows from thick rhizomes. In optimum conditions, plants can attain a diameter of 4 cm, grow 10 cm a day and reach a height of 5 m. Although plants develop plume-like flowerheads, no seeds are formed in New Zealand, and giant reed spreads via plant and rhizome fragments, with human-mediated transport and flood events enhancing spread. Its native range in the Old World extends from the Iberian peninsula, through the Mediterranean region and the Middle East, to south Asia. The plant has been taken around the world for many centuries as a fibre and roofing crop, as an ornamental, and for erosion control. It was for this latter purpose that it was commonly planted in New Zealand's Northland in the 1960s–1980s. Its wide tolerance of ecoclimatic conditions has contributed to it becoming invasive in many tropical, subtropical and temperate regions as a weed of waterways, wetlands and riparian areas. In New Zealand, it displaces native flora and fauna, and provides a habitat for pests such as rats and possums. It alters hydrology and nutrient cycling: the bulky stands and debris from them narrow or block waterways and increase sedimentation, thus increasing flood risk. Giant reed is also a fire risk because it is very flammable.

The arundo gall wasp (*Tetramesa romana*) and the arundo scale (*Rhizaspidiotus donacis*) were potential 'off-the-shelf' biocontrol agents because both species had already undergone extensive host-specificity testing and approval procedures in a joint US/Mexican programme. They were released by the US Department of Agriculture – Agricultural Research Service (USDA-ARS) in the Lower Rio Grande Valley of Texas in 2009 and 2011, respectively. Both species are now confirmed as established, and by 2012 *T. romana* was found along the entire infested length of the Lower Rio Grande. An average 22% decrease in giant reed biomass between 2007 and 2014 was attributed to the gall wasp. While it has been too early to assess scale impact and it was spreading more slowly, there is evidence that it is reducing recruitment of new canes. (See *BNI* 36(4), December 2015.)

Plans for testing in New Zealand began from the baseline established by the North American test results. This documentation included field collection data in the area of origin, which indicated that *T. romana* had been recorded only from *A. donax* and the closely related *Arundo plinii*. Host-specificity tests on 35 graminaceous and six other species were carried out by USDA-ARS scientists at Edinburg, Texas, on wasps from southern Europe. Results indicated that *Arundo formosana* was an alternative but marginal host, while the wasp did not complete development on any other test species. Post-release monitoring in the Lower Rio Grande Valley has found no evidence of wasp attack on any of 12 tested graminaceous species growing at sites where giant reed is being attacked. Because the USDA-ARS data collectively indicate that *T. romana* is specific to *Arundo* species, and there are no native species in the subfamily Arundinoideae and no valued *Arundo* species in New Zealand, it was decided that further testing of *T. romana* was not necessary.

*Rhizaspidiotus donacis* was recorded only from *A. donax* in the native range, but during US testing it showed a slightly higher potential than the gall wasp for developing on non-target species. *Arundo formosana* was again a marginal host, but in addition, a small number of offspring developed on two test plants in subfamilies closely related to the Arundinoideae, so further testing was deemed necessary for New Zealand. This found no evidence for scale attack on two endemic and one indigenous species in the subfamilies most closely related to giant reed.

Earlier this year, approval for release of both biocontrol agents in New Zealand was given by the Environmental Protection Agency.

USDA-ARS also provided biocontrol agents to South Africa, where host-range testing for *R. donacis* by ARC-PPRI (Agricultural Research Council – Plant Protection Research Institute) has been underway since early 2016. A new consignment of reproductive females expected in early 2018 should allow this to be completed.

There is already a widespread and abundant population of *T. romana* in South Africa, which work at USDA-ARS (Sidney, Montana) has shown to be genetically distinct from genotypes released in the USA. Further work at ARC-PPRI and the University of KwaZulu-Natal on the adventive populations indicated that there are two genotypes present. Future work will compare the impact and performance of these two genotypes to native range genotypes (particularly the Granada genotype from Spain, which has established and spread widely in Texas) to see if any of them offer better potential to suppress *A. donax* populations in South Africa. A new introduced genotype of *Tetramesa* will only be released if it proves, in laboratory studies, to be more damaging than the adventive genotypes.

