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CABI Annual Report Switzerland 2013

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CABI improves people's lives worldwide

by providing information and applying scientific expertise to solve problems in agriculture and the environment

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This annual report was prepared by the staff of CABI's centre in Switzerland and covers activities in 2013. Images are attributed to the photographers as far as is known and are by CABI staff unless specified.

Front cover photo – Saidou Nacambo preparing house fly diet in Mali (photo: S. Nacambo)

Inside front cover photo – Hariet L. Hinz checking the aquatic weed flowering rush, *Butomus umbellatus*, for damage (photo: P. Häfliger)

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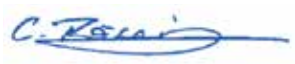
preface

It was a pleasure for me to accept the invitation to contribute a preface to the CABI Switzerland Annual Report. I work at the Global Programme Food Security of the Swiss Agency for Development and Cooperation (SDC) and am responsible for Switzerland's contribution to international agricultural research for development. SDC has been supporting CABI's research and international development work for over two decades now. During this time, CABI has built upon and further developed its strong international reputation in the field of plant health and has continued to apply its expertise in areas that are pertinent to SDC. Through its broad range of activities it effectively addresses the needs of the various actors in the agricultural sector, from smallholder farmers and extension workers to academic researchers and policy makers. In doing so, it directly addresses today's most critical challenges of poverty and long-term food security.

Most of the CABI projects and programmes that SDC has supported in the past were led very successfully and professionally by CABI's centre in Switzerland and resulted in tangible differences to sustainable agriculture and farmer livelihoods in various parts of the world. As an endorsement of CABI's ability to deliver, SDC decided to increase its support to the organization in 2011 in order to provide the opportunity to conceptualize and initiate its first global programme, Plantwise. SDC was particularly impressed with the relevance, organizational set-up and global character of the programme, as well as its aim to enable farmers, advisory services and researchers to access the knowledge they need to grow better quality crops and improve livelihoods. SDC, to this day, remains one of the major donors of Plantwise, supporting its rapidly expanding implementation across the world, and I am both pleased and proud that this successful programme is being coordinated by the CABI centre at Delémont, Switzerland.

As part of my role at SDC, I am also the liaison officer for CABI in Switzerland. Switzerland's membership of CABI, which commenced in 2000, has provided further opportunities for the organization to enhance collaboration with advanced Swiss research institutes and to obtain national funding for project implementation in areas such as biological control, invasion ecology, risk analysis, ecosystems management and crop health for food security. Switzerland has some of the world's highest standards of sustainable agriculture and I know that CABI's integrated crop management team, located at the Swiss centre, is making the best use of it to identify, test and implement solutions for sustainable agriculture to tackle environmental issues, alleviate poverty and enable food security.

I have been privileged to watch CABI thrive over the last few years as it continues to expand and put into practice its diverse range of expertise and experience. Through the dedication and enthusiasm of its staff, and the continued support of its member countries, partners and donors, I am certain of continued success and further impact of its work in the years to come. SDC is grateful to CABI for all its efforts, including the significant part played by the team in Delémont, and looks forward to ongoing collaboration in the coming years.



Carmen Thönnissen PhD
Senior Advisor
Federal Department of Foreign Affairs (FDFA)
Swiss Agency for Development and Cooperation (SDC)
Corporate Domain Global Cooperation
Global Programme Food Security

introduction

I am very pleased to report on our activities in 2013, which represent another year of positive progress for the CABI centre in Switzerland. This year, the centre either led or actively participated in 70 research and/or development cooperation projects, representing an increase of 13 projects from 2012. This demonstrates not only our capacity to deliver to our customers but also our desire to continually diversify and expand our project work. It also reflects the loyalty of our partners, without whom the successful acquisition and implementation of these projects would not be possible.

With the majority of the centre's projects being international, our global reach is becoming increasingly impressive, now spanning Europe, East and West Africa, Central and South America, and all major regions of Asia. This expansion also reflects the growing extent to which we work together with international partners, including colleagues from other CABI centres. Many of our projects are now being designed and implemented in partnership with other CABI centres, which is helping to bring the organization closer together and enhance our 'one CABI approach'.

I would like to highlight the remarkable publishing achievements of our staff in 2013. In total, our centre generated 41 scientific publications, of which 28 were peer-reviewed and nine were book chapters. We also presented 29 talks at various meetings and conferences. The CABI staff based in Switzerland was therefore a significant contributor to CABI's overall scientific publication achievements in 2013, thus reflecting the importance of the research activities carried out here as well as the dedication and expertise of our scientists.

We made headway this year with preparations for the Master of Advanced Studies in Integrated Crop Management (MAS ICM), which is being developed as part of a tripartite collaboration between the CABI centre in Switzerland, the University of Neuchâtel and the Canton Jura. The development of the course material is underway, funding for student scholarships is being sought and various logistics for implementing the course are being worked out. In 2014, we will be selecting the first group of students ready for commencement of the programme in March 2015.

I am very proud of our collective achievements in 2013, which have led to a growth in revenue for the centre despite challenging global economic conditions. The ongoing commitment, enthusiasm and professionalism of our staff continue to underlie the success of the centre and I am very grateful for this. Our partners and donors are also fundamental for our operation and I would like to thank them for their continued support and interest. Their input is vital in shaping the work we do and in achieving measurable benefits through our projects. Looking ahead to 2014, I am anticipating another productive year for the Swiss centre and am looking forward to working together with our staff and partners as we make further valuable contributions to the overall mission of CABI.

Dr Ulrich Kuhlmann
Regional Director

highlights

CABI highlights

CABI presents at an EU Parliament symposium on the invasive maize pest *Diabrotica*

On 28 November, Ulrich Kuhlmann and Stefan Toepfer from CABI in Switzerland took up an invitation from Arvalis in France to attend a symposium side event at the European Parliament in Strasbourg. The symposium, entitled 'Growing maize 20 years after the arrival of western corn rootworm in Europe', was organized by Arvalis, the lead-farmer organization in France, in collaboration with Copa, an organization representing the interests of European farmers. Both Ulrich and Stefan were keynote speakers at the event, which focused on approaches to improve management of the invasive maize pest western corn rootworm, *Diabrotica virgifera virgifera*, in line with the relevant EU directives and regulations. Stefan Toepfer gave a presentation on the management of rootworms using a nematode-based biological control product that was jointly developed by e-nema company and CABI. This sustainable pest management option is already available commercially in Germany, Italy and France, and will become available in Austria in 2014 and in Hungary in 2015. Ulrich Kuhlmann then explained the classical biological control options that could also contribute to sustainable management of the invasive rootworm across Europe. It is hoped that both pest management options will be taken into consideration in light of the EU Directive on the sustainable use of pesticides. From 1 January 2014, this directive requires member states to implement integrated pest management (IPM) and prioritize the use of non-chemical methods of crop management in order to reduce dependency on the use of pesticides.

Meeting moderator from Arvalis introducing speakers, including Ulrich Kuhlmann and Stefan Toepfer, who delivered keynote addresses on the pros and cons of different strategies of *Diabrotica* control in Europe (photo: M. Szalai, University of Gödöllö, Hungary)

Flyer for the symposium held at the European Parliament in Strasbourg, France

A parasitic fly, considered a potential classical biological control agent of the invasive alien maize pest *Diabrotica* (photo: S. Toepfer)

new weed biocontrol project

An initiative by Jennifer Andreas for the Integrated Weed Control Project/ Washington State University Extension in the USA has led to a new project on the biological control of flowering rush, *Butomus umbellatus*. The project has so far attracted funding from four different sources in North America: the Washington State Departments of Agriculture and Ecology, the Montana Weed Trust Fund through the University of Montana and the British Columbia Ministry of Forests, Lands and Natural Resource Operations. Flowering rush is ideally suited for biological control, since it is the only genus and species within the family Butomaceae, so there are no closely related native North American species. This increases the likelihood of finding a host-specific biological control agent and will limit the number of plant species to be tested. On 31 October 2013, a first consortium meeting was held in conjunction with the annual Wyoming Weed and Pest Council Meeting in Jackson, Wyoming.

You can find more information on this project on p.59.

Jennifer Andreas (chair of the flowering rush consortium) and Greg Haubrich (Washington Department of Agriculture) during the first flowering rush consortium meeting in Jackson, Wyoming (photo: H.L. Hinz)

the ragweed leaf beetle arrives in Europe

One of the most important entomological events of 2013 in Europe was the detection of the ragweed leaf beetle, *Ophraella communa,* on common ragweed, *Ambrosia artemisiifolia*, in northern Italy and southern Switzerland. *Ophraella communa*, a native of North America, is a successful biological control agent of this highly allergenic weed in China. The beetle was detected in Europe during field work being conducted within the framework of the recently launched EU COST Action on 'Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)'. It is not yet clear how *O. communa* reached Europe, although the fact that it was first observed in Italy in the area of Milano Malpensa International Airport suggests that it may have been accidentally introduced by air traffic or commercial exchanges related to the airport.

During surveys in autumn 2013, the beetle was found at more than 130 sites in southern Switzerland (Ticino) and northern Italy across an area of c. 20,000 square kilometres and in all habitat types occupied by common ragweed. In common with reports from China, up to 100% of ragweed plants were attacked at sites where we found *O. communa* in Europe, with attack levels high enough to completely defoliate and prevent flowering and seed set of most ragweed plants. The results of this survey have been recently compiled in a paper co-authored by Urs Schaffner and published in the journal Weed Research.

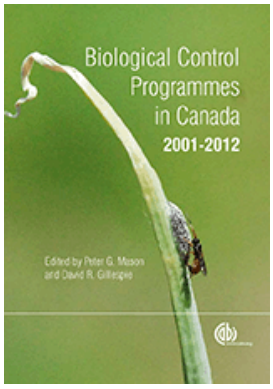
There remains, however, uncertainty regarding potential non-target effects of *O. communa* on sunflowers, because laboratory tests carried out in the 1970s in the USA revealed that larvae can complete their development on this crop plant. Field studies are urgently needed to help decide whether the establishment of *O. communa* in Switzerland and Italy should be considered as a troublesome introduction of an alien invertebrate that will have non-target effects on sunflower, or whether it is likely to become the first case of successful biological control of an invasive weed in continental Europe.

Ragweed leaf beetle, *Ophraella communa* (photo: P. Tóth, Slovak Agricultural University, Nitra)

tripartite meeting in Montpellier, France

On 7 February 2013, scientists from CABI in Switzerland and the UK, the US Department of Agriculture – Agricultural Research Service (USDA-ARS) European Biological Control Laboratory (EBCL) and the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) European Laboratory gathered at the EBCL facility at Montpellier in southern France to hold their traditional tripartite meeting. This year an invitation was extended to a fourth entity, the Biotechnology and Biological Control Agency (BBCA) in Italy, but unfortunately they were unable to participate. These meetings, which have been conducted on an irregular basis for many years, aim to exchange information, avoid overlap between the three, now four, foreign exploration laboratories and strengthen collaboration. A scientific paper by John Gaskin and co-authors, which gives an overview on molecular methods in weed biocontrol, was initiated at one of these meetings and published in the journal *Biological Control* in 2011. After project updates in the morning and more specific group discussions on current and potential future common projects in the afternoon, the meeting wound up with a communal dinner in a typical southern France bistro.

Tripartite meeting for scientists from CABI, the USDA-ARS European Biological Control Laboratory and the CSIRO European Laboratory at Montpellier in southern France (photo: D. Barcea, EBCL)



new book: *Biological Control Programmes in Canada 2001–2012*

For the last 66 years, CABI's Swiss centre has collaborated with Agriculture and Agri-Food Canada (AAFC) and the Canadian Forest Service as well as provincial governments and university laboratories in Canada to undertake classical biological control research. Joint publishing initiatives are a feature of this special relationship and in 2013 CABI published the fifth volume of a series recording the history of biological control in Canada: *Biological Control Programmes in Canada 2001–2012*, edited by Peter Mason and Dave Gillespie. In total nine scientists from our Swiss centre contributed to 13 chapters in the book. Reporting on the status of biocontrol agents released in Canada over the last decade, the book has chapters on each target pest that evaluate the impact of biocontrol and recommend future priorities, followed by a chapter on potential future targets and an appendix listing established agents. The volume contains information of interest to a global audience, including chapters that address the effects of invasive species and climate change.

tripartite collaboration between CABI, the University of Neuchâtel and the Canton Jura

A major component of the agreement established in 2013 between CABI, the University of Neuchâtel and the Canton Jura is the development of a Master of Advanced Studies course in Integrated Crop Management (MAS ICM). CABI made headway in 2013 in developing key partnerships for establishing the MAS ICM. We were also successful in securing four years' funding from SDC to provide scholarships for the course for international students. The programme, which begins in 2015, will provide advanced teaching in the field of sustainable agriculture and promote the adoption of sound crop management principles. Through pursuing the ICM MAS, the ability of students to address global challenges such as food security, resource management and environmental change will be enhanced. The MAS itself will take place in Delémont and will require students to obtain a minimum of 60 credit points according to the European Credit Transfer and Accumulation System (ECTS). The courses will be led by CABI staff and invited experts.

Under the research component of the agreement, two PhD students have been hired to carry out research on invasive species and weed biological control. They will be supervised at CABI by Marc Kenis, Hariet L. Hinz and Urs Schaffner.

In 2013 CABI was, for the second time, a host institute for Bachelor's students taking a problem-based learning (PBL) course at the University of Neuchâtel. Six students spent almost four weeks at CABI in March and April working on the PBL project 'Risk assessment of weed biological control agents: *Ceutorhynchus cardariae* against whitetops'. CABI also co-organized, with the University of Neuchâtel, a two-day Doctoral programme on 'Ecological benefits and risks of biological control'. We plan to increase our contribution to Bachelor's courses at the University of Neuchâtel in the coming years.

The Canton Jura is providing a total of CHF 300,000 over two years from 2013 to support this collaborative programme with the University of Neuchâtel.

CABI – Canton Jura collaboration on local projects

A 200-page manual to be used for teaching primary school children in the Jura about the functioning of river ecosystems, which we adapted during 2012, was successfully tested in eight classes in spring 2013 under the supervision of our centre.

Funding for this initiative came from a two-year service contract between CABI and the Department of Education, Culture and Sports of the Canton Jura, which was ratified in 2012. The contract covers several educational components worth a total of CHF 130,000 and includes CHF 70,000 core funding, CHF 30, 000 for the manual and CHF 30,000 on demand. New projects are being developed under the framework of a CABI-Canton Jura collaborative programme in the hope that funding will be renewed for another four years from 2014.

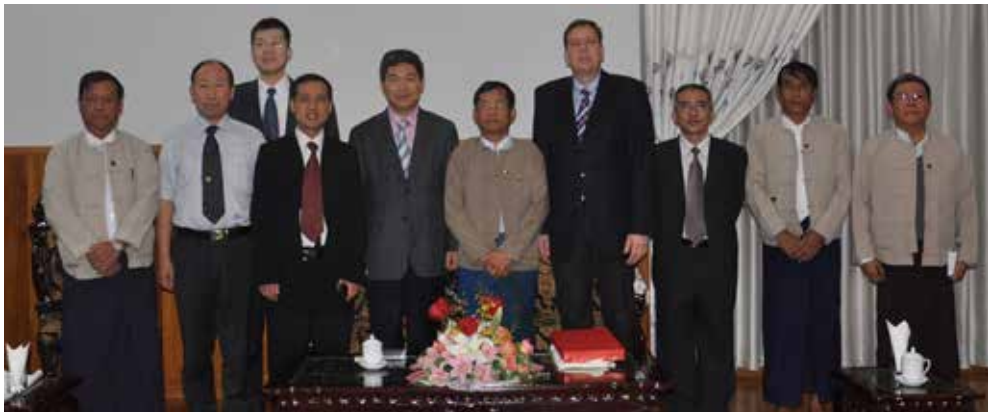
PBL students with Hariet L. Hinz, Urs Schaffner and André Gassmann (photo: C. Cloşca)

highest-level support for collaborative action in Myanmar

In January 2013, a high-ranking delegation from CABI and the Chinese Academy of Agricultural Sciences (CAAS) met the Agriculture Minister of the Republic of the Union of Myanmar, H.E. U Myint Hlaing. CABI Regional Director Dr Ulrich Kuhlmann and the Director General of CAAS's International Collaboration Department, Prof. Zhang Lubiao, explored and discussed opportunities to enhance existing cooperation in Myanmar, which is a CABI member country. The Union Minister stressed that 'The agricultural sector is the back bone of Myanmar's economy'. Opportunities were outlined to enhance agricultural development through technology transfer and capacity building through a collaborative approach between the Ministry of Agriculture and Irrigation (MoAI) and CABI along with the technical input from CAAS. Key results of this January meeting included the signing of a partnership statement for CABI's Plantwise activities and a Cooperation Statement, in which CABI, CAAS and the Union Minister agreed to cooperate in agricultural research, extension and education to promote the development and improvement of agricultural production.

In line with the Cooperation Statement, project development activities were carried out in July 2013 with 28 representatives of key departments of the MoAI during a workshop in Nay Pyi Taw. During the workshop, a generic ICM framework was agreed by all partners as an overall strategy for collaborative activities in Myanmar, and crop specific ICM concept notes were developed. A letter of intent, summarizing the outcomes of the project development workshop and the planned next steps was signed by MoAI, CABI and CAAS's Institute of Plant Protection (IPP-CAAS).

At the end of the workshop, the delegation was again received by the Union Minister, who confirmed full MoAI support for tripartite cooperation and urged actions of collaborative activities as early as possible.



Participants of the meeting with H.E. the Union Minister U Myint Hlaing, Nay Pyi Taw (photo: MoAI)

Ulrich Kuhlmann and Zhang Feng receive Visiting Professor status from the Institute of Plant Protection, Chinese Academy of Agricultural Sciences

Since its establishment in 2008, the CABI – Chinese Ministry of Agriculture Joint Laboratory of Bio-safety (CABI-MoA Joint Laboratory) has successfully implemented a number of international projects, varying from increasing rice and maize production in the Greater Mekong Subregion to facilitating the Second International Congress on Biological Invasions, which brought together around 350 experts to exchange research and technical progress on invasive species management. At the Fifth Steering Committee Meeting in Beijing in late March 2013, both sides were very pleased with the significant progress made and confident that the Joint Laboratory can play an even more important role in facilitating joint research, knowledge sharing, capacity building and technology transfer activities. In order to allow joint training of more postgraduate students, Drs Ulrich Kuhlmann and Zhang Feng had Visiting Professor status at IPP-CAAS conferred on them by Prof. Wu Kongming. This recognition is further evidence of the strength of the partnership and collaborative work at the Joint Laboratory to support sustainable agriculture, rural development and food security in the region.

Ceremony to award Visiting Professor status at IPP-CAAS, Beijing, in March 2013 (photo: CABI-MoA Joint Laboratory, Beijing)

emerging best practices in tertiary agricultural education in Cambodia

Cambodia has several public and private agricultural universities that are responsible for training future agricultural extension staff, agricultural administrators, researchers and agro-business people. Like many agricultural universities around the world, the Cambodian tertiary education system has not fully kept up with recent developments in education. To help rectify this, the Plant Biosecurity Cooperative Research Centre and the University of Sydney in Australia and CABI have participated in a World Bank-funded project, 'Higher education quality and capacity improvement'.

Under this project, a workshop was held at the University of Battambang in Cambodia on emerging best training practices in agricultural higher education. Participants from several universities as well as different ministries were able to acquire good understanding of contemporary topics in agricultural education, such as research as a basis for experiential and problem-oriented learning, recent trends in teaching and learning in agricultural education, systematic approaches to agricultural education, and technology adoption in education. They also developed ideas on how best-practices thinking could be applied in Cambodia in relation to its major national goals. It was concluded that regular training would be needed for higher education staff in all public and private agricultural universities (c. 300 people) to keep them up to date in key topics in agriculture (e.g. pest and disease management, agricultural extension, technical aspects of ICM) as well as in training methodologies, communication and language, while follow-up training on how to adapt and modify local curricula and training techniques would be desirable.