In the USA, a third agent has been approved for release: the cecidomyiid leaf miner *Lasioptera donacis*. A recent publication provides an update for the North American biological control programme.[2]

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Contact: Quentin Paynter, Landcare Research Manaaki Whenua, Auckland, New Zealand.
Email: PaynterQ@landcareresearch.co.nz

Angela Bownes, ARC-PPRI, Hilton, South Africa.
Email: BownesA@arc.agric.za

John Goolsby, USDA-ARS, Cattle Fever Tick Research Laboratory, Edinburg, TX, USA.
Email: John.Goolsby@ARS.USDA.GOV

## Richard W. Hansen (1956–2017): a Great Loss to Weed Biological Control

It was with great sadness that we heard about the sudden passing of Dr Richard (Rich) Hansen. Rich was CABI's long-time collaborator, counterpart and colleague at USDA APHIS CPHST and, due to his self-effacing nature, was quietly but truly an inspired visionary and inclusive leader, researcher and dedicated worker in the cause of weed biological control. I personally met Rich at various conferences and was in contact with him by email. I, like most who met him, thought he was one of the nicest and most genuine people among our relatively small but global community of weed biocontrol practitioners. I remember that during the Wyoming Weed & Pest Conference in 2007 in Jackson Hole, Rich introduced me to oyster shots. The oyster shots came with three different sauces, and rather than choosing one, of course we had to try all three of them! Rich liked to eat well. On occasion, his love for food overlapped with his love of insects. On one visit to us at CABI in Delémont, Switzerland, he ate several of the weevil larvae we found mining in garlic mustard, a European plant invasive in North America, and he convincingly exclaimed that they tasted of garlic, which, however, did still not encourage me to follow his example. During that same visit, I took Rich and several other of our North American counterparts on a field trip to southern Germany where we dined at a typical 'home-style cooking' restaurant. We had white asparagus with local smoked Black Forest prosciutto and Black Forest cherry cake for dessert! He raved about that asparagus forever after.

Rich was a funny person and extremely entertaining company. He liked to tell stories and jokes, often throwing in an anecdote or update featuring his beloved family (and pets), which literally loosened up any meeting he participated in. In short, Rich was simply a lot of fun to be around.

Rich's career spanned a period of nearly four decades and saw an expansion in biological control of weeds in rangelands in the western USA, which CABI's centre in Switzerland was fortunate to be involved in, and to have in Rich a supportive collaborator.

During his time as an entomologist at the USDA APHIS Biological Control Facility in Bozeman, Montana, Rich was a member of the long-running leafy spurge (*Euphorbia esula*) project[1,2], under which European biocontrol agents provided by CABI were introduced throughout infested areas of the USA, establishing in almost all states where they were released. Thirty years after biological control began, success was being widely reported, notably as *Aphthona* flea beetle species released in the 1980s–1990s 'took off'. Building on this success, APHIS joined forces with USDA ARS and established the TEAM Leafy Spurge in 1997. This project set out to integrate biological control with other management techniques to create a comprehensive IPM effort and, for the time, ground-breaking emphasis on teamwork and public outreach. The success of the project was reflected by the huge network of TEAM partners that developed and the dramatic area-wide reductions in leafy spurge as some 85 million flea beetles were redistributed, increasing the interest in the biological control of other rangeland weeds. The leafy spurge project has become one of the best documented weed biological control successes and has led to economic annual net benefits of US$ 19 million.

Following the leafy spurge success, Rich continued to collaborate with CABI on several projects, especially when he assumed the position of director of the Bozeman biocontrol lab and his subsequent move to join the USDA APHIS CPHST lab in Fort Collins, Colorado.

Notable collaborative successes, which he was instrumental to, include weevil biocontrol agents for the rangeland weeds Dalmatian toadflax (*Linaria dalmatica*), diffuse knapweed (*Centaurea diffusa*) and spotted knapweed (*C. stoebe*), while a gall midge released in 2009 against Russian knapweed (*Rhaponticum repens*), one of the last projects he led, is already showing promising impact.

Benefits garnered from Rich's long-term collaborations are particularly well illustrated by the toadflax biocontrol project.[3,4] In 1991, a stem-mining weevil identified at the time as *Mecinus janthinus* was first approved for release in North America, in Canada, for control of Dalmatian and yellow (*Linaria vulgaris*) toadflax. In the late 1990s Rich made multiple trips to toadflax biocontrol release and collection sites in western Canada to gain a better understanding of agent biology, ecology and impact, usually returning to the USA with weevils generously supplied by Canadian collaborators and in turn generously shared with US researchers and stakeholders. While it proved effective against Dalmatian toadflax, this agent appeared to have little impact on yellow toadflax. Advances in molecular techniques adopted by CABI showed that both agents and target weeds in this system exist as species complexes. New species and highly specific host–natural enemy associations were then identified: weevils released in 1991 included the cryptic species *Mecinus janthiniformis*, which is highly specialized on Dalmatian toadflax, and sister species to the 'real' *M. janthinus*, a specialist on yellow toadflax. Armed with this new understanding, Rich facilitated the literal coast-to-coast, from Oregon to Virginia, release of *M. jan-*

*thinus* on US yellow toadflax. His unflagging support and prioritization of toadflax biological control made continued investigation of additional candidate agents, including *Mecinus* and *Rhinusa* spp. stem- and shoot-galling weevils, possible. One of these, *R. pilosa*, is highly specific to yellow toadflax and is currently being considered for release in the USA, following encouraging results from Canadian releases that began in 2014. We believe that Rich's long-term commitment to this project will result in the successful control of what, at one time, seemed an intransigent weed problem.

Rich was an innovative and inquisitive scientist who asked questions others would shy away from. When a biocontrol agent for the rangeland weed houndstongue (*Cynoglossum officinale*), which was released with great success in Canada in 1997 but was controversial and unapproved in the USA, crossed the border, he immediately helped issue a USDA APHIS document warning about unwanted potential impacts of the insect on American flora. At the same time, however, Rich contracted out research to monitor the distribution of the intruder weevil *Mogulones crucifer* in the USA and investigations to find out whether or not the insect actually poses any risk to native plants. That research has recently concluded with the result that the weevil in all likelihood is environmentally safe after all, as Rich intuitively expected all along. Just this past spring, he excitedly discussed the notion of how to best revoke the warning document, a big step towards allowing the insect to be officially released in the USA.

Due to Rich's enduring efforts and with the help of Ken Bloem (also with USDA APHIS CPHST), the agency increased its financial support for CABI Switzerland from $73,000 in 2006 to about $200,000 from 2009 onwards. The increase supported many additional collaborative projects: dyer's woad (*Isatis tinctoria*), garlic mustard (*Alliaria petiolata*), hoary cress (*Lepidium draba*), perennial pepperweed (*L. latifolium*), hawkweeds (*Pilosella* spp.) and Canada thistle (*Cirsium arvense*)[5]. Finally, Rich was the driving force in revitalizing the field bindweed (*Convolvulus arvensis*) biocontrol project. Biocontrol agents previously released in North America have had limited impact and since 2009 CABI has been searching for additional potential agents. Although we have not found the 'silver bullet' yet, we are currently investigating two promising candidates.

We hope and strongly feel that our collaborative successes and recent ventures will become part of what will be Rich's legacy to our research discipline.

Rich left this world far too early to witness the success of the research he initiated and fostered. He will be missed profoundly by all of us, especially during our forthcoming XV International Symposium on Biological Control of Weeds, which will be held in Switzerland, and which he had been planning to attend. While we won't be able to enjoy his company, we will commemorate his achievements in weed biocontrol during the conference, and in the interim, will reflect upon the many fond memories until we raise our glasses together in his memory.

*USDA APHIS CPHST is the US Department of Agriculture, Animal and Plant Health Inspection Service, Center for Plant Health Science and Technology.*


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By: Hariet Hinz (CABI, Switzerland), with contributions from Sharlene Sing (USDA Forest Service, Rocky Mountain Research Station) and Mark Schwarzländer (University of Idaho), and support from colleagues at CABI and USDA APHIS.