Suggestions on how to improve tertiary agricultural education in Cambodia emerged during the workshop on 'Emerging best practices in agricultural education' (photo: S. Toepfer)

Participants of the workshop on 'Emerging best practices in agricultural education', held at Battambang University in Cambodia in January 2013 (photo: Ch. Prak, Battambang University)

Stefan Toepfer discussing problems in tertiary agricultural education during the workshop at Battambang University (photo: P. Knight, University of Sydney)

training course on scientific writing

Following the success of two earlier training courses at CABI's centre in Pakistan on experimental design and statistical data analysis, in 2013 Dirk Babendreier conducted a training course on scientific writing for ten staff there. The training was characterized by brief lectures followed by extensive group work. Participants were given details about all steps, procedures and technical details in the development of a scientific paper, from points to consider even before beginning to write through to the peer-review process. Backed up with a lot of examples from published work and manuscripts provided by training participants, guidance was given on how a sound title should be developed, as well as how abstracts, introductions, materials and methods, results and discussions should be structured and written. Common pitfalls and flaws of scientific publications were highlighted together with suggestions on how to avoid them. Finally, substantial reviewing of participants' manuscripts was used to demonstrate how they could be improved. As a result of the three training courses, staff at the centre are now better equipped to plan experiments, conduct sound statistical analysis and turn this into scientific publications.

Participants were unanimous in finding this training course beneficial, and agreed that the three courses together had increased their competence and capacity for conducting and publishing research.

Participants of the training course on scientific writing at CABI's centre in Pakistan (photo: D. Babendreier)

from DPR Korea to Rwanda – a new project on soil insect pest management

A new project funded by the UK Department for International Development (DFID) in Rwanda on soil insect pest management using entomopathogenic nematodes (EPNs) is drawing on knowledge and enduring regional links fostered during a similar and successful project in the Democratic People's Republic of Korea (DPR Korea). The new three-year project, which starts in January 2014, aims to make low-input, environmentally friendly and economically sustainable plant protection technologies accessible to farmers in Rwanda, so they can control key soil-borne pests and improve protection of important vegetable crops such as tomato, carrot and potato. This will involve developing a low-cost EPN pilot mass production facility by adapting technology developed in China to local conditions and building up capacity of Rwandan researchers and technical staff. In addition, a national dissemination strategy including scale-out of EPN production facilities will be developed to raise national awareness of the technology and to substantially increase the number of farmers profiting from the technology.

This project will be implemented by CABI in close collaboration with the Rwanda Agricultural Board, together with IPP-CAAS and the Guangdong Entomological Institute through the CABI-MoA Joint Laboratory in Beijing.

building plant protection capacity in DPR Korea

A two-day inception workshop held on 10–11 July 2013 in Pyongyang marked the formal start of the Directorate-General for Development and Cooperation (DG DEVCO) EuropeAid funded project 'Building plant protection capacity for improved food security in DPR Korea', while a preceding nine-day awareness raising study tour of China ensured that participants were prepared for the project.

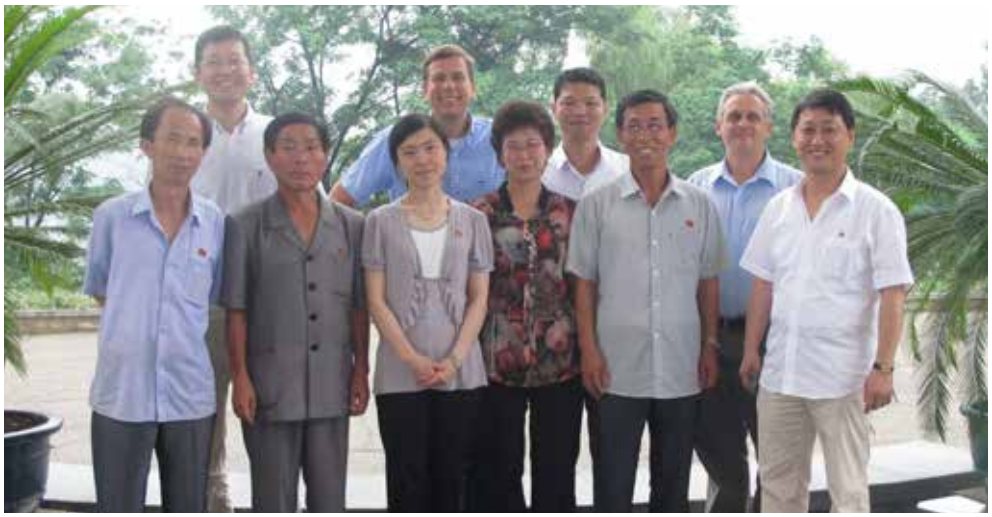
In this three-year project CABI will be working primarily with the Ministry of Agriculture, Department of Plant Protection (MoA-DoPP). The project aims to support improvement in the overall structure, management and operation of MoA-DoPP, in particular its capacity to exchange with other international organizations, and its technical and institutional capacity, which should lead to MoA-DoPP being in a stronger position to fulfil its mandate to improve plant protection and thus food production in DPR Korea. Participants in the inception workshop included representatives of MoA-DoPP, including the Director Mr Choe Kwang, the MoA Department of Science and Technology Transfer (MoA-DoS&TT) and the MoA Department of Foreign Affairs (MoA-DoFA). During the inception workshop all planning documents for the project were jointly developed to ensure that all partners recognize their responsibilities – a process aided by what MoA-DoPP and MoA-DoS&TT delegates had learnt during their study tour.

The visit to China (28 June – 6 July 2013) was designed to begin expanding the project partners' professional network of contacts and to provide an overview of the institutional organization and terms of reference of MoA-DoPP's sister organization in China, the MoA's Plant Protection and Quarantine Division (MoA-PPQD-CN), with particular reference to pest management, quarantine and development and implementation of national policy and regulations, as well as international responsibilities. The tour began with a meeting at MoA in Beijing, where DPR Korea's delegates
met with the Director of MoA-PPQD-CN, as well as representatives of the MoA's Division of Pesticide Management, National Agro-Technical Extension Service Center and International Cooperation Department. This was the first time that MoA-DoPP staff had met with their Chinese counterparts and was an important event to link these groups and enable useful bilateral discussions. The delegates gained further insights into the organization of plant protection and implementation of key responsibilities at provincial level by visiting and meeting staff at the Provincial Plant Protection Station (pPPS-CN) in Hubei, Wuhan Province. The role of pPPS-CN in developing and implementing regulations and policy was outlined and discussed in relation to pesticides, quarantine, and agricultural best practices.

During a two-day workshop at IPP-CAAS, the delegates were provided with detailed information on other topics relevant to the project, including the management and registration of pesticides and associated regulations in China, the importance of international conventions such as the Stockholm, Basel and Rotterdam conventions in relation to use and distribution of chemicals, and quarantine related issues, in particular sanitary and phytosanitary standards. The experience and knowledge shared during the study tour helped to prepare project partners for the inception workshop and will facilitate further project planning and adaptations in the future.

Delegates from MoA, DPR Korea meeting in Beijing with representatives of MoA, China (photo: K. Holmes)

Delegates from DPR Korea and staff of Wuhan Provincial Plant Protection Station at Hubei in China (photo: K. Holmes)



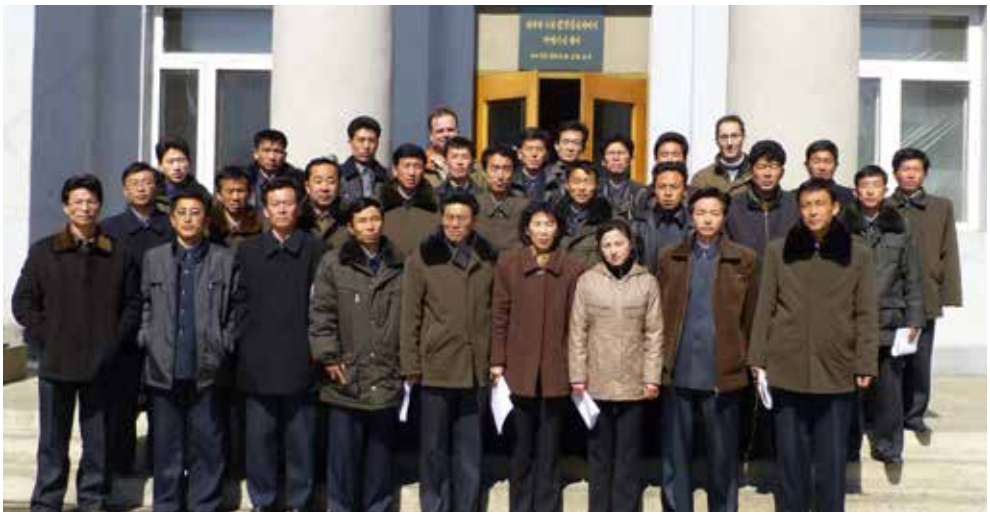
Participants of the MoA Partnership Project inception workshop in DPR Korea (photo: K.N. Tak, Korean–European Cooperation Coordination Agency (KECCA), DPR Korea)

ToT participants prepare media in the AAS-PPI Experimental Nematode Production Facility (photo: S. Toepfer)

ToT participants select nematode infected *Tenebrio* for propagation (photo: S. Toepfer)

training of trainers on mass production of beneficial nematodes in DPR Korea

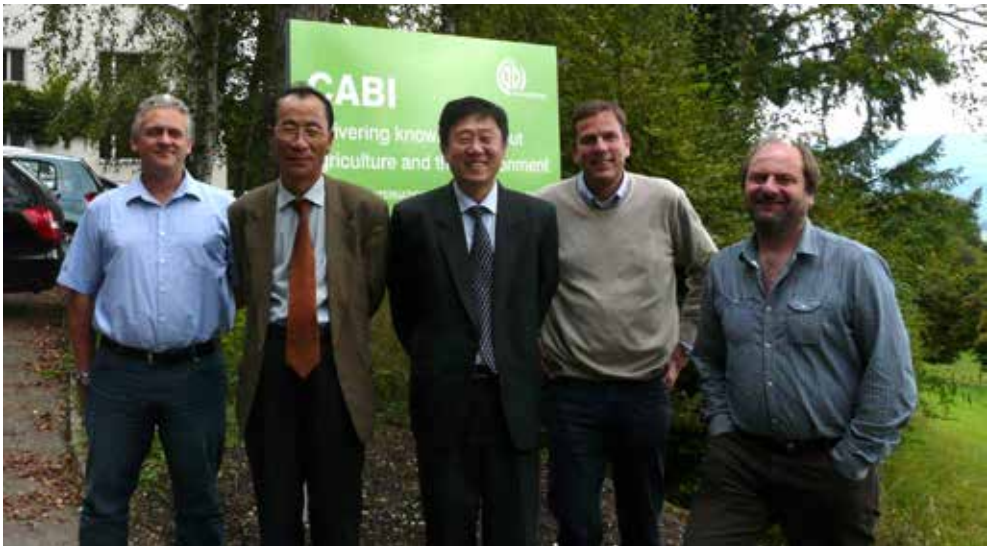
Twenty-five representatives from provincial plant protection stations, county plant protection stations and cooperative farms in DPR Korea participated in a ten-day Training of Trainers (ToT) workshop on nematode mass production in March 2013. The workshop was held at the Plant Protection Institute of the Academy of Agricultural Sciences' (AAS-PPI's) training facility and their Experimental Nematode Production Facility in Pyongyang, and the training was provided by master trainers from AAS-PPI and the Central Plant Protection Station of the Ministry of Agriculture (MoA-CPPS) with support from CABI and Andermatt Biocontrol AG, Switzerland. Participants were provided with theoretical and practical hands-on training in all aspects of EPN mass production, including alternative host rearing and *in-vivo* and *in-vitro* mass production methods. The training was well received by the participants and considered a success by all involved. The participants are now fully trained and capable of mass producing nematodes for application in the field against soil insect pests.



Participants of the ToT in nematode mass production methods at AAS in Pyongyang (photo: Ri, H.C., KECCA, DPR Korea)

DPR Korea embassy representatives visit Delémont

A welcome event at our centre this year was the visit on Friday 13 September by Mr Pak Jin Yong and Mr Pak Yong Sul, Consul and Second Secretary, respectively, at the DPR Korea Embassy in Bern. During their visit they met with Ulrich Kuhlmann, Manfred Grossrieder and Keith Holmes and had informal discussions on past and future activities of the centre's ICM team in DPR Korea, in particular on the SDC and EuropeAid development cooperation projects. This visit strengthened our existing close link with the embassy in Bern and supports current and future interactions with DPR Korea.



Consul Mr Pak Jin Yong (second from left) and Second Secretary Mr Pak Yong Sul (third from left) from the DPR Korea Embassy in Bern during their visit to our centre in Delémont (photo: W. Jenner)

video production in Albania and Turkey

Two videos made in 2013 are a permanent, visual addition to the outputs of two of our centre's recent projects.

The final activity for the Swiss National Science Foundation (SNSF)/SDC Scientific Co-operation between Eastern Europe and Switzerland (SCOPES) programme for improving sustainable agriculture was to produce a video in Albania that captured the achievements of the project, including how it has provided invaluable lecture materials for teaching IPM to students, and farmer training on IPM in general and rational pesticide use in particular, as well as providing equipment and knowledge that has improved our project partners' research capacity. Making the video entailed recording interviews with a number of farmers and students, all the project partners, and other stakeholders such as spokesmen from the Ministry of Education. The video portrays the universally positive responses to the project, ranging from farmers talking about increased income, to students describing improved job opportunities, and project partners talking about their improved teaching and scientific skills.

Likewise, CABI produced a video, with the support of its project partners, to capture results from the oriental tobacco project in Turkey, which established model farms to demonstrate best practices and new technologies. Farmers who participated in the project were interviewed to obtain qualitative data and farmer perspectives on the impact of model farms on the adoption of the new practices and technologies and reduction of crop protection agent (CPA) use. The interviews highlighted the successful implementation of IPM and best management practices and application of new technologies. The farmers were extremely positive about their experiences, saying that they would continue to implement the new practices, and also noted that other farmers in their villages were sceptical at first but impressed with the final results.

CABI's Julia Dennis interviewing an IPM farmer in Albania (photo: D. Babendreier)

student highlights

Lars Andreassen completes his PhD at the University of Manitoba

Lars Andreassen, who undertook his PhD research as part of a collaborative research programme involving CABI, the University of Manitoba in Canada, and AAFC, passed his examination in September 2013, successfully defending his work and gaining his PhD. Ulrich Kuhlmann, Regional Director of CABI in Switzerland, was a member of Lars' PhD committee.

Lars' PhD thesis was entitled 'Investigation of *Aleochara bipustulata* (Coleoptera: Staphylinidae) adult diet and community interactions'. His research has contributed significantly to the risk assessment for the introduction of this European staphylinid beetle to control the exotic cabbage maggot *A. pustulata* in Canada, and the knowledge generated during his PhD will also be highly relevant to the decision-making process of the Canadian Food Inspection Agency (CFIA) if a petition for the release of *A. bipustulata* is submitted.

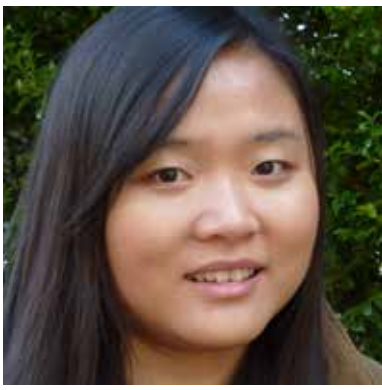
Lars previously completed his MSc as part of the same partnership between CABI, the University of Manitoba and AAFC. Between 2004 and 2012, Lars spent his summer months based at the CABI centre in Switzerland, conducting his field research, before returning to Canada for the winter months to complete university courses and continue his research there. This type of partnership between CABI and a university or other organization for implementing a joint research project in biological control is very common for us and has led to the development of a very strong international student programme at the CABI centre in Switzerland.

Lars Andreassen
(photo: G. Grosskopf-Lachat)

Dr Sun Yan

Sun Yan successfully defended her PhD thesis in September 2012. She was affiliated to the University of Fribourg, where she was supervised by Prof. Heinz Müller-Schärer, but did most of her field work at CABI in Delémont. In her thesis, Yan investigated the mechanisms underlying the environmental impact of invasive plant species. Her work included the development of new conceptual models to assess this impact as well as biogeographic and community-based experimental studies to compare the environmental impact of invasive and dominant native plant species. One of Yan's main findings is that the impact of invasive species appears to be largely driven by competition for the same limiting resources in the home range, but by other factors in the introduced range, such as interference competition or exploitation of resources that are not used by the new neighbours. This distinction has important consequences for the management of invasive species; for example, ecosystems recovery may be less likely following simple biomass reduction. A first chapter of her thesis has already been published as a paper in the high-ranked journal Ecology, and more publications are underway.

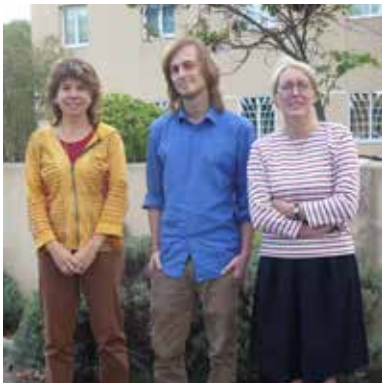
In early 2014, Yan will take up a post-doctoral position in Prof. George Roderick's laboratory at the University of California, Berkeley, where she will study the evolutionary ecology of the invasive alien plant *Ambrosia artemisiifolia* and its specialist herbivores. We would like to congratulate and thank Yan for her accomplishments during her PhD and wish her all the best for her future career.



Sun Yan
(photo: G. Grosskopf-Lachat)

new MSc student

Thanks to financial support from the USDA-ARS Northern Plains Agricultural Research Laboratory (NPARL) in Sidney, Montana, we were able to engage MSc student Adrien von Virag. Adrien is conducting his project on the root-gall forming weevil *Ceutorhynchus assimilis*, which we are investigating as a potential biological control agent for *Lepidium draba* (see p.47). The host-specific strain of *C. assimilis* that we are interested in has so far only been found in southern France and Italy, where climatic conditions are much milder than in the western parts of North America, where the species would be introduced. Adrien is therefore investigating the temperature dependent development of the specialist strain in southern France as well as its phenology and cold hardiness in comparison to the generalist strain of *C. assimilis* in Romania. Overall, we hope that the data will indicate whether or not the specialist strain has the potential to adapt to continental climates as encountered in western North America. The project is being conducted in close collaboration with Marie-Claude Bon from the USDA-ARS EBCL at Montpellier in France. Adrien is being supervised at CABI by Hariet L. Hinz with input from Tim Haye and is registered at the University of Fribourg in Switzerland, where his supervisor is Prof. Heinz Müller-Schärer.



Hariet L. Hinz, Adrien von Virag and Marie-Claude Bon at the USDA-ARS European Biological Control Laboratory (photo: M. Roche, EBCL)

Alicia Leroux completes the experimental work for her MSc

After three years' research at CABI, Alicia Leroux from the University of Manitoba has completed her experimental work on the seed-feeding fly *Euphranta connexa* for her Master's degree. This work has been complemented by a literature review on the impacts of and management methods for invasive plants, with a focus on biological control. Alicia's MSc was supervised by Prof. Neil Holliday at the University of Manitoba, and by André Gassmann and Hariet L. Hinz at CABI. Alicia will defend her thesis in January 2014.