## New Centre for Biological Control at Rhodes University

The new Centre for Biological Control at Rhodes University in South Africa is going to allow its staff to build on the work and achievements of the last 15 years by creating a hub for cultivating young scientists and increasing participation in national and international biological control initiatives.

Since 2002, the Biological Control Research Group (BCRG) under the leadership of Prof. Martin Hill has grown substantially to the point where there are about the same number of employees as postgraduate students and postdoctoral fellows. This growth is due to generous external funding and University and infrastructural support. Over the years, the group has narrowed its focus to the classical biological control of weeds and the biological control of significant crop pests using microbial agents such as viruses and entomopathogenic fungi. Our staff and students are based across four campuses in the Eastern Cape: Rhodes University campus, the Waainek Research Facility outside Grahamstown, the Uitenhage Research Facility and Citrus Research International offices in Port Elizabeth. At

Rhodes University, students are based in the Departments of Zoology and Entomology, Microbiology, Botany, Chemistry and Economics.

Since 2002, the BCRG has published over 150 peer-reviewed papers and 180 conference papers, supervised 40 master's students and 25 PhD students and hosted nine postdoctoral fellows. Significantly, the majority of these students have gone on to employment in biological control in industry, universities, government departments and research institutes representing an impressive capacity-building programme. The group has received several awards in recognition of the research undertaken, including the Rhodes University Vice-Chancellor's Distinguished Research Medal (2006), the Rhodes University Vice-Chancellor's Senior Distinguished Research Medal (2013), the Rhodes University Environmental Award (2014) and notably the NSTF (National Science and Technology Forum) – GreenMatter Award (2015), which is awarded to an individual or an organization for contributions towards achieving biodiversity conservation, environmental sustainability and a Greener Economy.

The research group has been committed to engaging with the community on biological control and, through these activities, we aim to inform people and empower them in the areas of biological control mass-rearing, research and knowledge. The community engagement activities include a School Internship Programme (since 2009), various Educational Outreach Events, the Sisonke Programme (enabling people with disabilities to mass-rear and release biological control agents) and an annual accredited Weed Biological Control Short Course. These activities resulted in the BCRG being awarded the Rhodes University Vice-Chancellor's Community Engagement Award (2013).

Our research is mainly aimed at national problems, however we are involved in African projects in Morocco, Ghana, Cameroon, Kenya, Uganda, Mozambique and Madagascar. Farther afield, we collaborate with colleagues in New Zealand, Australia, Argentina, Brazil, the USA and Europe, which involves partners in many institutions locally. There are great opportunities to increase these collaborations; Rhodes University is the seat of the International Organisation for Biological Control (IOBC) – Afrotropical Regional Section, which puts us in a great position to do so.

The BCRG at Rhodes University has been a very successful entity and we are continually expanding the mandate of our group. We have followed protocol and are expanding further by opening the Centre for Biological Control. Becoming a Centre significantly increases our external profile, both locally and internationally, and provides a *home* for the staff and students until now spread over several departments and localities. The Centre will complement other biological control organizations locally and regionally using a holistic approach to biological control, including not only pre-release studies, but also quantifying the biodiversity and economic benefits of classical and inundative biological control. A further aim of the Centre will be to increase biological control capacity in South Africa and in Africa more broadly through short courses and nurturing undergraduate and postgraduate students.

*The Centre's Vision:* To (i) sustainably control environmental and agricultural pests for the protection of ecosystems and the societies that depend on them, and (ii) ensure that the maximum benefits of biological control are realized through excellence in research, implementation and community engagement.

*The Centre's Mission*: To make the Rhodes University Centre for Biological Control an internationally recognized research institute and a leading research centre.

The Centre for Biological Control will remain in the Department of Zoology and Entomology in the Science Faculty at Rhodes University. The Centre's official launch was on the 2nd of November 2017 and gave us an opportunity to host most of the national biological control community and celebrate its achievements.