Alicia Leroux (photo: A. Firebaugh)

arthropod biological control

introduction

This year was a very busy and productive one for the Arthropod Biological Control section! During the summer our team at Delémont was joined by three students from Canada (Sara Abdallah, Allison Carter and Léna Durocher-Granger) who carried out research focused on the biological control of insect pests such as cabbage seedpod weevil (*Ceutorhynchus obstrictus*), swede midge (*Contarinia nasturtii*), plant bugs (*Lygus* spp.), red clover casebearer (*Coleophora deauratella*) and brown marmorated stink bug (*Halyomorpha halys*). In addition, we were pleased to work on a joint project with CABI's centre in the UK, investigating biological control options for the European earwig (*Forficula auricularia*) on the Falkland Islands. I would like to stress that achieving our research goals would not have been possible without the immense contribution of all three of our summer students.

Team member Stefan Toepfer and his staff at the Joint Laboratory of CABI and the Plant Protection Directorate at Hodmezovasarhely in southern Hungary continued to investigate the efficacy of nematode products against different densities of the invasive western corn rootworm (*Diabrotica virgifera virgifera*).

Li Hongmei, Zhang Jinping, Wan Huanhuan, Luo Shuping and Zhang Feng from the CABI-MoA Joint Laboratory in Beijing continued to investigate biological control options for box tree moth (*Cydalima perspectalis*), plant bugs and brown marmorated stink bugs. As a result of our successful joint work, five research manuscripts were published in 2013 in peer-reviewed international journals, including the *Journal of Pest Science, Biocontrol Science and Technology, Molecular Ecology* and the *Journal of Applied Entomology.*

Our joint work with AAFC was represented in eight chapters of the recently published CABI book Biological Control Programmes in Canada 2001–2012, edited by our project partners Peter Mason and Dave Gillespie. In addition, our research was presented at international meetings including the Joint Meeting of the Entomological Society of Canada and the Entomological Society of Ontario in Guelph, Canada, the Fourth International Symposium on Biological Control of Arthropods in Pucón, Chile, and the Brown Marmorated Stink Bug Working Group meeting in Bridgeton, New Jersey, USA.

I am delighted to announce that our PhD student Lars Andreassen (University of Manitoba, Winnipeg, Canada) successfully defended his thesis entitled 'Investigation of *Aleochara bipustulata* (Coleoptera: Staphylinidae) adult diet and community interactions' on 10 September 2013. During his time at our centre he was supervised by Ulrich Kuhlmann.

In April this year Ulrich Kuhlmann handed over full responsibility for the Arthropod Biological Control programme to me, and I would like to thank him for his confidence in me. In addition, I am grateful to all my colleagues in China and Hungary for making 2013 a successful year, and I would like to thank particularly my Canadian partners for their support!

Dr Tim Haye
Head of Arthropod Biological Control

Dr Tim Haye
Head of Arthropod Biological Control

Dr Stefan Toepfer
Research Scientist

Lars Andreassen
PhD Student

Sarah Abdallah
Summer Student

Alyson Carter
Summer Student

Léna Durocher-Granger
Summer Student

Andor Kiss
Summer Student based in Hungary

Ferenc Koncz
Summer Student based in Hungary

Rajmond Stuber
Summer Student based in Hungary

biological control of the cabbage seedpod weevil, *Ceutorhynchus obstrictus*

Cabbage seedpod weevils (photo: T. Haye)

The cabbage seedpod weevil, *Ceutorhynchus obstrictus*, is a widely distributed pest of cruciferous crops in Europe and North America. Accidentally introduced from Europe, the weevil was first discovered in the Canadian province of British Columbia about 80 years ago, and has since spread to other parts of western and eastern North America. Since its arrival in North America, the weevil has become a problem particularly in the Canadian Prairie Provinces of Saskatchewan and southern Alberta where it causes substantial economic losses in canola crops. In eastern Canada, the occurrence of *C. obstrictus* is regarded as a threat to canola seed production. Yield losses result from adults feeding on flower buds and larvae feeding within seedpods. Currently, control measures for the cabbage seedpod weevil continue to rely on the application of broad-spectrum insecticides. Although never intentionally released in eastern Canada, the most effective natural enemy of *C. obstrictus* in Europe, the parasitic wasp *Trichomalus perfectus*, was first recorded from Ontario and Québec in 2009. To date it remains unclear whether the parasitoid has the potential to spread and establish throughout the canola growing area of Canada.

Bioclimatic simulation models have been applied successfully to predict the distribution and extent of invasive insect pest establishment in new environments. To a much lesser extent, bioclimatic models have been developed to predict the potential areas where insect natural enemies being considered for classical biological control programmes may be successful against invasive pests. The objectives of our study are to investigate the temperature requirements of *T. perfectus* and its distrib ution in Europe in order to develop bioclimatic models predicting the potential distribution and abundance of the parasitoid in North America.

Trichomalus perfectus searching for larvae of the cabbage seedpod weevil (photo: T. Haye)

In 2013, we studied the development of *T. perfectus* at different temperatures to develop a degree-day model and define its developmental thresholds. In addition, surveys for cabbage seedpod weevil parasitoids were conducted in Croatia, France, Germany, Hungary, Spain and the UK, to determine the distribution and abundance of *T. perfectus* in Europe. In total, more than 8700 weevil larvae were collected, from which more than 2700 parasitoids emerged. *Trichomalus perfectus* was the most common species in northern parts of Europe, whereas *Mesobolobus morys* was more abundant in southern locations. In 2014, surveys will be expanded to additional areas in Europe, e.g. northern France and Norway.

T. Haye (t.haye@cabi.org), **S. Toepfer**, **A. Carter**, **S. Abdallah** and **L. Durocher-Granger**, in collaboration with **A. Übelhardt** (Courroux) from Switzerland, **M. Roche** (EBCL, Montpellier) from France, and **P.G. Mason**, **G.A.P. Gibson** (both AAFC, Ottawa), **D. Gillespie** (AAFC, Agassiz), **O. Olfert**, **R. Weiss** (both AAFC, Saskatoon), **T. Gariepy** (AAFC, London) and **L. Dosdall** (University of Alberta, Edmonton) from Canada. Funded by: AAFC, Canada.

Sara Abdallah collecting cabbage seedpod weevil parasitoids in a canola field at Courroux in Switzerland (photo: T. Haye)

Canola flower heavily infested with swede midge larvae (photo: T. Haye)

Swede midge, *Contarinia nasturtii* (photo: T. Haye)

biological control of the swede midge, *Contarinia nasturtii*

The swede midge (*Contarinia nasturtii*), a pest of Eurasian origin, was first detected in the Canadian province of Ontario in 2000. It causes severe damage to a wide variety of important cabbage crops such as broccoli, cabbage, cauliflower, turnip, radish and canola. Swede midge larvae feed actively on the growth points and leaf stalks of cabbage plants, resulting in deformed plants, decreased seed production and reduced crop yield. Damage can reach up to 80% if crops are left untreated.

Since its first detection in Ontario surveys have confirmed the presence of swede midge in four additional Canadian provinces: Québec, Nova Scotia, Manitoba and Saskatchewan. In the USA the midge was first detected in New York state in 2004, and has since been found in Massachusetts, New Jersey, Connecticut and Ohio. Bioclimatic models have predicted that it could spread further and become established in every Canadian province and a large area of the USA. There is concern that, if the swede midge becomes widespread in western Canada, it could become a pest of spring-planted canola, an extremely valuable and widely cultivated crop. Since its arrival in the main cabbage growing areas of eastern Canada, pesticide applications in cabbage crops have increased, threatening already existing biological control programmes against other cabbage pests.

Comprehensive surveys for natural enemies of swede midge in Europe have demonstrated that parasitoids do not seem to regulate the pest efficiently. Life table studies were therefore initiated in Switzerland to compare mortality from natural enemies with other sources of mortality acting on the pest and to assess the contribution to population regulation by a given natural enemy. Results of studies conducted in 2013 suggest that swede midge suffers from nearly 45% egg mortality, whereas larval mortality is extremely low (6%). Foraging soil predators and low soil humidity in summer are probably the reasons for an observed pupal mortality of 90%.

T. Haye (t.haye@cabi.org), **A. Carter**, **S. Abdallah** and **L. Durocher-Granger**, in collaboration with **C. Sauer** and **J. Krauss** (both Agroscope Changins-Wädenswil) from Switzerland, and **D. Gillespie** (AAFC, Agassiz), **G. Boivin** (AAFC, St-Jean-sur-Richelieu), **T. Gariepy** (AAFC, London) and **P. Mason** (AAFC, Ottawa) from Canada. Funded by: AAFC, Canada.

Léna Durocher-Granger collecting canola seedlings infested with swede midge larvae at Courroux in Switzerland (photo: T. Haye)

biological control of the brown marmorated stinkbug, *Halyomorpha halys*

The brown marmorated stink bug, *Halyomorpha halys*, is native to East Asia and invasive in the USA, Canada, Italy, France and Switzerland. Owing to its extremely wide host range it is a serious pest of many fruit trees, ornamental and other shrubs, and fruit and vegetable crops. In addition, its habit of entering structures to overwinter makes it a major nuisance pest in cities.

In North America the pest was first detected in 1996 in the US state of Pennsylvania, and is now present in 40 states in the USA. The discovery in 2012 that it was established in the Canadian province of Ontario immediately raised concern among Canadian fruit growers because major outbreaks of *H. halys* in 2010 had caused severe losses in fruit production in the mid-Atlantic states of the USA. It can be anticipated that in the coming years *H. halys* will continue to spread throughout Canada and become a serious threat to Canadian fruit production, with potential economic impact on other crops including maize and soybean. Control of *H. halys* is currently confined to broad-spectrum chemical insecticides, but research is being conducted on the use natural enemies from Asia, which are thought to be an important mortality factor there. In China, parasitoid wasps in the genera *Trissolcus* and *Anastatus* cause high levels of egg parasitism. Of these, *Trissolcus japonicus* is the most promising candidate for biological control of brown marmorated stink bug in North America.

Field surveys to assess the natural enemy assemblage of *H. halys* and non-target stink bugs in China, which began in 2012, were continued in 2013. The main objective of our study is to investigate the ecological host range of *T. japonicus*. Since egg masses of stink bugs are difficult to find in the field, hundreds of laboratory reared egg masses of *H. halys*, and the non-target species *Plautia fimbriata* and *Dolycoris baccarum*, were exposed throughout the season in two orchards outside Beijing. We found that *H. halys* was primarily attacked by *T. japonicus*, *Trissolcus flavipes* and *Anastatus* sp., whereas *Trissolcus plautiae* and *Trissolcus* sp. were the dominant *parasitoids* of *P. fimbriata* and *D. baccarum*, respectively. Investigations on the ecological host range of *T. japonicus* will be continued in 2014.

T. Haye (t.haye@cabi.org), **Zhang J.**, **Li H.**, **Zhang F.**, **A. Carter**, **S. Abdallah** and **L. Durocher-Granger**, in collaboration with **D. Wyniger** (Natural History Museum Basel) from Switzerland, **K. Hoelmer** (USDA, Newark), **M. Buffington** and **E. Talamas** (both USDA, Washington, DC) from the USA, Marie-Claude Bon (EBCL, Montpellier) from France and **D. Gillespie** (AAFC, Agassiz), **T. Gariepy** (AAFC, London) and **P. Mason** (AAFC, Ottawa) from Canada. Funded by: AAFC, Canada.

Trissolcus flavipes parasitizing brown marmorated stink bug eggs (photo: T. Haye)

Brown marmorated stink bug, *Halyomorpha halys* (photo: T. Haye)

Zhang Feng and Zhang Jinping collecting stink bugs in an orchard near Lengquan village, China (photo: T. Haye)

Lygus plant bug (photo: T. Haye)

impact of climate on *Lygus* parasitoids

Lygus plant bugs are highly polyphagous pests of field and greenhouse crops throughout North America, including vegetable and fruit crops, alfalfa and canola. Overall parasitism by native parasitoids is insufficient to significantly suppress pest *Lygus* populations in North America, but parasitism of *Lygus* species in Europe was found to be much higher. Consequently, the European *Peristenus relictus* was released in large numbers in New Jersey and California for neoclassical biological control. It failed to establish in New Jersey from releases made between 2001 and 2012, but recently became established in California. Attempts were also made to introduce *P. relictus* into western Canada, but several smaller releases between 1978 and 1981 failed to result in establishment. Reasons for *Peristenus digoneutis'* failure to establish in New Jersey and western Canada are largely unknown but could be related to local climates.

The objective of our current study is to develop a bioclimatic model to predict potential range and relative abundance of *P. relictus* in North America and to investigate whether established populations in California could expand their distribution northwards into Canada.

In 2013 we started to estimate initial model parameter values for *P. relictus* including its lower developmental threshold and the number of degree-days needed to complete development from egg to adult. In addition we collected distribution data from Europe, which will help to define the climate requirements of the parasitoid. In 2014 we plan to investigate the upper developmental threshold and the impact of heat stress on the performance of *P. relictus*.

Peristenus relictus parasitizing a *Lygus* nymph (photo: T. Haye)

T. Haye (t.haye@cabi.org) and **L. Durocher-Granger**, in collaboration with **O. Olfert**, **R. Weiss** (both AAFC, Saskatoon), **T. Gariepy**, **A.B. Broadbent** (both AAFC, London), **D. Gillespie** (AAFC, Agassiz) and **P.G. Mason** (AAFC, Ottawa) from Canada. Funded by: AAFC, Canada.

Sara Abdallah collecting *Lygus* plant bugs in a meadow near Courroux in Switzerland (photo: T. Haye)

biological control of red clover casebearer

The red clover casebearer, *Coleophora deauratella*, is a widely distributed pest of clover grown for seed in south-eastern and western Canada and in the north-eastern USA. It is native to Europe, eastern Siberia and the Middle East and was accidentally introduced into North America as early as 1962, but the first economic damage to clover seeds, in the Canadian province of Ontario, was not reported until 1989. First records from western Canada date back to 2001, but since 2006 it has become a significant pest in the Peace River region of Alberta, causing up to 99.5% seed loss in second-year stands. Damage is caused by the larvae, which are present in fields from bud to harvest, feeding on florets and developing seeds from mid-June until late September.

In Europe, *Coleophora* species are controlled by a complex of at least 17 parasitoids. Thousands of parasitoids belonging to several species were imported from Europe into New Zealand between 1952 and 1969, resulting in the establishment of two species, *Bracon variegator* and *Neochrysocharis formosa*, which subsequently contributed to a considerable reduction in *Coleophora* populations there. The latter species was then imported from New Zealand into Canada, where it was released in Ontario between 1993 and 1995.

Remarkably, the parasitoids that contributed to the biological control of the moth in New Zealand were not those that had been predicted to be most likely to succeed. Studies in Europe had shown that two other parasitoids, *Agathis rufipalpis* and *Chelonus contractus*, were causing far higher parasitism and were more closely synchronized with the host than *B. variegator* and *N. formosa*.

The success of European parasitoids in New Zealand and the importance for seed and honey production of protecting pollinator species increased interest in biological control from clover seed producers in Alberta. Since the impact of parasitoids, particularly *A. rufipalpis* and *C. contractus*, on *Coleophora* populations is still not understood, life table studies in Europe may help to identify the most susceptible life cycle stage of the moth and the most promising candidates for biological control in Canada.

In 2013, surveys were conducted across Switzerland, the German Rhine Valley and northern Germany. The largest moth populations were located in natural clover stands in Basel in Switzerland, whereas populations in Germany were small. Mass collection in Basel resulted in nearly 400 overwintering larvae, which will be incubated in spring 2014 to allow parasitoids to emerge. In 2014 we are planning to survey southern Sweden, where populations were located near Lund in 2013.

T. Haye (t.haye@cabi.org), **A. Carter**, **S. Abdallah** and **L. Durocher-Granger**, in collaboration with **J. Otani** (AAFC, Beaverlodge), **P.G. Mason** (AAFC, Ottawa), **D. Gillespie** (AAFC, Agassiz) and **T. Gariepy** (AAFC, London) from Canada. Funded by: AAFC, Canada.

Red clover casebearer moth
(photo: T. Haye)

Red clover casebearer larva
(photo: T. Haye)

Léna Durocher-Granger inspecting a pheromone trap for red clover casebearer in the CABI garden at Delémont
(photo: T. Haye)

A tachinid pupa next to an adult earwig, *Forficula auricularia* (photo: T. Haye)

Triarthria setipennis, a parasitoid of the European earwig (photo: T. Haye)

biological control of the European earwig, *Forficula auricularia*

The European earwig, *Forficula auricularia*, was recently introduced to the Falkland Islands, where it has become a nuisance pest in the Port Stanley and Mount Pleasant Airport area since 2008. Earwigs are not only a nuisance in autumn when they retreat into houses, but they also cause immense damage to garden crops (cabbage, broccoli, turnip, beetroot, etc.) and some commercially grown crops such as lettuce.

Chemical insecticides are ineffective because of the earwig's widespread occurrence and great mobility, so there is an urgent need for an alternative and sustainable control measure, such as classical biological control. In its native range in Europe *F. auricularia* is attacked by two parasitic tachinid fly species, *Ocytata pallipes* and *Triarthria setipennis*, which have previously been introduced into Canada, the USA and New Zealand for earwig control. However, little is known about the success of those releases. The host specificity of both parasitoids is also largely unknown and their potential impact on non-target species needs to be properly assessed before either control agent can be imported. However, the risk can be predicted to be minimal since no native earwigs or closely related invertebrates occur on the Falklands or other nearest islands.

In 2013 a joint project between CABI's centres in the UK and Switzerland for the biological control of earwigs on the Falkland Islands was initiated by Norbert Maczey. The first phase of the control programme covered host-range testing and the development of suitable methods to provide sufficient numbers of *T. setipennis* and *O. pallipes* for a release on the Falkland Islands. Earwig traps were set out at our centre in May to complement collections made in the UK. Collecting in Switzerland continued until end of August and resulted in a total of 1300 earwigs, from which 62 tachinid pupae were obtained.

N. Maczey (n.maczey@cabi.org), **S. Edgington**, **D. Moore**, **E. Thompson** and **T. Haye** (t.haye@cabi.org). Funded by: the Environmental Planning Department of the Falkland Islands Government.

Tim Haye setting out earwig traps in an apple orchard at Delémont (photo: S. Edgington)

biological control of the box tree moth, *Cydalima perspectalis*

The box tree moth, *Cydalima perspectalis*, an invasive alien species of Asian origin, was first reported in Europe in south-western Germany in 2006. It quickly spread into Switzerland, the Netherlands, France, Austria and the UK. Larvae feed on leaves, shoots and bark of box trees (*Buxus* spp.) and severe infestations can lead to almost complete defoliation of the plants. Imported box trees are commonly planted in European gardens for ornamental purposes, but native box trees (*Buxus sempervirens*) also grow in forests as understorey shrubs. The introduction of *C. perspectalis* into Europe represents a severe threat to nurseries, parks and gardens, and natural *Buxus* stands.

In 2013 a bioclimatic model predicting the pest's potential distribution in Europe was published, based on biological parameters measured at CABI. It shows that all European regions are suitable for the development of the moth, but damage will probably be greater in southern and central regions, where it is able to complete two generations per year in contrast to more northern regions where only one generation is possible.

In late 2013, we started a new project focusing on damage to wild box from the box tree moth. The objectives of the project, which runs until December 2014, are to (i) map natural box tree stands in the Jura, (ii) monitor damage by the box tree moth in the most important stands, (iii) propose a management strategy in forests, (iv) produce a leaflet for local foresters and other stakeholders, and (v) assess the ecological impact of the moth on natural box stands in north-western Switzerland. First observations have shown that wild box is quite rare in the Canton Jura and that the moth has already reached all stands although it has not inflicted any damage so far. However, around Basel we found that most of the trees that were heavily defoliated in 2010 are now dead. The impact of *C. perspectalis* on wild box stands will be studied in 2014.

In China, field surveys for natural enemies of *C. perspectalis* were extended to Shandong and Zhejiang provinces in 2013, but parasitism rates were found to be generally low. As in previous years, the most frequent parasitoid was *Chelonus tabonus*.

T. Haye (t.haye@cabi.org), **S. Nacambo**, **M. Kenis**, **D. Weber**, **Li H.M.** and **Zhang F.**, in collaboration with **A. Aebi** (University of Neuchâtel, Switzerland) and **G. Vétek** (University of Budapest, Hungary). Funded by: the Office of the Environment of the Canton Jura, Switzerland.

Casinaria sp., a parasitoid of *Cydalima perspectalis* in China (photo: T. Haye)

Box tree caterpillar (photo: T. Haye)

Gábor Vétek setting up pheromone traps for box tree moth at Liestal near Basel (photo: T. Haye)

Peristenus spretus, a parasitoid of *Apolygus lucorum* in China (photo: Luo S.)

biological control of plant bugs in Chinese cotton

Apolygus lucorum is a widely distributed species throughout Eurasia. In China, *A. lucorum* is one of the most important pests in cotton. It feeds on the terminal meristems, bolls and various other tissues of the plant, often leading to bushy plants and boll abscission. At high population density, it can cause considerable yield loss. Historically, the cotton bollworm, *Helicoverpa armigera*, has been the most important pest of cotton in China. *Apolygus lucorum* was often treated as a secondary pest and usually controlled by insecticide sprays targeting the cotton bollworm. Since 1997, however, Chinese farmers have been increasingly adopting *Bt* cotton to combat the cotton bollworm and, as a consequence, the amount of insecticides applied in cotton production has fallen. The reduction in pesticide use has meant that in recent years mirids such as *A. lucorum* have become key insect pests of *Bt* cotton, particularly in the cotton growing regions of the Yellow River (Hebei, Henan and Shandong provinces) and Changjiang River (Anhui and Jiangsu provinces). In the last ten years, outbreaks in these regions have caused 15–50% yield losses in cotton. Currently, insecticide use is the sole pest management option available for most Chinese cotton farmers. As irrational pesticide use may have a number of undesirable effects, environmentally sound and sustainable management alternatives are urgently needed.

During surveys for parasitoids native to China in 2009, two native nymphal parasitoids, *Peristenus relictus* and *P. spretus*, were identified as potential biological control agents. A mass-rearing system was successfully developed for *P. spretus* at the MoA-CABI Joint Laboratory. This allowed us to conduct a study on the functional response of *P. spretus* to its host, *A. lucorum*, which was published in 2013. The ability to mass produce the parasitoid also means that for the first time we can test the efficacy of *P. spretus* in field cages, which have been set up in Hebei, Henan and Shandong provinces.

Chinese date tree damaged by *Apolygus lucorum* (photo: Luo S.)

In 2013 we established a laboratory rearing colony of the European parasitoid *Peristenus digoneutis*, following its importation into China in 2012, which is allowing us to study its response to *A. lucorum* and its potential for use in biological control.

Studies on the *Lygus* parasitoids' biology and efficacy will be continued in 2014.

Luo S.P., **Li H.M.**, **T. Haye** (t.haye@cabi.org), **Zhang F.**, **Wei N.**, **Zhou W.G.**, **He B.J.**, **Yi C.R.**, **Chen Y.L.**, **Duan X.X.** and **U. Kuhlmann**, in collaboration with **Prof. Wu K.M.**, **Lu Y.H**. and **Fu X.W.** (IPP-CAAS, Beijing) and **Men X.Y.** (Shandong Academy of Agricultural Sciences), China). Funded by: MoA, China.

Field cage experiment set up in Shandong Province to test the efficacy of *Peristenus spretus* (photo: Luo S.)

finding the optimal dose for beneficial nematodes to control *Diabrotica* in Europe

The western corn rootworm, *Diabrotica virgifera virgifera*, is one of the most destructive pests of maize in North America. The rootworm is a leaf beetle with eggs that overwinter in the soil. After maize has germinated, the eggs hatch, and its three larval instars feed on maize roots, often causing plant lodging and yield losses. Adults can occasionally reduce yields through intensive silk feeding, which interferes with maize pollination. Over the last 25 years, the western corn rootworm has moved into Europe causing problems in maize.

Ten years of joint efforts in research and development have led to a nematode-based biological control solution for this destructive maize pest. During this period CABI collaborated with diverse partners in different countries including universities (the University of Neuchâtel; the University of Kiel), research institutes (the Cereal Research Station, Szeged; Agroscope Reckenholz-Tänikon, Zurich; Landwirtschaftliches Technologiezentrum, Stuttgart), government institutions (the Plant Protection Directorate, Hodmezovasarhely; the Austrian Agency for Health and Food Safety – AGES, Vienna), farmer associations (fenaco – UFA-Samen Beneficials, Aesch), nematode producers (e-nema, Schwentinenthal; Andermatt Biocontrol AG, Grossdietswil), nematode application manufacturer (Cult-tec Ltd, Freiburg) and many others. As a result, mass-produced beneficial *Heterorhabditis bacteriophora* have been available as a commercial product since 2012. They are currently on the market in Germany, Italy, France and Austria, and registration is ongoing for the Czech Republic and Hungary. The nematodes can be applied in different ways, but a fluid stream spray into soil at sowing is considered to be the most effective application method.

Because of the potential for use of the product in Bavaria in southern Germany, and in the light of a current EU-wide ban on neonicotinoid seed coatings owing to bee toxicity, the Bavarian State Research Centre for Agriculture in Freising requested a one year study to further clarify the extent to which the nematode product can reduce *Diabrotica* populations and the damage they inflict below threshold levels, and to assess this at different pest densities. Results revealed that control efficacies of both nematodes and pesticides have some variability, but the nematodes can usually achieve sufficient reductions in pest level to prevent severe root damage.

S. Toepfer (s.toepfer@cabi.org) and **U. Kuhlmann** (u.kuhlmann@cabi.org), in collaboration with **M. Zellner** (Bavarian State Research Centre for Agriculture, Freising, Germany), and the Plant Protection Directorate, Hodmezovasarhely, Hungary. Funded by: the Bavarian State Ministry of Food, Agriculture and Forestry through LfL Germany.

Stefan Toepfer giving a presentation on management of *Diabrotica* with a nematode-based biological control product at a symposium side event at the European Parliament in Strasbourg in November 2013 (photo: U. Kuhlmann)

Nematode application equipment on a maize sowing machine developed by cult-tec of Freiburg in Germany, www.culttec.de/nematec-projekt.html (photo: M. Lichtenberg, e-nema, Schwentinenthal)

Stefan Toepfer preparing different dosages of beneficial nematodes for field trials on the biological control of western corn rootworm in southern Hungary (photo: F. Koncz, Hodmezovasarhely)

risk analysis & invasion ecology

introduction

For our section, the most important event of 2013 was undoubtedly the start of the EU Seventh Framework Programme (FP7) project PROteINSECT, not only because it is a new EU-funded project – we have been involved in many in recent years – but also because it takes the team into a new field of research, i.e. the use of insects as a source of protein for animal feed and human food. The project is being coordinated by Fera (Food and Environment Research Agency) in the UK, and involves 12 European, Asian and African teams that are assessing the feasibility of using maggots and maggot-derived proteins in animal feed. Our section and the CABI-MoA Joint Laboratory in China are involved in the development of new fly rearing methods in China and West Africa. For the project we have recruited a new team member, Saidou Nacambo, who did research for his MSc thesis with us in 2011–2012 on the impact, developmental biology and biological control of the box tree caterpillar, *Cydalima perspectalis*. With support from the CABI Development Fund, we are taking advantage of the opportunities afforded by the PROteINSECT project to enlarge our activities and develop further projects on this topic in West Africa.

Of course, our main activities remain the ecology and management of invasive insects. In two current European projects (the FP7 project ISEFOR and the EU COST (European Cooperation in Science and Technology) Action PERMIT), we are investigating the introduction of alien forest pests into Europe and, in particular, the trade in woody plants for planting, which is a major pathway of invasion for forest pests. Our investigations, led by René Eschen, are being carried out in collaboration with a large number of European and Asian partners. René is also responsible for our field research on the ecological impact of the invasive harlequin ladybird (*Harmonia axyridis*) on indigenous ladybirds. Disturbing results are emerging, with the finding that the two-spot ladybird (*Adalia bipunctata*) has nearly disappeared from the Swiss Jura.

In 2013, we won another new EU FP7 project, DROPSA (Strategies to develop effective, innovative and practical approaches to protect major European fruit crops from pests and pathogens), which will start in January 2014. This project will focus on an invasive fruit pest of Asian origin, the fruit fly *Drosphila suzukii,* and three invasive fruit pathogens. We will be developing biological and integrated control methods against *D. suzukii*, activities that will also involve the CABI-MoA Joint Laboratory in China. In addition, we are involved in a new COST Action, ALIEN CHALLENGE (European information system for alien species) in which 31 European countries are participating. I am representing Switzerland on the management committee and coordinate a Working Group aiming to review invasive species impacts in Europe and improving impact assessment methods.

This is an opportune moment for me to highlight the extent to which our section is actively collaborating with other sections here at Delémont and with CABI centres in other parts of the world. Our expanding work with the CABI-MoA Laboratory in China also includes the ISEFOR, PERMIT and PROteINSECT projects. We have teamed up with CABI's newly established West African centre in Ghana as well as our colleagues in the ICM section at Delémont in new initiatives on insects as animal feed in Africa. We are also working in collaboration with CABI's centre in Brazil in reviewing the potential for implementing biological control against forest pests in South America. Finally, we are collaborating with colleagues in the Arthropod Biological Control section at Delémont, in particular in the DROPSA project and in studies of the box tree moth (see p.23).

Dr Marc Kenis
Head of Risk Analysis & Invasion Ecology

Dr Marc Kenis
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increasing sustainability of European forests: ISEFOR

The trade in plants for planting is recognized as a key pathway for the spread of invasive forest pests and diseases. Despite precautionary regulations and phytosanitary border inspections, the number of exotic forest pests and diseases in Europe continues to rise. Factors affecting the risk of new and hitherto unknown pests and diseases becoming established in Europe's forests include a large increase in trade volume over the past 15 years and changes in the identity and origin of the traded plants. In addition, climate change may be affecting the susceptibility of trees to pests and diseases. An analysis of the trade in plants for planting and quarantine inspection procedures in Europe and elsewhere will assist quarantine authorities in tackling the risks associated with alien pests and pathogens.

The ISEFOR project (Increasing sustainability of European forests: modelling for security against invasive pests and pathogens under climate change) addresses the threat to European forests from the combined forces of climate change and large increases in the numbers of invasive alien pests and pathogens. The ISEFOR consortium comprises 17 partners from the EU and China and the project is funded under the EU's FP7. CABI's input focuses on defining threats to European forests from invasive species, drawing on current knowledge of pests and their host plants and through a critical assessment of issues related to the nursery trade and phytosanitary inspection procedures, mainly in Europe and China.

In 2013, together with teams from various European countries, we carried out a detailed assessment of trade in Acer plants through the Netherlands from both outside and within Europe, and we investigated the inspection procedures for imports into the EU. We have also been analysing pest distribution data from CABI's Crop Protection Compendium and the Plantwise Knowledge Bank and identifying potential new invasive species from outside the EU. In addition, we are working with project partners on the development of a database of alien forest insects and pathogens that pose an immediate threat to European forest ecosystems. As a complement to analysing existing information and literature, an experimental approach is proving promising. Monitoring results from the project's two test nurseries set up in China – one close to Beijing managed by CABI's China office – have revealed the value of inspecting commonly imported plants in their region of origin for identifying pests and pathogens that may be potentially harmful should they be imported into Europe.

The short-term output of this project will be diagnostic tools for the plant health surveillance community.

M. Kenis (m.kenis@cabi.org), **R. Eschen** and **Li H.M.**, in collaboration with partners in the ISEFOR project. Funded by: EU RTD (Research, Technological development and Demonstration) FP7 (www.isefor.com/).

Leaf wilt on a *Fraxinus* tree in the sentinel nursery near Beijing (photo: R. Eschen)

Trees ready for shipment at a large European nursery (photo: R. Eschen)

Prof. Andrea Vannini inspecting a diseased tree in the sentinel nursery close to Beijing (photo: R. Eschen)

Inspectors sampling soil during a phytosanitary inspection of imported trees (photo: R. Eschen)

Some pests are not easy to detect (photo: R. Eschen)

pathway evaluation and pest risk management in transport: PERMIT

The number of invasive alien organisms in European forests is steadily increasing. Identification of pathways for the international transfer of pests, including species identity, known hosts, origins and trade patterns, may enable phytosanitary services to respond to the threat of current, known harmful species. It may also allow the development of generic procedures that could be applied to pathway management in a 'manage once, remove many' approach that could also mitigate the threat of new, hitherto unknown pests.

The COST action PERMIT (Pathway evaluation and pest risk management in transport) focuses on reducing threats from exotic pests by promoting enhanced pathway management; 32 countries participate in the Action. One of the working groups, co-chaired by Marc Kenis, is concerned with identifying pathways for the movement of forest pests and diseases, finding evidence of pests moving along these pathways, and analysing international trade patterns in relation to the movement of pests and diseases along them. We discovered that most forest pests and pathogens arrive in Europe through the trade in plants for planting, with billions of live plants being imported into Europe every year. Therefore, most of our research in this project focuses on that particular pathway. Other working groups are developing mitigation measures to reduce the movement of pests along pathways and investigating the level of education and awareness of risks associated with different pathways.

In 2013 we completed an analysis of (i) past interceptions of quarantine pests and diseases during inspections of plants for planting at European borders and (ii) tree pests and pathogens that have established, and compared the two. We also completed an analysis of the intra-European plant trade. Together, the analyses should help to describe potential pathways for the spread of forest pests and provide evidence for the movement of pests along them.

We have continued working on a comparison of plant health legislation in countries around the world, with the aim of identifying measures that are effective in combating the introduction of new pests and diseases. In 2013 we conducted a questionnaire survey that specifically addressed awareness of invasive alien pests and diseases of trees among stakeholders in forestry. The results will be useful to the project for developing measures aimed at reducing the movement of pests along the identified pathways.

M. Kenis (m.kenis@cabi.org), **R. Eschen** and **Li H.M.**, with many partners in the COST action PERMIT. Funded by: the Swiss Department for Education and Science (SER) and the EU.

International trade in live plants is one of the major pathways for the introduction of harmful organisms into Europe (photo: R. Eschen)

ecological impact of the harlequin ladybird, *Harmonia axyridis*, in Switzerland

Harmonia axyridis, the harlequin ladybird, is a polyphagous predatory coccinellid beetle, native to Asia. It has been widely released as a biological control agent of aphids in the field and in greenhouses in both North America and Europe. Since its accidental establishment in North America in the 1980s and in Europe in the late 1990s, it has spread and its populations have increased dramatically so that it is now the dominant ladybird species in much of North America and Europe. *Harmonia axyridis* can have strong negative effects on biodiversity owing to its predatory and competitive abilities, impacting on many native species, including aphids and other ladybirds and aphidophagous insects but also other kinds of herbivorous insect. It may have a direct effect on humans by invading buildings in huge numbers to seek overwintering sites. Moreover, in North America, *H. axyridis* has been reported to damage fruit crops in late summer and to taint wine when inadvertently captured and crushed during grape harvesting and processing.

The main objective of our research programme on *H. axyridis* is to assess the impact of the invasive ladybird on native ladybirds and other non-target organisms in Switzerland. A long-term study based on 45 permanent field sites in three habitats (broadleaved and coniferous woodlands and meadows) in north-western Switzerland was set up in 2006 to observe changes in populations of native ladybirds during and after the invasion of the Asian species.

In 2013, as in the previous four years, *H. axyridis* accounted for over half of all ladybirds found on broadleaved trees. The native two-spot ladybird, *Adalia bipunctata*, has been severely affected and has been found at our sites only twice since 2010 although it used to be the dominant species in this habitat. These results mirror signs of decline found throughout Europe. However, our data from 2013 reveal the recovery of three other native species that were previously thought to be in decline due to the abundance of *H. axyridis*.

M. Kenis (m.kenis@cabi.org) and **R. Eschen**. Funded by: the Swiss Federal Office for the Environment (FOEN).

Adalia bipunctata has become very rare following the establishment of *Harmonia axyridis* (photo: R. Eschen)

Hedgerows are one of the habitat types where the impact of *Harmonia axyridis* is being studied (photo: R. Eschen)

René Eschen uses a beating tray to collect ladybirds on trees (photo: R. Eschen)

Jatropha curcas canker, Burkina Faso (photo: C. Ellison)

Jatropha curcas plant fed on by the flea beetle *Aphthona whitfieldi* in Mali (photo: M. Kenis)

investigating impacts of Jatropha curcas production: JATROPHABILITY

Jatropha curcas, a member of the Euphorbiaceae, is native to Central America yet cultivated pantropically. Its seeds contain 27–40% oil which is suitable for biodiesel. The plant is presently promoted as a biofuel crop in several regions around the world, in particular in the four project countries of India, Mali, Burkina Faso and Mexico. However, little is known about its basic agronomy and ecological impacts across the different agro-ecoregions. JATROPHABILITY, funded by various donors under the ERA-ARD (European Research Area – Agricultural Research for Development) initiative of the EU's Sixth Framework Programme (FP6) involved nine partner teams from India, Mali, Burkina Faso, Mexico, Belgium, Spain, Switzerland and the UK. The project, which ran from June 2009 to May 2013, aimed to assess the profitability, together with the economic, social and environmental impacts, of *J. curcas* cultivation as a bioenergy crop. It aimed to use data obtained by the project partners to identify the most suitable ecoregions for maximizing yields, taking into account the different pest and disease pressures and economies of scale of production (smallholder vs. large-scale plantings), and the extent of economic, social and environmental production risks. It also aimed to identify current shortfalls in land tenure systems and law, and to support governments to develop legislation to ensure social sustainability and equity of bioenergy projects.

CABI scientists based in Switzerland and the UK, in addition to coordinating the project, were principally involved in looking at pests and diseases and, more generally, in environmental impact assessments. In Mexico, we worked with collaborators from INIFAP (Instituto Nacional de Investigaciones Forestales y Agropecuarias) to assess both yield constraints and energy and carbon balances in a number of field sites and along rainfall gradients. In Mali and, later on, in Burkina Faso, we worked in collaboration with Mali Biocarburant and its sister organization, Faso Biocarburant. Our research in Burkina Faso focused largely on pests and diseases, which are seriously hampering *J. curcas* adoption and cultivation in West Africa.

The final months of the project were devoted to ensuring results and reports were finalized, together with writing opinion papers and other publications. In conjunction with two other projects in the ERA-ARD *J. curcas* programme, we produced a series of five policy briefs that give research insights into important issues surrounding *J. curcas* and bioenergy, with particular emphasis on Africa. Each policy brief addressed a specific aspect: growth and oilseed production; potential for climate change mitigation; potential for rural energy supply; economic feasibility of biofuels; and food security implications.

M. Kenis (m.kenis@cabi.org), **T. Haye**, **C.A. Ellison** and **S. Edgington**, in collaboration with **L. Norgrove** (University of Basel, Switzerland) and partners from Mexico, Mali, Burkina Faso, Spain and Belgium. CABI's staff based in Switzerland were funded by SDC.

Students and collaborators in Burkina Faso: Alizèta Sawadogo, Esther Abonyo and Aklilu Negussie (photo: M. Kenis)

insects as a source of protein: PROteINSECT

Global demand for animal-sourced foods is accelerating rapidly owing to population growth and economic development. Fishmeal and crops such as soya are key ingredients in animal feeds but their use for this purpose is not ecologically and economically sustainable. Insect protein presents a viable alternative, relieving pressure on fisheries and freeing up significant quantities of food crops for human consumption. Maggots, the larvae of various fly species, are particularly promising as animal feed because of their nutritional properties and because they can be mass produced easily on a wide range of waste substrates, offering potential for low economic and environmental costs. Working in collaboration with partners, the PROteINSECT project (Enabling the exploitation of insects as a sustainable source of protein for animal feed and human nutrition) is exploring insects as an alternative source of protein for animal nutrition in Europe, China and West Africa.