By: Kim Weaver,
Department of Zoology and Entomology,
Rhodes University, Grahamstown, South Africa.
Email: k.weaver@ru.ac.za

## First International Congress of Biological Control

The First International Congress of Biological Control (ICBC-1), 'Biological Control for a Healthy Planet: Interdisciplinary Biological Control', will be held on 14–16 May 2018 in Beijing, China. It will be hosted jointly by the Chinese Academy of Agricultural Sciences (CAAS), Chinese Society of Plant Protection (CSPP) and International Organization for Biological Control (IOBC) with organizational and other support from national and international organizations. This new meeting series is intended to complement the separate symposium series for weed and invertebrate biological control, with meetings held every 3–4 years to provide greater opportunities for a wide range of biocontrol stakeholders to interact.

Topics for ICBC-1 include: 'Integration of the various classes of biological control', 'Biological control of plant diseases, insect pests and weeds', 'Biological control as means of preserving biodiversity', 'Risk assessment and biosafety for biological control', 'Industrial policy and market development of biological control', 'Socio-economic impacts and capacity building for biological control' and 'Current status and uptake of biological control in the Belt and Road countries'.

Web: www.canevent.com/customPage/custom
PagePreiew?pageId=43608&eventId=10003226

## First International Conference on Biological Control in Bengaluru, India

The First International Conference on Biological Control (ICBC) will be held on 27–29 September 2018 at Le Meridien hotel in Bengaluru, India. Within the broad theme of 'Approaches and Applications', research papers would be accepted under the following sub-themes: 'Biodiversity and biosecurity', 'Conservation strategies', 'Biotechnological approaches in biocontrol', 'Production and utilization of macrobials for insect pest management', 'Production and utilization of microbials for insect pest and disease management', 'Biocontrol-compatible approaches' and 'Biological control: industrial perspective and policy issues'.

The International Organization for Biological Control (IOBC) has scheduled an International Workshop on the Biological Control and Management of *Parthenium hysterophorus* alongside ICBC2018. A satellite session on the tomato leafminer, *Tuta absoluta*, an invasive pest of global concern, is also programmed during the conference. Further, CABI is planning to have a separate session on the production and utilization of macrobials and microbials.

Keynote and invited speeches will be published in a special issue of *Biocontrol Science and Technology*.

Riding on the success of the recent Fifth National Conference on Biological Control, the Society for Biocontrol Advancement, the chief organizer of ICBC2018, is hopeful of attracting biocontrol researchers, students and entrepreneurs from across the globe to this international event. Those interested should please visit www.icbc2018bengaluru.com for more information and continuous updates.

By: Prakya Sreerama Kumar,
Organizing Secretary (Liaison) & Chairman, Proceedings Committee, ICBC2018.
ICAR–National Bureau of Agricultural Insect Resources, Hebbal, Bengaluru 560 024, India.
Email: psreeramakumar@yahoo.co.in

## Biological Control in Natural Areas

The USDA Forest Service has published a useful contribution to support the adoption of biological control in natural areas.[1] The editors say that such projects will need 'better integration of biological control into conservation practice, a better understanding by societies of the reasons for such work and its possible risks and benefits, as well as continued, consistent public funding.' The opening chapter describes the history of biological control in natural areas with reference to many examples worldwide, and discusses issues affecting development of such biological control programmes. Ongoing and successful project case studies form the basis of subsequent chapters, in St Helena, the Galapagos Islands, Tahiti, Hawaii, continental USA and South Africa, thus covering projects in oceanic islands, wetlands and forests. The volume ends with a discussion of future trends and challenges.

[1] Van Driesche, R. and Reardon, R.C. (eds) (2017) *Supressing Over-Abundant Invasive Plants and Insects in Natural Areas by Use of their Specialized Natural Enemies.* FHTET, USDA Forest Service, Morgantown, WV.
Web: www.fs.fed.us/foresthealth/technology/pdfs/FHTET-2017-02_Biocontrol_Natural_Areas.pdf

Additional copies from: Richard Reardon, USDA Forest Service, 180 Canfield Street, Morgantown, WV 26505, USA.
Email: rreardon@fs.fed.us