The three-year project, which started in February 2013, involves scientists from 12 institutions in Europe, China, Mali and Ghana who will be working towards a number of goals that need to be achieved if the potential of insects in animal feed production is to be realized in these regions. The goals include solving the technical challenges associated with developing and optimizing existing and novel maggot production systems together with processing methods for animal feed. Other activities are aimed at determining associated safety and quality criteria, and evaluating the performance of protein extracts through fish, poultry and pig feeding trials. Comprehensive insect life cycle assessments, taking environmental and socio-economic considerations into account, should lead to technical and policy recommendations by the end of the project. A complementary goal for PROteINSECT is to support a pro-insect platform in Europe, to encourage adoption of insect protein as a long-term, sustainable source of animal feed and reduce the reliance on ecologically costly fish and plant sources – ultimately paving the way for insects to become a direct component of human food security.

Scientists from CABI's centres in Switzerland and China are leading the research aimed at optimizing existing production systems, and at developing new and economically viable fly breeding methods. We are creating a database of information on fly rearing and production methods. CABI is also collaborating on the environmental and socio-economic life cycle analysis that will be the basis of technical and policy recommendations.

M. Kenis (m.kenis@cabi.org), **S. Nacambo**, **Tang R**. and **Zhang F.**, in collaboration with partners in the PROteINSECT project. Funded by: EU RTD FP7 (www.proteinsect.eu/).

Marc Kenis and our collaborator N'golopé Koné in the fly rearing facility in Mali (photo: S. Nacambo)

Saidou Nacambo sorting maggots in Ghana (photo: S. Nacambo)

PROteINSECT partners at a farm producing maggots in China (photo: S. Nacambo)

Housefly maggots (photo: S. Nacambo)

Chicken and chicks eating maggots in Mali (photo: S. Nacambo)

use of insects for animal feed in Africa

Global demand for animal-sourced foods is accelerating rapidly owing to population growth and economic development, in particular in developing countries. In most animal production systems, feed represents the largest proportion of the costs. Fish meal and leguminous crops such as soybean are key ingredients in animal feed since they provide necessary protein. Animals require protein in their diet because they are unable to synthesize specific amino acids that they nevertheless require as protein building blocks. However, the use of conventional protein ingredients in feed is not ecologically or economically sustainable. The issue is especially severe in rural West Africa, where feed compounds, in particular proteins, are scarce or unaffordable for smallholder farmers and fish producers.

Indigenous poultry farming, practised by almost all farmers in West Africa, is challenged by the increasing cost of feed, which now represents up to 70% of total production costs. Scarcity of common protein ingredients (fish meal, groundnut cake, soybean) has led to inflated prices. Poor households resort to 'scavenging' poultry farming, which suffers from quantitative and qualitative food shortages and, consequently, very low productivity. Smallholder fish farmers rely on natural feed, i.e. plankton and green leaves, to feed their fish, supplemented with agricultural and/or agro-industrial by-products. The nutritional value of these kinds of feed and feeding systems is low and hence yields are poor.

Sustainable, productive household aviculture and aquaculture systems could be developed based on insects, which are a natural food source for free-range poultry and fish. Insects potentially provide an easily available and cheap protein source that is not in demand for other purposes.

This project, which ran for the 2013 calendar year, was closely linked to the PROtelNSECT project (see p.31), which is providing an opportunity for developing sister projects in other countries, particularly in Africa. Thus, the purpose of this project was to develop links and collaboration with national researchers and other teams in West Africa already working, or interested in working, on insects as feed. Our aim was to share knowledge on the use of insects for animal feed and develop further projects, and collaboration was established principally with new partners in Benin, Burkina Faso and Ghana.

A joint review paper was produced on practices and research on the use of insects as animal feed in West Africa, with discussion of how techniques could be further developed, in particular for smallholder farmers and fish farmers. Flies are identified as the most promising insects, especially the housefly (*Musca domestica*) and the black soldier fly (*Hermetia illuscens*), which can be mass reared on-farm for domestic use, in small production units at community level, or at industrial level. Flies have the advantage over most other insects of developing on freely available waste material and could even contribute to rural sanitation. An alternative is termites, which are traditionally used by smallholder farmers to feed village poultry. While their mass production is problematic, methods to enhance populations on-farm and facilitate their collection could be developed, although the economic profitability, social acceptability and environmental sustainability of such methods would need to be demonstrated before they are adopted.

M. Kenis (m.kenis@cabi.org), **V. Clottey** and **S. Nacambo**, Funded by: the CABI Development Fund.

Rearing flies for fish feed at Songhai farm in Benin (photo: M. Kenis)

forest pests and their biological control in South America

While forest plantation areas are increasing in South America, plantations are suffering damage from exotic and native pests and diseases that are seriously threatening their profitability and even survival. Biological control has been suggested as a sustainable solution, but there have been no surveys in South America to assess the potential for this approach against forest pests. The objectives of this project, which ran for the 2013 calendar year, were: (i) to assess the potential for biological control of forest pests in South America and select the most promising targets for collaborative projects between CABI and partners in the region; and (ii) to make a preliminary assessment of the potential for biological control of *Pissodes castaneus*, a European weevil presently threatening pine plantations in the central Patagonian region of Argentina and Chile.

During a literature and information survey, conducted in collaboration with the Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP) in Brazil, we collated data on major forest pests, both alien and native, evaluated their impact on forestry and assessed the potential for biological control for each species. We considered classical, augmentative and conservation biological control. We are currently producing a report and a review paper, which will identify the most promising targets for biological control, and these will be the focus for developing collaborative projects with UNESP and other South American organizations.

An evaluation was made of the need for biological control of *P. castaneus* in Patagonia, together with the potential for using European parasitoids. The pest was known to be present in Argentina, but has only recently been found in Chile. Marc Kenis travelled to Chile in November to assess the present situation in the invaded areas (damage, mortality factors, life cycle, etc.) and Ariel Sandoval, a Chilean scientist from the Servicio Agrícola y Ganadero (SAG), División Protección Agrícola y Forestal in Chile, visited CABI in Switzerland to see native habitats of the weevil and collect pine stems infested with the weevil and its parasitoids. He has taken these back to Chile where they are being reared for further study in SAG's quarantine facilities.

M. Kenis (m.kenis@cabi.org), **Y. Colmenarez**, and **I. Marchizeli Wenzel**, in collaboration with SAG (Chile) and UNESP (Brazil). Funded by: the CABI Development Fund.

Red gum lerp psyllid (*Glycaspis brimblecombei*), a pest of eucalyptus in South America (photo: L.-M. Nageleisen, Département de la Santé des Forêts, France)

Gallery and larva of *Pissodes castaneus* in Chile (photo: M. Kenis)

SAG scientists and foresters examining a tree killed by *Pissodes castaneus* in Chile (photo: M. Kenis)

ecosystems management

introduction

In 2013, we celebrated the successful defence of another PhD in the Ecosystems Management section. Sun Yan, who was co-supervised by Prof. Heinz Müller-Schärer at the University of Fribourg in Switzerland, did her PhD research with our section on the environmental impact of invasive weeds (see also Highlights, p.15). Yan, congratulations on your PhD, and all the best for the next step in your scientific career which will take you to California!

Another highlight in 2013 was the very surprising appearance of *Ophraella communa* in Europe. This leaf beetle, which is a successful biological control agent in China, was detected during surveys made within the framework of the new EU COST Action on 'Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)'. This offers a unique opportunity to evaluate the impact of classical biological control on one of Europe's flagship invaders.

In 2013 we launched a new project to improve the restoration of biodiversity in ecological compensation areas in the Swiss Jura mountains. In 1993, Switzerland introduced direct payments for these areas with the aim of conserving and restoring the original biodiversity. However, only some 20% of registered ecological compensation areas meet the minimum quality requirements with respect to botanical diversity. This new project will be conducted in close collaboration with regional stakeholders (extension services, farmers, etc.) and will strengthen our centre's links with authorities at the cantonal and national level.

We continued working on novel methods for disinfesting soil contaminated with roots of Japanese knotweed, *Fallopia japonica*, and on the biological control of the native plant *Rumex obtusifolius*, a major weed of pastures and meadows throughout Europe. In the *Rumex* project, we started a long-term experiment to assess the impact of the native biological control agent *Pyropteron chrysidiforme* on *Rumex* populations under a variety of environmental conditions. It will be very interesting to monitor whether and to what extent repeated mass releases of a native herbivore can impact on the population dynamics of a native weed.

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biological control of broad-leaved dock, *Rumex obtusifolius*

Broad-leaved dock, *Rumex obtusifolius*, is considered a weed of permanent pastures, meadows and arable crops throughout its native range in Europe. In Switzerland, it causes particular problems in organic and integrated farming systems. The only feasible control measure currently available for organic production in Europe is cutting the root at a depth of 10 cm below the soil surface. This is extremely laborious, and alternative solutions, such as biological control, would therefore be very welcome. However, all potential biological control agents investigated so far have turned out to be rather inefficient. In 2010, we obtained funding for a three-year project from the Swiss Commission for Technology and Innovation (CTI) to develop a biological control product for dock on the basis of the native clearwing moth *Pyropteron chrysidiforme*. This project is being conducted in collaboration with Agroscope Reckenholz-Tänikon, Andermatt Biocontrol AG and the University of Fribourg in Switzerland.

In field tests set up in 2012, we obtained larval establishment rates for the clearwing moth of over 50% for the first time. In the final year of the CTI project, we decided to establish a long-term field experiment, which will run for four years, in order to test whether and to what extent the impact of *P. chrysidiforme* on *R. obtusifolius* builds up over time. We are working at six sites in Switzerland (three sites near Zurich and three in western Switzerland), and at each site 275 plants were marked using GPS and assigned to different treatments (one, two and three applications of eggs until 2015 and controls). Plant survival and vigour will be recorded once a year and a small subset of plants dissected in order to assess larval attack rates.

U. Schaffner (u.schaffner@cabi.org), **N. Medeiros de Souza**, **J. Freise** and **P. Häfliger**.
Funded by: CTI, Federal Department of Economic Affairs, Education and Research, Switzerland.

Dock root infested by *Pyropteron chrysidiforme* (photo: P. Häfliger)

Jona Freise uprooting *Rumex obtusifolius* plants (photo: P. Häfliger)

Pyropteron chrysidiforme mating in a gauze cage (photo: P. Häfliger)

Recovery of native vegetation cover at a site in the Swiss Jura formerly invaded by exotic knotweed (photo: E. Gerber)

Rhizome crushing treatment (photo: E. Gerber)

novel method for controlling exotic knotweeds and restoring contaminated soil

Exotic knotweeds (*Fallopia* spp.) are among the most aggressive invasive weeds in Europe, inflicting high economic costs on infrastructure and threatening native biodiversity in natural habitats. In 2009, CABI joined forces with Mireille Boyer (Concept.Cours.d'EAU, France) to test the efficacy of a newly developed method to locally eradicate exotic knotweeds. The method consists of excavating and crushing soil containing knotweed rhizomes, then storing the crushed material under a plastic foil cover to accelerate decomposition of the rhizome fragments. In first trials, up to 100% mortality of rhizome fragments was observed within a few months.

A series of tests was initiated in 2010 to assess the efficacy of this method under different climatic conditions and to gather information on the recovery of native vegetation. Knotweed infestations were treated along Le Tabeillon river in the Canton Jura in Switzerland, and along the rivers Vidourle, Cèze and Gardon in southern France.

Monitoring of the site in the Canton Jura in 2013 revealed some regrowth of knotweed in the area treated in 2010. In contrast to sites in France, where all knotweed rhizome fragments had decayed after storage under the plastic cover for 12 months, some remained viable at the Swiss site. We assume that the cool climatic conditions of the Jura slowed down decomposition and that a longer time span is needed to achieve 100% mortality at such sites. We have been manually removing the regrowing shoots, and the number of knotweed shoots recorded in 2013 was lower than last year, indicating that manual removal might eventually eradicate knotweed at this site.

A vegetation census carried out in the treated area indicated that crushed soil is quickly recolonized by native plant species. Plants growing on the former knotweed site are species commonly found in the surrounding vegetation. The number of plant species recorded on the site in 2013 was higher than before the mechanical intervention. Hence, re-seeding of the treated areas does not seem to be necessary, unless site-specific conditions require the establishment of a closed vegetation cover in the first year after the plastic foil is removed (e.g. in sites with high risk of soil surface erosion and/or in sites that are likely to be colonized by other invasive plant species).

E. Gerber (e.gerber@cabi.org) and **U. Schaffner**. Joint project with **M. Boyer** (Concept. Cours.d'EAU). Funded by: Office de l'Environnement, République et Canton du Jura, Switzerland; Syndicat Mixte d'Aménagement et de Gestion Equilibrée (SMAGE) des Gardons, Nîmes, Syndicat Interdépartemental d'Aménagement du Vidourle, Nîmes, and Syndicat Mixte d'Aménagement du Bassin de la Cèze, Saint Ambroix, France.

environmental impact of invasive plants

Most hypotheses to explain exotic species success posit that exotics 'behave differently' in recipient communities compared with their native range, but there is still considerable confusion over whether the ecosystem changes caused by invasive exotic species are primarily due to special species traits or due to their sheer numbers. The goal of this project is to improve our understanding of the mechanisms underlying ecosystem impact by invasive plant species.

In a field experiment, we assembled native plant communities that differed in species and functional richness and compared (i) the effects of resident diversity on invasibility by invasive alien and dominant native species in the Asteraceae family, and (ii) the impact of invasive alien and dominant native species on the resident communities along a diversity gradient. When we 'invaded' the plant assemblages with seeds, both invasive alien and dominant native species showed very poor establishment. The results for the European species *Centaurea stoebe* clearly contrasted with those obtained in a similar experiment carried out in the invaded range in the northwestern USA, where *C. stoebe* showed very high establishment rates in low diversity plots. When we transplanted seedlings into the experimental plant assemblages, we found that increasing diversity reduced the performance of alien invader but not native dominant species. However, the impact of alien invasive and native dominant plants on resident plant species remained minimal. Our results suggest that diversity is an attribute of resident communities that makes them more or less susceptible to invasion by novel invasive alien but not coevolved native plant species, and that undisturbed grasslands in western Europe may be less prone to be impacted by alien invasive plants than North American grasslands.

In a greenhouse experiment, we assessed the relative importance of neighbouring plant community and soil biota in explaining the high impact of *Centaurea stoebe* in the introduced range. We conducted a greenhouse experiment with both European and North American tetraploid *C. stoebe* competing with/without a European vs North American neighbouring community. In the competition pots, relative competitive ability (difference between the relative growth rates of *C. stoebe* and the neighbouring community) and impact level (biomass of the neighbouring community relative to that in non-competition pots) of *C. stoebe* was significantly higher when grown with the North American than with the European neighbouring community, although growth rates of European and North American neighbouring communities did not differ in the non-competition pots. Both soil origin and *C. stoebe* origin had no effect on these processes. These results suggest that during the colonization of new sites in North American grasslands, the impact of *C. stoebe* is strongly driven by reduced competitive ability of North American neighbours compared with European neighbours, while altered biotic soil conditions in the introduced range and post-introduction evolutionary changes in the invader appear to be of less importance.

U. Schaffner (u.schaffner@cabi.org) and **Sun Y.**, in collaboration with **H. Müller-Schärer**, **A. Junod** and **R. Collins** (University of Fribourg, Switzerland). Sun Yan was a PhD student at the University of Fribourg, co-supervised by Prof. H. Müller-Schärer. Funded by: SNSF, through the National Centres of Competence in Research (NCCR) programme 'Plant Survival' (lead institution: University of Neuchâtel), Switzerland.

Sun Yan collecting seeds of native neighbours of *Centaurea stoebe* (photo: U. Schaffner)

Centaurea stoebe (photo: Sun Y.)

Set-up for a common garden experiment with assembled plant communities differing in species richness (photo: Sun Y.)

Adult ragweed leaf beetle, *Ophraella communa* (photo: P. Tóth, Slovak Agricultural University, Nitra)

Thousands of adult ragweed leaf beetles collected from sweep-netting a few times in heavily infested ragweed populations in northern Italy (photo: P. Tóth, Slovak Agricultural University, Nitra)

working towards sustainable management of *Ambrosia artemisiifolia* in Europe

Common ragweed, *Ambrosia artemisiifolia*, has raised the awareness of invasive alien species in Europe in a unique fashion. A major problem with this plant is its particularly large production of highly allergenic pollen, which generates huge medical costs and leads to reduced quality of life among the allergic population. Ragweed has also increasingly become a major weed in European agriculture, especially in spring-sown crops such as sunflower, maize, sugarbeet and soybean. Nonetheless, the majority of infested land in Europe is non-crop land, and both spread and impact of *A. artemisiifolia* are likely to increase with changing climate, posing a significant risk to society even in countries presently not yet affected.

In January 2013, a new COST Action on 'Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)' was launched as the result of a proposal developed largely by Prof. Heinz Müller-Schärer (University of Fribourg) and CABI in Switzerland. The goal of this Action is to develop habitat- and region-specific recommendations for integrated management of ragweed across Europe. CABI has the lead in Working Group 1, which is focusing on developing biological control methods.

To our surprise, during surveys in July/August 2013 the North American ragweed leaf beetle, *Ophraella communa*, was found at more than 130 sites in Ticino in southern Switzerland and northern Italy. So far, it is not clear how *O. communa* reached Europe. The beetle is a very successful classical biological control agent of common ragweed in China, where it kills ragweed plants over large areas before seed set. At sites where we found *O. communa* in Switzerland and Italy, up to 100% of the plants were attacked, with attack levels high enough to completely defoliate and prevent flowering and seed set of most ragweed plants. In 2014, we will therefore put particular emphasis on collecting data to help decide whether the establishment of *O. communa* in Switzerland and Italy should be considered as a troublesome introduction of an alien invertebrate that causes damage to crops or native plant species, or whether it is likely to become the first case of successful biological control of an invasive weed in continental Europe.

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In 2013, *Ophraella communa*, a leaf beetle that is native to North America and used as a biological control agent in China, was found in Europe for the first time, attacking *Ambrosia artemisiifolia* populations in northern Italy and southern Switzerland (photo: H. Müller-Schärer, University of Fribourg)

improving the establishment of ecological compensation areas in the Swiss Jura mountains

The intensification of agricultural practices and the widespread use of chemical fertilizers and pesticides in the 20th century have led to a strong decline in the biodiversity of European landscapes. The Swiss government now requires that farmers manage at least 7% of their land in ways that aim to halt the decline in biodiversity, for example through set-aside of arable fields, and compensates the farmers financially for these efforts. However, the success of ecological compensation measures is often disappointing and the policy may not achieve its goal of halting or reversing the decline in biodiversity. In particular, measures to promote the re-establishment of species-rich grassland on arable land rarely result in the development of grassland communities that resemble typical species-rich grasslands of calcareous soils. Moreover, little is known about the colonization of the newly established vegetation by invertebrates from existing grasslands nearby.

This project (Pour un meilleur établissement de surfaces de compensation écologique dans l'Arc jurassien), which started in late 2013, aims to review the measures to promote the success of ecological compensation areas, and to compare successful and unsuccessful ecological compensation areas, in particular the vegetation, soil and invertebrate communities. In addition, a field experiment to test some of the most promising measures identified from the literature review and the correlative field study will be started in collaboration with the Fondation Rurale Interjurassienne (FRI).

Preliminary analyses of the data collected in the Canton Jura reveal that even after 20 years only approximately 40% of the ecological compensation areas have reached the ecological quality that is necessary to obtain additional subsidies from the government. This clearly illustrates the need for improved restoration practices.

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Most plant species establishing on ex-arable land are of low conservation value (photo: R. Eschen)

The marbled white (*Melanargia galathea*), a characteristic butterfly of species-rich grasslands in the Jura mountains (photo: R. Eschen)

Existing species-rich grasslands can be a reference for the creation of species-rich habitats on ex-arable land (photo: R. Eschen)

weed biological control

introduction

This year, the Weeds section was able to acquire one new project and to engage two new graduate students. In 2013 the section therefore included seven full or part-time scientists (including Ivo Toševski in Serbia and myself), two PhD students, three MSc students, 11 temporary research assistants and, last but not least, two gardeners and one garden assistant.

An initiative by Jennifer Andreas (Washington State University Extension, USA) led to a new project on the biological control of flowering rush, *Butomus umbellatus*. The project has so far attracted funding from four different sources in North America: the Washington State Departments of Agriculture and Ecology, the Montana Weed Trust Fund through the University of Montana and the British Columbia Ministry of Forests, Lands and Natural Resource Operations. Flowering rush is ideally suited for biological control, since it is the only genus and species within the family Butomaceae, so there are no closely related native North American species. This increases the likelihood of finding a host-specific biological control agent and will limit the number of plant species to be tested. Patrick Häfliger is leading the project and you can find more information on p.59.

With support from the USDA-ARS (Agricultural Research Service) laboratory in Sidney, Montana, through Kevin Delaney, we were able to engage MSc student Adrien von Virag from the University of Fribourg in Switzerland for the *Lepidium draba* project. Adrien is investigating the temperature dependent development of the specialist strain of the root-galling weevil *Ceutorhynchus assimilis* in southern France as well as its phenology and cold hardiness in comparison to the generalist strain of *C. assimilis* in Romania. Overall, we hope that the data will indicate whether this specialist strain has the potential to adapt to continental climates as encountered in western North America. Work on *C. assimils* is being shared between CABI, USDA-ARS European Biological Control Centre (EBCL) at Montpellier in southern France, and the USDA-ARS laboratory in Sidney, Montana.

Thanks to strengthened cooperation with the University of Neuchâtel, supported by the Canton Jura, we were able to create a new PhD position on the *L. draba* project, continuing the work that our former PhD student Carole Rapo had started. We recruited Veronica Marcari from Italy for the project. Veronica will spend part of her time at CABI in Delémont, and part at the University of Neuchâtel where she will conduct chemical analyses. The objective is to pin down chemical compounds that would help to explain the disjunct host range of the gall-forming weevil *Ceutorhynchus cardariae* under no-choice conditions.

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Tessa Scott
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Jelena Jović collecting galls on *Linaria dalmatica* in eastern Serbia in late April 2013 (photo: I. Toševski)

Galls induced by *Rhinusa pilosa* on *Linaria dalmatica* (photo: I. Toševski)

biological control of toadflaxes, *Linaria genistifolia* and *L. vulgaris*

The western USA and Canada have been invaded by what appears to be three different morphological types of toadflax: yellow toadflax (*Linaria vulgaris*), Dalmatian toadflax (*Linaria dalmatica*), and a type that appears to be morphologically intermediate. Of the five insect agents tested and released against toadflaxes since 1963, the shoot-boring weevil *Mecinus janthiniformis* has been reported to have a significant impact on *L. dalmatica*. In contrast, the reported efficacy of the majority of these agents on *L. vulgaris* has been minimal, with only *Mecinus janthinus* recently showing some promise following its first release in the 1990s in both the USA and Canada. Since 2000, several other European insects have been investigated for potential use against *L. vulgaris*, and the first of these, the shoot-galling weevil *Rhinusa pilosa* was approved for release in North America in September 2013.

Between 2006 and 2013, 83 plant species or populations were included in gall induction tests with *Rhinusa rara* ex *Linaria genistifolia* (formerly named *R. brondelii*), 46 of which were native North American species in 36 genera. Results suggest that *R. rara* is even more specific than *R. pilosa*; no larval development was recorded on any native plant species.

Oviposition and larval development tests with *Mecinus heydenii* ex *L. vulgaris* and *M. laeviceps* ex *L. genistifolia* under no-choice conditions are almost complete. For *M. heydeni*, development to the adult stage occurred on the native North American species *Epixiphium wislizenii*, *Maurandella antirrhiniflora*, *Nuttallanthus canadensis* and *Sairocarpus virga* and for *Mecinus laeviceps* on *N. canadensis* and *S. virga*. Repeated multiple-choice field cage tests with *M. heydeni* showed that *N. canadensis* is susceptible to attack when a high number of shoots is available compared with the target plant, *L. vulgaris*. Two multiple-choice field cage tests with *M. laeviceps* have not found evidence for attack on *N. canadensis* or *S. virga*.

In 2014, we will prepare and submit a petition for field release of *R. rara* in Canada and the USA in collaboration with our North American partners. In addition, work will focus on completion of host-specificity tests with the *Mecinus* species.

I. Toševski, **A. Gassmann** (a.gassmann@cabi.org), **O. Krstić** and **J. Jović**. Funded by: Wyoming Biological Control Steering Committee, USDA-APHIS-CPHST (Animal and Plant Health Inspection Service – Centre for Plant Health Science and Technology), Montana Noxious Weed Trust Fund through Montana State University, USA; British Columbia Ministry of Forests, Lands and Natural Resource Operations, Canada.

Ivo Toševski collecting galls on *Linaria dalmatica* in eastern Serbia in late April 2013 (photo: J. Jović)

is there still hope for biological control of houndstongue, *Cynoglossum officinale*, in the USA?

Adult *Mogulones borraginis* (photo: H.L. Hinz)

Houndstongue, *Cynoglossum officinale*, is a facultative biennial, native to Europe and Asia Minor. Introduced into North America in the mid-19th century, it now occurs in nearly all Canadian provinces and adjacent states of the USA. This rangeland weed hinders the establishment of forage species in new pastures. The barbed nutlets become attached to cattle causing irritation and potential market loss. A biological control programme was started in 1988 because chemical and cultural control methods against large infestations are often neither feasible nor economic.

To date, six insect species have been investigated as potential biological control agents at CABI. The root-mining weevil *Mogulones crucifer*, released in Canada in 1997, has successfully established and is showing impressive impact. However, doubts about its host specificity prevented its release in the USA, where many more native species in the same family as houndstongue (Boraginaceae) exist. Host-specificity tests for the root-mining flea beetle *Longitarsus quadriguttatus*, the root-mining weevil *Rabdorrhynchus varius*, the stem-mining weevil *Mogulones trisignatus*, and the root-mining hoverfly *Cheilosia pascuorum* have shown these species capable of attacking several indigenous North American species and they are no longer being considered as potential agents.

The only agent left with potential for release in North America is the seed-feeding weevil *Mogulones borraginis*. It is by far the most specific agent on houndstongue, with development restricted to the genus *Cynoglossum*. A petition for field release is in preparation.

In November 2012, 21 vials each containing 9–10 pupating weevils (201 in total) were placed into incubators set at three different temperatures: –2.0°C, –2.5°C and –3.0°C. In spring 2013, 65–70% of weevils successfully emerged. This confirms that *M. borraginis* is able to overwinter at constant negative soil temperatures.

Of the remaining larvae, overwintered in our underground insectary, 63 adults emerged in 2013, a success rate of approximately 95%. On 4 May, Prof. Mark Schwarzländer (University of Idaho, USA) hand-carried 40 females and 19 males to the quarantine facility in Pullman, Washington for additional investigations on the host-choice behaviour of the weevil. The rest were placed onto potted, gauze-covered houndstongue plants to maintain our rearing colony. A total of 88 rearing plants were set up from which 1150 larvae emerged; 340 were placed into vials (ten in each) containing a mix of fine vermiculite and quartz sand, which were sent to the USA, and the rest were transferred into sifted soil for pupation and adult emergence in 2014.

H.L. Hinz (h.hinz@cabi.org), **C. Cloşca** and **P. Pardo**. Funded by: USDA-APHIS-CPHST, USA.

Pablo Pardo checking houndstongue rearing plants for emergence of *Mogulones borraginis* larvae (left); set-up for an *M. borraginis* rearing plant (right) (photos: H.L. Hinz)

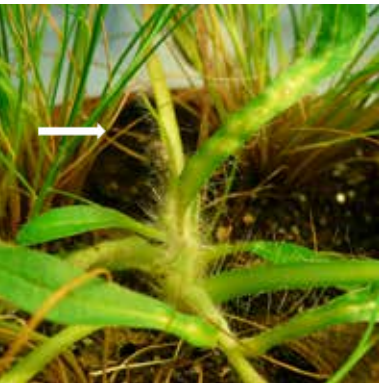
Ovipositing female *Aulacidea pilosellae* (photo: G. Cortat)

biological control of hawkweeds, *Pilosella* spp, for North America

Eurasian hawkweeds have been introduced into North America where several species have become troublesome weeds, particularly in the north-western USA and in the Canadian province of British Columbia. They invade roadsides, pastures, clear-cut areas and nature reserves. CABI has been investigating potential biological control agents of European origin for North America since 2000. To date testing has been discontinued for four of seven insect species, because they either lack specificity or show a preference for non-target *Pilosella* species, or because of difficulties in obtaining conclusive results. A petition for field release of the root-feeding hoverfly *Cheilosia urbana* will be submitted in 2014.

The gall wasp *Aulacidea subterminalis* attacks stolons of *Pilosella officinarum* (mouse-ear hawkweed), *P. flagellaris* (whiplash hawkweed) and *P. aurantiaca* (orange hawkweed). Since 2011, several field releases have taken place in the USA and Canada. So far, establishment has been recorded on *P. aurantiaca* and *P. flagellaris* in British Columbia and monitoring is ongoing at all release sites. Mass rearing is being maintained at CABI in Switzerland to complement North American cultures.

Several populations of another gall wasp, *Aulacidea pilosellae*, are currently being investigated at CABI. As part of a wider study, molecular analyses were performed in parallel on wasps (Dr Kevin Floate, AAFC) and their hosts (Dr John Gaskin, USDA-ARS) collected from different sites in the Czech Republic, eastern Germany and Poland. Results indicate that *A. pilosellae* collected from *P. officinarum*, regardless of location, are of a different lineage to *A. pilosellae* collected from several other *Pilosella* species. The sequencing of the plants revealed that there is confusion in field identification for several species.



Stunted *Pilosella officinarum* flowering stem (see arrow) in a combined grass competition and *Aulacidea pilosellae* impact experiment (photo: G. Cortat)

Host-range tests with *A. pilosellae* ex *P. officinarum* are continuing. Studies on host preference among separately collected field populations were started in 2013. Results were similar to the host-range tests conducted with mixed populations, except that we recorded attack by *A. pilosellae* ex *Pilosella* spp. on *Pilosella floribunda* and by *A. pilosellae* ex P. *officinarum* on *Pilosella caespitosa*. However, until we are confident about host plant identification, we have to be cautious in interpreting these results. In an impact experiment combining grass competition and three insect densities, grass competition strongly affected most of the measured plant growth parameters. Gall wasp attack significantly reduced shoot and stolon length.

Puccinia hieracii var. piloselloidarum, a rust fungus that was first evaluated for controlling *Pilosella officinarum* in New Zealand, was collected from several *Pilosella* species in eastern Europe. Samples were sent to Dr Rosemarie De Clerck-Floate at AAFC, where studies in quarantine were initiated. Infections proved difficult to obtain and she found that fresh spores are essential for success. Additional field collections and shipments are planned for 2014. Emphasis will be put on morphological and molecular host plant identification and target preference in the gall wasp.

G. Cortat (g.cortat@cabi.org), **Y. Chabaane**, **E. Oliveira** and **L. Sauvain**. Funded by: British Columbia Ministry of Forests, Lands and Natural Resource Operations and AAFC, Canada; Montana Weed Trust Fund through Montana State University, USDA-APHIS-CPHST, and the US Department of the Interior – Bureau of Land Management (USDI BLM), Montana, USA.

Yosra Chabaane and Emily Oliveira measuring plants for an impact experiment (photo: G. Cortat)

controlling noxious Russian knapweed, *Acroptilon repens*, in the USA and Canada

Russian knapweed, *Acroptilon repens*, a perennial forb that is native to Asia, was accidentally introduced into North America in the late 19th century as a contaminant of alfalfa seed. To date, Russian knapweed is considered noxious in 16 western states and one Canadian province. In the 1970s, first efforts to control Russian knapweed in the USA by biological means led to the release of a nematode species. However, this agent did not prove to be effective. Investigations on biological control of Russian knapweed were therefore resumed in 1997.

In spring 2013, field-collected galls of the gall wasp *Aulacidea acroptilonica* were sent to the quarantine facility at AAFC in Lethbridge, Canada to maintain an ongoing rearing programme. The gall wasp as well as the gall midge *Jaapiella ivannikovi* have established in the USA and in Canada. In 2013, outbreak densities were reported from a few release sites for both biological control agents.

In collaboration with Dr Ghorbani and Dr Asadi at Mashhad University, two open-field experiments were set up in Iran to assess the host range of the mite *Aceria acroptiloni*. In a first test, Russian knapweed and 16 test plant species were arranged in a Latin square design and artificially inoculated with *A. acroptiloni*. The second test was aimed at establishing a population of *A. acroptiloni* on the university's experimental farm and transplanting test plants next to infested Russian knapweed shoots so that the above-ground plant parts touched each other. In autumn, all test and control plants were harvested and sent to Dr Radmila Petanović at the University of Belgrade in Serbia, and Dr Philip Chetverikov at the Russian Academy of Sciences for molecular and morphological identification of the mites. The analysis of these samples is still underway.

Mite-infested plants were also hand-carried to the quarantine facility at the CABI centre in Delémont to assess different methods for host-range testing. For the first time, we succeeded in conducting no-choice host-range tests with *A. acroptiloni* under quarantine conditions. The results are in line with the results from the field tests, indicating that this mite has a very narrow host range.

In late April 2013, a field trip was made to Kattakorgan in Uzbekistan to set up an open-field host-range test with *Galeruca* sp. Replicates of the test plants *Centaurea rothrockii*, *Cynara scolymus* and *Saussurea discolor* were transplanted to the edge of a field site where *Galeruca* sp. occurs naturally. Larvae were collected at the site and transferred onto test and control plants. Towards the end of the monitoring period, most test plants revealed feeding damage on the leaves, but it was not possible to clearly attribute them to *Galeruca* sp., since larvae of other beetles and moths were also found feeding on the test plants.

Work in 2014 will focus on shipping field-collected galls of the gall wasp *Aulacidea acroptilonica* and the gall midge J. *ivannikovi* to North America, on continuing host-range testing with the mite *Aceria acroptiloni*, as well as on repeating the field experiment with *Galeruca* sp. in large field cages.

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Funded by: Wyoming Biological Control Steering Committee, USDA-APHIS-CPHST, and Montana Weed Trust Fund through Montana State University, USA.

Field site for an open-field host-range test with *Aceria acroptiloni* on Mashhad University's experimental farm in Iran (photo: U. Schaffner)

In order to inoculate test and control plants with *Aceria acroptiloni* under quarantine conditions, the brackets of mite-infested Russian knapweed flowerbuds were removed, and the open flowerbuds pinned to leaves of potted plants (photo: U. Schaffner)

Test plants for an open-field host-range test with *Aceria acroptiloni* were grown in a greenhouse at Mashhad University in Iran (photo: U. Schaffner)

Jess Inskeep releasing *Ceutorhynchus constrictus* in no-choice cage tests (photo: E. Gerber)

Ceutorhynchus constrictus crawling out of a vial during a no-choice cage test (photo: E. Gerber)

biological control of the environmental weed garlic mustard, *Alliaria petiolata*

Garlic mustard, *Alliaria petiolata*, is a biennial cruciferous plant of European origin and is considered to be one of the most serious invaders in the north-eastern and mid-western USA and south-eastern Canada. This project to investigate the potential for biological control of the weed was started in April 1998 in collaboration with Prof. Bernd Blossey at Cornell University in the USA. At present, we are concentrating on four weevil species: *Ceutorhynchus alliariae, C. constrictus, C. roberti* and *C. scrobicollis*.

A petition for field release of the root-mining weevil *C. scrobicollis* had been submitted to the USDA-APHIS Technical Advisory Group (TAG) in 2008. Additional information required by TAG was submitted at the beginning of September 2011. In May 2013, TAG reviewers raised additional concerns, which were discussed at the TAG meeting in June 2013. In the meantime, a list of additional species to be tested was compiled and submitted to TAG for review and tests were initiated from October onwards, both at the quarantine facility at the University of Minnesota in the USA and at CABI.

No-choice tests conducted in 2013 revealed that three native North American plant species can be attacked by the two shoot miners *C. alliariae* and *C. roberti*, i.e. *Nasturtium gambelii* and *Thysanocarpus curvipes* by *C. alliariae* and *Rorippa sinuata* by *C. roberti*. Acceptance of these species by *C. alliariae* will be further explored in 2014. An open-field test in 2012 had revealed that some attack by *C. alliariae* can also occur on *Lobularia maritima*, a Mediterranean species grown as ornamental. An impact experiment in 2013 showed, however, that attack does not negatively affect vigour of *L. maritima* or jeopardize its quality as an ornamental plant. Overall, we judge the incidence of impact and non-target attack of *C. alliariae* on *L. maritima* as very low.

None of the test species exposed to *C. constrictus* in no-choice oviposition and development tests in 2013 was attacked. No-choice field cage tests in 2013 revealed only very limited attack on *Brassica juncea* (brown or Indian mustard), a species from which complete adult development has been recorded for *C. constrictus* in previous years. No attack was found in an open-field test, i.e. under the conditions *B. juncea* is grown as a crop. Overall, our data indicate that the risk of *B. juncea* being attacked by *C. constrictus* under natural condition is very low to negligible.

Work in 2014 will concentrate on tests with *C. constrictus, C. alliariae* and *C. scrobicollis*. In addition, a shipment of *C. constrictus* to the quarantine facility at the University of Minnesota is scheduled for spring 2014, where additional tests with North American species will be conducted.

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Open-field test to assess the acceptance of *Brassica juncea* by *Ceutorhynchus constrictus* (photo: E. Gerber)

biological control of whitetops, *Lepidium draba* and *L. appelianum*, for the USA

Whitetops or hoary cresses, *Lepidium draba* (= *Cardaria draba*) and *L. appelianum*, are deep-rooted, perennial mustards that are aggressive invaders of cropland, rangeland and riparian areas. In spring 2001, Prof. Mark Schwarzländer (University of Idaho, USA) established a consortium to investigate the scope for classical biological control of these weeds. During 2013, we concentrated our work on four potential biological control agents.

On 13 December 2011, a petition for field release of the gall-forming weevil *Ceutorhynchus cardariae* was submitted to TAG. At the end of November 2012 we received TAG's comments, which indicated that additional tests are needed before the petition can be reconsidered. In 2013, we conducted no-choice tests with 11 new test species, nine native to North America, including two federally listed threatened or endangered (T&E) species. Five plant species, four native to North America, supported adult development of *C. cardariae*. We also exposed one additional native North American species, *Streptanthus anceps* (= *Caulanthus anceps*) under multiple-choice conditions as it had had supported development under no-choice conditions in previous tests. Unfortunately it was attacked and so an open-field test will need to be conducted in 2014.

The seed-feeding weevil *Ceutorhynchus turbatus* is the most specific agent we are currently working with. Tests in 2013 again worked very well. Apart from controls, eggs were only found in two test species, the European *Lepidium campestre* and the native North American *L. nitidum*. We will test whether the latter species supports *C. turbatus* development in 2014. Fewer eggs were found in *Lepidium chalepense* than in *L. draba,* reflecting the high specificity of *C. turbatus*. The proportion of viable seeds destroyed in *L. draba* during oviposition and development tests was again high (57–83%). Only the closely related European *L. campestre* had comparable numbers of seeds destroyed.

In 2013 we repeated an open-field test with the stem-mining weevil *Ceutorhynchus merkli* in southern Russia. Although none of the seven test species exposed showed any signs of attack, the test will need to be repeated, since only very low attack levels were recorded on *L. draba* control plants.