## Opportunities in Augmentative Biological Control

A significant review in *BioControl*[1] makes a strong case for greater use of invertebrate and microbial agents for augmentative biological control (ABC) of agricultural pests (invertebrates, weeds and diseases). The authors estimate ABC is currently applied on 30 million hectares worldwide. They ascribe its popularity to several elements: being environmentally benign, in concert with pressure and policy to reduce and more strictly regulate synthetic pesticides; the professionalism of the biocontrol industry; and a recent history of success. They argue that new, less-dogmatic approaches to pest control – they introduce the term 'conscious agriculture' – could see ABC become more significant. They review the history and current practice of ABC, commercial biocontrol agent production, and the viability and future of the market. A key feature of the paper is the comprehensive information it provides about biocontrol agents and products available for use in ABC. Invertebrate and microbial biocontrol agents and registered commercial microbial products, each with country/region and target pest information, are tabulated in the paper. Similar information for commercially available invertebrate biocontrol agents is included in supplementary online information.

[1] van Lenteren, J.C., Bolckmans, K., Köhl, J. *et al.* (2017) Biological control using invertebrates and microorganisms: plenty of new opportunities. *Biocontrol.* DOI: 10.1007/s10526-017-9801-4

# Conference Report

## Successful Fifth International Symposium on Biological Control of Arthropods

More than 130 biological control researchers and practitioners from 25 countries came together during the week of 11 to 15 September 2017 to participate in the global flagship conference on the biological control of arthropods using parasitoids and predators. Organized by CABI Malaysia and the Malaysian Agricultural Research and Development Institute (MARDI), the International Symposium on the Biological Control of Arthropods (ISBCA) took place in Langkawi, Malaysia. The local organizing committee for the symposium comprised Dr Loke Wai Hong and Dr A. Sivapragasam from CABI together with Dr Mohamad Roff from MARDI.

The conference, the fifth in a series of symposia held every four years, presented a unique forum for arthropod biological control researchers and practitioners to meet, exchange information and discuss current issues relating to biological control. This year's event focused on the use of parasitoids and predators in the ongoing battle to control certain invasive arthropod species.

Fourteen sessions, addressing the most relevant current topics in the field of biological control of arthropods, were organized and delivered by invited speakers, and through contributed talks and poster presentations. Many of the topics were interdisciplinary in nature, reflecting new challenges and ways of working. Some of the topics have remained important issues since the first ISBCA meeting, such as understanding non-target impacts in arthropod biological control, and biological control as the cornerstone of successful integrated pest management programmes, underlined by an understanding of the compatibility of biological control with pesticide applications. Since the beginning of the meeting series we have also talked about the importance of regulation and risk assessment methodology. This remains an important topic, but today biological control practitioners also need to be better prepared for implementing access and benefit sharing policies relevant to classical biological control practices. In addition, as new tools and environmental concerns arise, some fresh interdisciplinary topics have emerged. These days the importance of ensuring that baseline data are in place to be able to assess the impact of biological control programmes is more widely recognized. Such impact studies should not only comprise benefit–cost analyses; they also need to look at the socio-economic impact of biological control and its effect on livelihoods. In this context, it is also important to understand the uptake of existing biological control solutions in low and lower-middle income countries in order to be able to formulate strategies to replace the use of highly hazardous pesticides through the use of biological control agents. Ecological questions also remain at the forefront of biological control research. Topics that are currently high on the agenda include understanding the relative roles of native and exotic natural enemies, as well as the importance of pre- and post-release genetic studies in biological control.

One of the aims of ISBCA is to stimulate creative solutions for arthropod control by introducing delegates to new information. With this in mind, all presentations at ISBCA 2017 utilized original project data, and the event showcased findings from postgraduate and postdoctoral students. More than 47 poster presentations were displayed during the event.

Founded by Dr Roy Van Driesche in 2002, previous ISBCA meetings have been held in a diverse range of countries, including Hawaii, Switzerland, New Zealand and Chile, in order to encourage meaningful participation from all corners of the world. Holding the 2017 event in Asia for the first time continued this tradition, enabling delegates to develop important links with colleagues from the region who had not been in a position to participate in previous ISBCA symposia.

The proceedings have been published by CABI as an open access e-book:
www.isbca-2017.org/index.php?cat=PROccedings

The next and Sixth International Symposium on the Biological Control of Arthropods will take place in Canada in September 2021. Please reserve this date now in your diary.

By: Annamalai Sivapragasam and Ulli Kuhlmann, CABI.