Work on the root-gall forming weevil *Ceutorhynchus assimilis* advanced very well in 2013. In no-choice development tests, *C. assimilis* emerged from two native North American Brassicaceae. However, in a subsequent multiple-choice test, *C. assimilis* did not lay any eggs on these two species. This result justifies continuing work with *C. assimilis*. We set up additional no-choice development tests with 34 test plant species in autumn 2013, which are currently being overwintered. Results will greatly advance our host-specificity tests with this species.

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Ceutorhynchus assimilis galls on a *Lepidium draba* control plant (photo: C. Closca)

Galling attempts on North American test plant species by *Ceutorhynchus cardariae* (photo: P. Pardo)

Tatyana Moskaleva dissecting plants exposed during an open-field test with *Ceutorhynchus merkli* at the Zoological Institute at St Petersburg in Russia (photo: S. Reznik, Zoological Institute, St Petersburg)

Technique used to infest PPW with *Metaculus lepidifolii* (photo: M. Cristofaro, BBCA)

foreign exploration consortium for biological control of perennial pepperweed, *Lepidium latifolium*, in the USA

Perennial pepperweed, *Lepidium latifolium*, (PPW), is a highly invasive mustard of Eurasian origin. This project to investigate the potential for biological control of PPW was started in 2004 in collaboration with Prof. Mark Schwarzländer (University of Idaho, USA). In 2005, we joined forces with the Biotechnology and Biological Control Agency (BBCA) in Italy.

At present we are concentrating on five potential biological control organisms: the gall-forming weevil *Ceutorhynchus marginellus*, the shoot-mining flea beetle *Phyllotreta reitteri,* the root-mining weevil *Melanobaris* sp. near *semistriata*, the gall-forming eriophyid mite *Metaculus lepidifolii* and *Lasiosina deviata*, a chloropid stem-mining fly.

No-choice and single-choice tests conducted with *C. marginellus* in quarantine at CABI have so far revealed that 20 other species support adult development. Several of these have already been tested in multiple-choice cage tests in southern Russia, and results in 2013 showed that the native North American *Cardamine breweri, Lepidium virginicum* and *L. latipes* were attacked. Both *Lepidium* species were tested in an open-field test and were not attacked.

No-choice larval transfer tests with *P. reitteri* under laboratory conditions further confirmed the wide physiological host range of larvae of this species. Although it turned out to be much more specific when tested in the field (only the European *Lepidium perfoliatum* was attacked), we decided to suspend working with it, because we feel that it would be prohibitively time consuming to prove its environmental safety and it is unclear whether it would pass the regulatory process.

Alexey Moseyko releasing *Ceutorhynchus marginellus* and *Phyllotreta reitteri* in a multiple-choice cage test in southern Russia (photo: S. Grigoriev, Krasnodar)

Multiple-choice cage tests were carried out on 11 critical test plant species with *Melanobaris* sp. n. pr. *semistriata* and *Metaculus lepidifolii* at a field site in Turkey. Besides PPW, larvae of *Melanobaris* sp. n. pr. *semistriata* were found in two European *Lepidium* species. No symptoms or evidence of mite presence were recorded on PPW or on any of the test plant species. Enforced regulations have made it increasingly difficult to collect insects in Turkey, including for our Turkish collaborators. We will therefore suspend working with *M.* sp. n. pr. *semistriata* for the time being. The possibility of organizing another field test with *Metaculus lepidifolii* is still being discussed with our local collaborators.

Host-specificity testing with *Ceutorhynchus marginellus* will continue in 2014 both in quarantine and in the field. Provided permission to conduct field research in Turkey can be obtained, the work on *M. lepidifolii* will also be continued. In addition, we will extend field surveys to areas not yet covered and where the potential biological control agents we are currently working on might also occur, e.g. Georgia and Armenia.

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Sinan Yüksel, Esther Gerber and Franca Di Cristina releasing *Melanobaris* sp. n. pr. *semistriata* in a multiple-choice cage test in Turkey (photo: M. Barlattani, ENEA, Rome)

giving dyer's woad, *Isatis tinctoria*, the blues

Dyer's woad, *Isatis tinctoria*, is of Eurasian origin and was introduced to North America by early colonists as a source of blue textile dye. Today, it is a declared noxious weed in ten western US states. In 2004, an initiative was started by Prof. Mark Schwarzländer (University of Idaho, USA) and Jim Hull (Weed Superintendent, Idaho) to investigate the potential for biological control of dyer's woad. Work is currently concentrating on three biological control candidates, i.e. the seed-feeding weevil *Ceutorhynchus peyerimhoffi*, the root crown-mining weevil *C. rusticus*, and the stem-mining flea beetle *Psylliodes isatidis*.

Unfortunately, *C. peyerimhoffi* rearing worked less well in 2013 than in previous years owing to a cold and rainy spring, which reduced seed set of dyer's woad plants. Despite the adverse weather conditions, host-specificity tests advanced very well, with 182 plants of 49 test species exposed. Apart from dyer's woad, eggs were found in only eight test plant species. In subsequent development tests, none of the six exposed test species supported larval development of *C. peyerimhoffi*, confirming its narrow host range. Only two native North American species had relatively high proportions of seeds damaged by adult feeding (27.5% and 17.8%, respectively). We will therefore try to establish a multiple-choice field cage test with these species in 2014.

Many more *C. rusticus* adults emerged from more dyer's woad control plants during no-choice development tests in 2013 than in previous years, rendering results more reliable. None of the 12 test species exposed supported adult development. In two additional open-field tests established in autumn 2012 and 2013, about 40–50 eggs were found on average on dyer's woad. Not surprisingly, eggs were also found on the European *Isatis glauca* exposed in 2013, but there were 80% fewer than on dyer's woad. Finally a few eggs were found on two North American species: on one *Descurainia californica* plant (2012) and three *Sisymbrium linifolium* plants (2013).

Adult transfer tests established in autumn 2012 confirmed that female oviposition behaviour of *P. isatidis* is much more specific than larval host choice. Of 26 test plant species that had supported adult development after newly hatched larvae were transferred onto plants, only five had adults of *P. isatidis* emerge following the transfer of egg laying females. Although this is a very encouraging result, one adult of *P. isatidis* did emerge from the commercially grown *Brassica rapa* (turnip), and the physiological larval host range does include two additional economic *Brassica* species, plus one federally listed T&E species (*Boechera hoffmannii*). We therefore decided not to further pursue work with *P. isatidis*, since we would be unlikely to obtain a permit for its field release based on these results.

In 2014 we will continue and if possible complete host-specificity tests with *C. peyerimhoffi*. We expect to prepare a petition for field release either next winter or at the latest in winter 2015.

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Dyer's woad rosette with heavy feeding damage after exposure to *Ceutorhynchus rusticus* and *Psylliodes isatidis* during an open-field test (photo: H.L. Hinz)

Defoliating lepidopteran larva on dyer's woad in Georgia (photo: H.L. Hinz)

Hariet L. Hinz and Cornelia Cloşca setting up an open-field test with *Ceutorhynchus rusticus* and *Psylliodes isatidis* in autumn 2013 (photo: P. Pardo)

Preparing reed shoots for laboratory rearing of noctuid moths (photo: P. Häfliger)

Mature *Archanara neurica* larva before pupation (photo: J. Freise)

protecting the USA's wetland areas from common reed, *Phragmites australis*

The perennial grass *Phragmites australis*, or common reed, is considered one of the most widespread plant species in the world. It can form large monocultures in wetlands and along river-banks and lakesides. Although reed-beds are seen in Europe as valuable and endangered ecosystems, *P. australis* is regarded to be invasive and reduce biodiversity in North America and Australia. Population studies using molecular techniques have shown that the dramatic spread of *P. australis* in recent decades in North America is due to an introduced population from Europe, which is displacing indigenous genotypes. Investigations to evaluate the potential for classical biological control of the invasive populations of common reed started in 1998. The native North American populations of common reed were recently recognized as a distinct subspecies, *P. australis americanus*.

We are currently concentrating on two shoot-mining noctuid moths, *Archanara geminipuncta* and *A. neurica*. Although both species can develop on native North American reed under test conditions, we expect the native *Phragmites* to escape attack in the field, because their leaf sheaths are less suitable for oviposition and eggs suffer higher mortality during winter than on the invasive reed.

Besides maintaining rearing colonies of *A. geminipuncta* and A. *neurica*, we repeated an open-field oviposition test in 2013 which had been carried out before in 2011 with native North American, introduced and European reed. The plan was to obtain more reliable results by using more vigorous plants and releasing a higher number of moths. Results from this test should verify our hypothesis that the native subspecies *P. australis americanus* is less attractive than the invasive subspecies for oviposition by the moths. The experiment was a success for *A. neurica*: only six of 230 eggs found were laid on native reed. However, *A. geminipuncta* did not lay enough eggs to produce reliable results: out of the 41 eggs found, 24 were laid on native reed. The main problem was that the stem diameters of European and introduced reed were too thin to be attractive to *A. geminipuncta*.

In March 2013, we again shipped 600 eggs of both *A. geminipucta* and *A. neurica* to the University of Rhode Island in the USA for final host-specificity tests in quarantine. A petition for release of at least one of the two moths will be submitted in 2014.

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Set-up for an open-field oviposition test with *Archanara geminipuncta* and *A. neurica* (photo: R. Batallas)

searching for specific pathogens to control Canada thistle, *Cirsium arvense*, in the USA

Cirsium arvense, Canada thistle, is among the most important invasive plants in the world. To date, five biological control agents have been released against it in North America and several other natural enemies have been accidentally introduced. Thus far, however, none appears to have been able to halt the spread or reduce the impact of Canada thistle. Coevolved fungal pathogens can be more host specific than insects at the plant species level. Since host specificity is the main hurdle to introducing additional potential biological control agents of *C. arvense* into North America, we are now focusing on the potential of pathogens.

We selected China as a survey area because a large number of *Cirsium* species are recorded from there, and some areas show a good eco-climatic match with infested areas in North America. Because CABI's fungal expertise lies with our staff in the UK, they are leading this project in cooperation with staff at the MoA-CABI Joint Laboratory in Beijing.

During surveys in 2010, different pathogens had been collected on *C. arvense*, and a white blister 'rust', *Pustula spinulosa*, was identified as the most promising agent. The blister 'rust' proved to be difficult to work with, and the first successful infection of *C. arvense* under laboratory conditions was only achieved in 2012. In 2013, inoculations were attempted with oospores – purported to be able to survive for several years in dried plant parts – but no infection occurred. At the end of July 2013, fresh material of *C. arvense* infected with zoosporangia of the blister 'rust' was collected in Urumqi, in Xinjiang Province in north-eastern China, and used for simultaneous inoculation tests in the UK and China. Both tests showed that single populations of *C. arvense* from China, the USA and Canada were fully susceptible, while two other US populations were only moderately to weakly susceptible. Three native North American *Cirsium* species that were inoculated proved to be resistant or only weakly susceptible. In addition, a mycoparasite (*Lecanicillium* sp.) was found on the *P. spinulosa* culture, which is probably responsible for our previous difficulties in maintaining a laboratory culture of the blister 'rust' and in developing a consistent inoculation method. Zoosporangia of *P. spinulosa* were found to survive well in liquid nitrogen.

Plans for 2014 include trying to obtain a mycoparasite-free culture of *P. spinulosa*, continue host-specificity tests in our quarantine facility in the UK and conduct an open-field test in China.

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Wan Huanhuan collecting blister 'rust' infected *Cirsium arvense* in Xinjiang Province (photo: C. Ellison)

The native North American *Cirsium tracyi*, 40 days after being inoculated with the white blister 'rust': a single, tiny (c. 1-mm) pustule (arrow) is evident on the lower leaf surface (photo: C. Ellison)

Cirsium arvense, nine days after being inoculated with the white blister 'rust'; many newly developing pustules are evident (photo: C. Ellison)

Jona Freise indicating *Tancetum vulgare* galled by *Rhopalomyia tanaceticola* in northern Germany in August 2013 (photo: E. Palmer)

Overwintering galls of *Rhopalomyia tanaceticola* on below-ground vegetative buds of *Tanacetum vulgare* at Iaşi in Romania in November 2013 (photo: A. Diaconu, Biological Research Institute, Romania)

tackling common tansy, *Tanacetum vulgare*, in North America

Common tansy, *Tanacetum vulgare*, is a Eurasian perennial plant that was introduced to North America for medicinal purposes in the 17th century. To date, it is a declared noxious weed in five US states and three Canadian provinces. A biological control project was started in 2006. Work in 2013 focused on the stem-boring weevil *Microplontus millefolii*, the shoot-boring moth *Platyptilia ochrodactyla* and the shoot, leaf and flower gall midge *Rhopalomyia tanaceticola*.

Microplontus millefolii has been collected in the areas around St Petersburg in Russia, Kiev in Ukraine, Kiel in Germany and Iaşi in Romania – the first record of the weevil from this country. Specimens from Romania show 3.2% genetic divergence from those from Russia, Ukraine and northern Germany, indicating that they may also differ in biological features from the other populations. Under no-choice conditions, *M. millefolii* from Ukraine and Romania accepted the native North American species T*anacetum camphoratum* and *T. huronense* for oviposition and completed its development in them. Both plants were also accepted for oviposition in multiple-choice field cage tests, but little attack was recorded on these species in two open-field tests carried out in Russia.

Surveys in northern and western Germany in 2013 confirmed the relatively frequent occurrence of *P. ochrodactyla* in this part of Europe. We collected 370 stems from which 182 adults emerged. *Platyptilia ochrodactyla* successfully mated in confinement but no egg laying was recorded.

The gall midge *R. tanaceticola* is multivoltine and pupation occurs within the gall. Several field surveys have found that the midge overwinters as larvae in galls induced on below-ground vegetative buds.

In 2014, we will focus work on host-range testing with *M. millefolii* in Russia. The oviposition behavior of *P. ochrodactyla* will be studied and, provided a successful method can be developed, preliminary host-range tests will be conducted. A rearing method will be developed for *R. tanaceticola* and initial host-range tests will be carried out.

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Emily Palmer collecting shoots of *Tanacetum vulgare* attacked by *Platyptilia ochrodactyla* larvae in western Germany in May 2013 (photo: A. Gassmann)

biological control of swallow-worts, *Vincetoxicum* spp.

Two European species of swallow-worts, *Vincetoxicum nigrum* (black swallow-wort) and *V. rossicum* (pale swallow-wort) were introduced into eastern North America around 1850 as ornamental vines and have since become naturalized in north-eastern North America. Both species are considered invaders of natural areas and abandoned pastures.

Since 2006, several potential insect biological control agents have been investigated in collaboration with Prof. Richard Casagrande at the University of Rhode Island in the USA, and Dr Robert Bourchier at AAFC in Canada. The leaf-feeding chrysomelid beetle *Chrysolina aurichalcea asclepiadis* is polyphagous and unsuitable for biological control of *Vincetoxicum* spp. Work on the root-feeding *chrysomelid Chrysochus* (= *Eumolpus*) asclepiadeus has been suspended because test results showed that the larvae can develop on several native North American non-target plants mainly in the genus *Asclepias*. Also, female beetles will occasionally oviposit in the vicinity of non-target plants even in the presence of *Vincetoxicum*, resulting in occasional larval development on some non-target plants in the genus *Asclepias*. The news is better for a third species: based on positive scientific reviews from both Canadian and US panels, the Canadian Biological Control Review Committee–CFIA granted a release permit for the leaf-feeding noctuid moth *Hypena opulenta* in September 2013.

In 2013, larvae of the leaf-feeding noctuid *Abrostola asclepiadis* were collected in Finland and Ukraine and sent to the quarantine facility at the University of Rhode Island. The material will be used in 2014 for comparative diapause experiments and potentially for future releases.

Alicia Leroux, from the University of Manitoba at Winnipeg in Canada, completed her Master's research on the biology of the seed-feeding tephritid fly *Euphranta connexa*. This research established the thermal requirements for the pupal development of *E. connexa* to adult emergence, allowing the design of effective host-range testing methodology. The research also showed that host-range testing needs to be done within 8–15 days after female emergence, which is when females have close to their full complement of eggs. Preliminary no-choice oviposition tests indicate that, of the five non-target species tested (*Asclepias curassavica*, *Cynanchum acutum*, and three North American species: *Asclepias tuberosa, Apocynum cannabinum* and *Amsonia tabernaemontana*), only *Asclepias curassavica* provided oviposition cues for *E. connexa*.

Due to limited funding, work in 2014 will focus on maintaining a small rearing colony of the chrysomelid *Chrysochus asclepiadeus*. Work on *E. connexa* can be revived at any time.

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Moritz Albeimer from the University of Turku collecting *Abrostola asclepiadis* eggs in Finland (photo: A. Leroux)

Euphranta connexa ovipositing on a *Vincetoxicum* seed pod (photo: A. Leroux)

Alicia Leroux collecting *Vincetoxicum hirundinaria* seed pods in Ticino, Switzerland (photo: A. Firebaugh)

Test or control plants are experimentally inoculated with the mite *Aceria angustifoliae* by clipping field-collected, mite-infested Russian olive leaves onto healthy leaves of potted plants (photo: U. Schaffner)

Dr Ghorbanali Asadi inspecting a Russian olive tree in the garden of Mashhad University's experimental farm in Iran (photo: U. Schaffner)

stemming the spread of Russian olive, *Elaeagnus angustifolia*

Russian olive, *Elaeagnus angustifolia*, a small tree native to Asia, has been widely planted in North America for erosion control, as a shade tree or as a nectar source for honey bees. To date, this tree has invaded many semi-natural and natural habitats and has become the fifth most abundant woody species along rivers in the western USA. In 2007, CABI started a biological control project against Russian olive, focusing on agents that attack the plant's reproductive parts or seedlings, so as to slow its spread without harming established trees. This work is being conducted in collaboration with BBCA, Prof. Ghorbani and Dr Asadi at the University of Mashhad in Iran, Prof. Aloviddin Khamraev at the Uzbek Academy of Sciences, and Dr Toshpulat Rajabov at the University of Samarkant in Uzbekistan.

In spring 2013, new test plants were shipped to Iran to complement locally available species for a common garden experiment at Mashhad University to assess the host specificity of the mite *Aceria angustifoliae*. Visual inspections indicated that, by the end of 2013, eight of the ten control plants but none of the test plants had been attacked by *A. angustifoliae*. Mite-infested Russian olive branches were also hand-carried to the quarantine facility at CABI in Switzerland to continue with host-range testing. Mites that were found on control and test plants were sent to Dr Radmila Petanović at the University of Belgrade in Serbia, and Dr Philipp Chetverikov at the Russian Academy of Sciences for identification. The results of the no-choice test support earlier findings that *A. angustifoliae* is highly host specific.

We also continued with the long-term impact experiment set up at Mashhad University's experimental farm. Inspection of the Russian olive trees that were inoculated with *A. angustifoliae* in 2010 revealed that the level of mite attack had dropped compared with the previous year, probably due to a very cold winter with maximum temperatures below −20°C for three continuous weeks. Therefore, first results from this impact study will not now be available until 2015.

In summer 2013, a field cage experiment was set up in Uzbekistan and Iran to further assess the host range of the fruit-attacking moth *Ananarsia eleagnella*. Infested fruits were collected in August, and adults emerging from the fruits were released in field cages and offered either fruit-bearing cut branches or small trees from test and control plant species. While only a few adults emerged in September/October in Uzbekistan, several replicates of the single-choice cage experiment could be conducted in Iran. Unfortunately, females oviposited on neither fruits of the control nor those of the test plants.

In 2014, we will continue exploring the host specificity and impact of the mite *Aceria angustifoliae* and the moth *Ananarsia eleagnella*. We will also continue with surveys of the herbivore community close to the Uzbekistan/Tajikistan border. In addition, a stakeholder workshop will be held in North America in early February 2014 to review current knowledge on the invasion and impact of Russian olive in North America and to discuss the proposed approach to reduce the reproductive output of Russian olive by biological means.

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Massimo Cristofaro infesting young Russian olive trees with *Aceria angustifoliae* mites (photo: U. Schaffner)

prospects for the biological control of oxeye daisy, *Leucanthemum vulgare*

Oxeye daisy, *Leucanthemum vulgare*, a perennial herb of European origin, has naturalized throughout most of temperate North America, where it has become a particularly aggressive invader in pastures and meadows. CABI started to explore the prospects for biological control of oxeye daisy in 2008.

In 2013, additional no-choice larval development tests were conducted with the root-mining tortricid moth *Dichrorampha aeratana* using 27 test plant species and varieties. A multiple-choice cage test was set up with three plant species that had been attacked under no-choice conditions. Larvae were found on all control plants but only two larvae were found on test plants, one on a *Matricaria occidentalis* and one on a *Leucanthemella serotina*. An open-field test that was set up with three different Shasta daisy (*Leucanthemum* × *superbum*) varieties revealed that the moth clearly prefers oxeye daisy for oviposition.

An impact experiment set up in 2011 found only a small impact of *D. aeratana* on the biomass of potted oxeye daisy plants after one and two years of larval attack. We therefore set up a new impact experiment with oxeye daisy plants from the invaded range and *L.* × *superbum* Amelia, both with and without competition from grasses.

No-choice larval development tests were established with the root-mining weevil *Apion stolidum* using 22 test plant species and varieties. Apart from *L. vulgare*, several larvae were found on six test plant species outside the genus *Leucanthemum* as well as on two Shasta daisy varieties. If time and resources permit we will check whether these test plants also support adult development.

In 2013, we located more oxeye daisy populations infested with the rare root-feeding weevil *Cyphocleonus trisulcatus* in southern France and were also able to establish a rearing colony. We are currently overwintering over 200 adults.

Our planned host-specificity tests with the flowerhead-attacking fly *Tephritis neesii* had to be postponed because of low overwintering success.

To clarify the taxonomy of invasive oxeye daisies, we continued collecting seeds and DNA samples from oxeye daisy populations in North America and Europe. Flow cytometric analyses, which were continued in collaboration with Prof. Heinz Müller-Schärer at the University of Fribourg in Switzerland, confirmed that invasive oxeye daisies are mainly the diploid *L. vulgare*, whereas the tetraploid species *Leucanthemum ircutianum* seems to be much less abundant. Molecular analyses, which were performed by Dr J. Gaskin and his group at USDA-ARS at Sidney, Montana, showed that the haplotype diversity in the introduced range is reduced compared with the native range.

In 2014, we will continue with studies on the host range and impact of *D. aeratana* and start host-range testing of *C. trisulcatus* and *T. neesii.*

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Adult *Apion stolidum* (photo: L. Sauvain)

Adult *Dichrorampha aeratana* (photo: S. Stutz)

Marianne Rutishauser collecting oxeye daisies (photo: S. Stutz)

Emelia trabealis in the Slovak Republic (photo: P. Tóth, Slovak Agricultural University, Nitra)

revisiting biological control of field bindweed, *Convolvulus arvensis*

Field bindweed, *Convolvulus arvensis*, is a perennial vine of Eurasian origin that has been introduced into North America and Australia. In the 1970s, USDA initiated a programme for the biological control of this species. Two biological control agents were released, the gall mite *Aceria malherbae* and the bindweed moth *Tyta luctuosa*. Establishment and impact of the two species did not prove satisfactory and the project was revived. Investigations on three additional potential biological control agents started in 2009, i.e. the stem-mining agromyzid fly *Melanagromyza albocilia* and the root-mining flea beetles *Longitarsus pellucidus* and *L. rubiginosus*.

In an open-field test at a site where both flea beetles occur, *L. rubiginosus* emerged from the two North American natives *Convolvulus equitans* and *Calystegia macrostegia*. It was therefore deemed not specific enough and rejected. *Longitarsus pellucidus* emerged only from *Convolvulus arvensis*, but few adults emerged and the results were not conclusive. The test would therefore need to be repeated.

In no-choice and choice tests exposing cut plant parts, the agromyzid fly *M. albocilia* accepted four of eight test plant species for oviposition. In subsequent development tests on potted plants, not enough plants were attacked. In 2013, we focused on improving methods for development tests. Using 20 field bindweed plants, we exposed single plants to one or two mated females and one male in three types of cages: gauze sleeves (smallest cage) and small and large screen cages. Overall, development of larvae occurred in 40% of the plants exposed. The results indicate that the chances of obtaining development were best with the smallest cages and two females, but the mean number of larvae per attacked plant was higher with only one female. In contrast, no development occurred in the screen cages exposed to only one female.

Eggs of the beetle *Hypocassida subferruginea* in the Slovak Republic (photo: P. Tóth, Slovak Agricultural University, Nitra)

In 2013, a pilot open-field test was established in the Slovak Republic by Dr Peter Tóth (Slovak Agricultural University, Nitra) for two additional potential agents, the defoliating noctuid moth *Emelia trabealis* and the defoliating chrysomelid beetle *Hypocassida subferruginea*. Attack and presence of all stages of the two insects were recorded once in June and once in July. Attack by both insects occurred at a similar rate on *Convolvulus arvensis* and *Calystegia sepium*, and at a very low rate on *Ipomoea batatas* (sweet potato).

We are planning to repeat the open-field test with *E. trabealis* and *H. subferruginea* in 2014 and expose critical native North American species.

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Peter Tóth setting up an open-field test in the Slovak Republic (photo: P. Tóth, Slovak Agricultural University, Nitra)

what are the prospects for biological control of tutsan, *Hypericum androsaemum*, in New Zealand?

Tutsan, *Hypericum androsaemum*, is a semi-evergreen shrub of European origin that has become a common weed in higher rainfall areas in New Zealand. Tutsan is shade tolerant, unpalatable to livestock, and tends to infest areas where mechanical and/or chemical control options are impractical. A rust pathogen, *Melampsora hypericorum*, which successfully controlled tutsan in Australia, is present in New Zealand but does not appear to be sufficiently virulent. In 2011, CABI started conducting field surveys in the area of origin of tutsan to evaluate prospects for its biological control.

In 2013, many field sites in Ireland, the UK, France and Spain were revisited, more extensive sampling was conducted in Spain, and Georgia was visited for the first time. The mountainous region of Adjara, located on Georgia's Black Sea coast, proved to be home to relatively large tutsan populations and a diversity of herbivorous insects, including several species not collected at any of the western European sites.

To date, 96 species of herbivorous insects have been collected during both visual inspection and quantitative sampling, representing seven orders and 38 families. The majority of these species are polyphagous and at least eight species are oligophagous on *Hypericum*. Two species collected in Georgia could have the highest potential for biological control and warrant further research. The leaf beetle *Chrysolina abchasica* was relatively abundant at one Georgian site where extensive foliar damage was observed. This species has only been reported from the Caucasus and has no reported host records, indicating that potentially it may have a restricted host range. The second species, *Lathronympha strigana*, is an oligophagous tortricid moth recorded from several *Hypericum* species throughout Europe. During surveys in April 2013 in Spain, larvae were commonly found boring into young shoot tips. In Georgia in July 2013, larvae were also fairly abundant but were found boring into individual young fruits, an uncommon behaviour for the species, and not observed during summer visits to Spain. The Georgian populations could represent a specialized biotype whose suitability for biological control should be further investigated.

Melampsora hypericorum was found at 52 sites across all countries surveyed. In autumn 2013, we began preliminary host-specificity and pathogenicity tests with three *M. hypericorum* isolates collected from Spain, Ireland and the UK. Eight New Zealand tutsan populations were tested, of which four were resistant, three exhibited reduced infection, and one was fully susceptible to all three isolates. The four resistant populations are all from New Zealand's North Island, where tutsan has become the most problematic. Four European tutsan populations were also tested, each of which was most susceptible to the isolate that originated from the same region. Initial host-specificity tests were conducted with eight other *Hypericum* species, none of which was infected. An additional 20 European isolates of *M. hypericorum* were tested on excised tutsan leaves. Results were consistent with those obtained from the first three isolates.

If the project were to continue, we would concentrate on shipping the most promising insect biocontrol agents to New Zealand for testing in quarantine, and continuing with pathogenicity tests with *M. hypericorum*.

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Chrysolina abchasica adult collected in Mtirala National Park in Georgia (photo: E. Olsen)

Recently inoculated plants: plants are initially covered with plastic bags to facilitate infection by *Melampsora hypericorum* (photo: E. Olsen)

Pablo Pardo inspecting tutsan plants in Spain (photo: E. Olsen)

Adult *Aphalara itadori* (photo: R. Eschen)

Fifth instar *Aphalara itadori* nymph (photo: G. Cortat)

evaluating the risk of biocontrol introductions for Japanese knotweed, *Fallopia japonica*, in Switzerland

In 2010, the psyllid *Aphalara itadori* was released in the UK against Japanese knotweed, *Fallopia japonica*, an exotic plant in the family Polygonaceae that is a particularly aggressive invader along watercourses. The UK government approved its field release based on the results of many years of pre-release studies conducted by CABI's centre in the UK. While these studies covered almost all close relatives of Japanese knotweed native to the UK, they did not include related plant species native to other parts of Europe.

In spring 2012, FOEN approved a two-year project proposed by CABI's Swiss centre that aims to assess the risks of potential non-target attack by the psyllid if released in Switzerland. Host-specificity studies are being conducted with species in the family Polygonaceae that are native to Switzerland, as well as with varieties of closely related cultivated species that are grown in Switzerland and neighbouring countries.

Between August 2012 and December 2013, no-choice oviposition and development tests were established with *Persicaria mitis*, three *Rumex* species and the closely related species *Fallopia convolvulus*, all native to Switzerland, as well as one variety of *Fagopyrum esculentum* (buckwheat) and one of *Rheum rhabarbarum* (rhubarb) sourced in Switzerland. Individually potted plants were each exposed to five pairs of psyllid adults for five days. Eggs were laid on all *Fallopia japonica* control plants and on most of the test plant species, but in much lower numbers than on *F. japonica* (mean number of eggs per plant: 415 vs < 40). No development to adult occurred on test plants, while the survival rate to adult was about 40% on the controls. On *F. convolvulus*, one nymph reached the fifth instar (representing only 0.6% of total eggs laid on this species). On the other test plant species, nymphs died before they reached the second instar.

In 2014, we will assess the suitability of the five remaining test plant species for oviposition and larval development of *A. itadori,* and we will study variation in resistance of various genotypes of *Fallopia* $\times$ *bohemica* by assessing the growth rate and survival of the psyllid on replicated clones of genotyped hybrids.

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Funded by: FOEN, Switzerland.

Aphalara itadori adults and nymphs on Japanese knotweed (photo: R. Eschen)

Prospects for biological control of *Butomus umbellatus*

Flowering rush (*Butomus umbellatus*) is an aggressive invader of freshwater systems that is becoming an increasing problem in the mid-western and western states of the USA. Since no effective control methods are currently available, a biological control project was started in spring 2013 and CABI in Switzerland subcontracted to conduct surveys on potential insect agents.

We began with a literature search on phytophagous arthropods and fungal pathogens associated with flowering rush in Europe. So far, we have found records of four fungal pathogens and 18 insect species: eight Coleoptera (five chrysomelids and three curculionid weevils), five Lepidoptera, four Diptera and one Hemiptera (an aphid). We prioritized four species, since they are described as monophagous on flowering rush and information currently available suggests they will damage the plant. These are two weevil species, *Bagous nodulosus* and *B. validus*, and two flies, *Phytoliriomyza ornata* and *Hydrellia concolor*. All are described as feeding in the leaves and stems of flowering rush.

First field trips were made between June and August 2013 to the Bremen and Kiel/Lübeck areas of northern Germany and to the Czech Republic and Slovakia. The main purpose of these trips was to find *B. nodulosus* and collect and rear any other phytophagous species present. We found at least six sites with *B. nodulosus* adults or larvae, two in northern Germany and four in the Czech Republic/ Slovakia. We also found two reed beetles, larvae of two lepidopterans, and three fly species, including *P. ornata*.

We collected 48 *B. nodulosus* adults, 18 of which were definitely female. Adults make characteristic feeding marks on the leaves which facilitates finding them in the field. Eggs are laid above and below the water. First instar larvae are very mobile and move, mostly externally, down into the leaf bases and the rhizome, where they feed. Pupation takes place inside the plant and adults emerge during July and August. We were able to establish a small rearing colony and are currently overwintering 56 weevils under different conditions at CABI.

In addition, we started developing a test plant list in collaboration with our US collaborators with a view to future host-specificity testing. *Butomus umbellatus* is the only species and genus in the family Butomaceae. The lack of closely related native congeners makes it an ideal target for biological control.

For 2014, we are planning to extend field surveys for additional potential agents and to start first host-specificity tests with *Bagous nodulosus*.

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Third instar *Bagous nodulosus* larva (photo: P. Häfliger)

Adult *Bagous nodulosus* (photo: P. Häfliger)

Flowering rush site in northern Germany where *Bagous nodulosus* was found (photo: P. Häfliger)

integrated crop management

introduction

This year saw the successful completion of our EuropeAid-funded Partnership Project in DPR Korea, which we carried out in collaboration with the CABI China Office, the MoA-CABI Joint Laboratory in Beijing, and other partners in China and DPR Korea. Over the four years of this project, significant progress has been made towards strengthening the knowledge and in-house applied research capacity of the Academy of Agricultural Sciences (AAS) so that they are better equipped to solve agricultural problems on a national level. As one project in DPR Korea ended, however, another one began, with the official launch taking place in July of another, three-year, EuropeAid-funded Partnership Project. The aim of the new project is to support the improvement of the overall structure, management and operation of the newly established Department of Plant Protection of the Ministry of Agriculture (MoA-DoPP). It will be implemented in close collaboration with partners in China and DPR Korea, and it is anticipated that our joint efforts will put MoA-DoPP into a stronger position for fulfilling its mandate to improve plant protection and food production in DPRK.

Another highlight in 2013 was the diversification of our activities with Philip Morris International (PMI), which came about following a request for CABI to develop a training component for their new global programme on sustainable fuelwood management. We were delighted to take this on board in collaboration with the CABI Brazil Office and to work together with Philip Morris Brazil (PMB) to train field technicians and tobacco producers during the year.

Our involvement in the SNSF/SDC-funded SCOPES (Scientific Co-operation between Eastern Europe and Switzerland) Institutional Partnership project in Albania came to an end with the completion of its final phase this year. During the three years of this project, tangible progress has been made towards strengthening the capacity of four local institutions. Interviews and questionnaires conducted with project partners and beneficiaries revealed that the project has led to significant improvements in the agricultural sector, particularly to the level of education offered to agricultural students as well as the advisory services available to apple producers.

Besides project work, our ICM team members have been contributing to the coordination and implementation of CABI's global programme, Plantwise. This work has mainly focused on implementing workshops in various countries to develop pest management decision guides (PMDGs) based on 'Green and Yellow Lists', but has also involved running training workshops for plant doctors. In addition, various members of our team are heavily involved in developing lectures and course material for the Master of Advanced Studies in Integrated Crop Management (MAS ICM), which will be implemented as part of a tripartite collaboration between CABI, the University of Neuchâtel and the Canton Jura. We are delighted to be playing such a significant role in establishing a landmark higher education programme within the Canton Jura and are looking forward to its launch in March 2015.

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SCOPES institutional partnership project in Albania

Following the completion of the project funded by SNSF/SDC through Scientific Cooperation between Eastern Europe and Switzerland (SCOPES) in 2012, a valorization grant was obtained from SCOPES for further work in 2013. The objective was to further strengthen the capacity of four institutional partners in Albania: the Agrobusiness School Korçë (ABS), the University of Korçë, the Centre for Agricultural Technology Transfer (CATT) and the local NGO Agrinet.

One major activity was developing a video to capture the story of the project and its results in three key areas. The video begins by documenting everyday challenges involved in apple production, agricultural research and the educational system in Korçë, Albania. It then captures project activities, such as how it provided invaluable lecture materials for teaching IPM to students, and farmer training on rational pesticide use and other aspects of IPM, as well as providing equipment and knowledge that has improved the research capacity of partner laboratories. Finally, and most critically, the video records the results of the project and the progress made by stakeholders in the wake of these interventions. The video is thus geared to increase our project partners' visibility, and also to attract new potential partners and donors and raise the profile of our work with the general public (see Highlights, p.13 and www.cabi.org/about-cabi/cabi-centres/switzerland/video-cabi-in-albania/. Interviewees were unanimous in being positive about the project, and were quick to name benefits from training, equipment and educational IPM materials provided through the CABI initiative. For instance, farmers described how higher income had been generated by using the IPM techniques and how this was being put to good use, allowing them to send their children to university, or re-invest in apple production. Students interviewed believed that the materials CABI provided were valuable in helping them reach their agricultural career goals, whether it be working on the family farm or finding a position in the private or public agricultural sector.

A questionnaire was developed to obtain feedback from students at the University of Korçë and the Agrobusiness School on the IPM lectures and training material. The analysis showed that the IPM lectures, comprising comprehensive PowerPoint® material and printed booklets provided by the project, were seen as invaluable tools to help students reach their agricultural career goals. The associated exams were viewed as difficult by some students but, altogether, the ICM lecture course was seen as being among the best available at the two institutions.

Progress was achieved in 2013 in the joint publication of data generated by CATT, with a final draft produced. Finally, an outcome report highlights all the results and achievements of the SCOPES project. This report nicely captures the outcomes and anticipated impacts, of which one was the decision of the Ministry of Education in Tirana to implement the IPM lectures at all five other Agrobusiness Schools operating in Albania. It is anticipated that the IPM lectures established during the SCOPES project will be seen as a model for other courses at the University of Korçë and the ABS and thus increase the quality of lectures and courses at these partner institutions. The report closes with statements of sustainability and an outline of suggested ways forward.

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Simple infrastructure remains in place in Albania (photo: D. Babendreier)

Farmer practising pruning (photo: J. Dennis)

Project staff and farmers inspecting apple orchards (photo: D. Babendreier)

Students at the University of Korçë following IPM lectures (photo: D. Babendreier)

Meeting of project staff and farmers at Jiangkou village in Guangxi Province, China, to discuss results from IPM demonstration plots (photo: D. Babendreier)

Collecting of pest density data from an IPM demonstration plot (photo: D. Babendreier)

Inspection of equipment for the *Trichogramma* rearing facility in Yunnan Province, China (photo: D. Babendreier)

improved food security for smallholder rice farmers in the Greater Mekong Subregion

This project, which is being implemented in the south-western Chinese provinces of Yunnan and Guangxi, the Lao People's Democratic Republic (Lao PDR) and Myanmar, aims to sustainably increase rice production through multi-regional research, capacity building and the implementation of biologically-based pest management. A key problem is the vast amount of pesticide being used in rice fields, often linked with a lack of knowledge on more sustainable practices within the framework of IPM.

In the third year of this five-year project, the IPM strategy was finalized, focusing on inundative release of *Trichogramma* egg parasitoids during the critical tillering stage of rice growth. Knowledge gained to date from laboratory and field work in the target region was incorporated in documents, including the IPM strategy and *Trichogramma* production guides. Research enabled us to select the optimum *Trichogramma* species for the most significant pests (yellow stem borer, *Scirpophaga incertulas*, striped stem borer, *Chilo suppressalis*, or rice leaf roller, *Cnaphalocrocis medinalis*), together with the best release time and density, etc. On a slightly higher level, an 'IPM Technical Guideline' was finalized as guidance for farmers and other stakeholders in the target region and to serve as a reference document for the implementation of the IPM strategy in south-western China. The guideline specifies various IPM measures in addition to the release of *Trichogramma* and strictly limits the use of pesticides, particularly broad-spectrum insecticides. We also drafted two scientific papers on the performance of *Trichogramma* and effects of pesticides that are currently under review.

To produce sufficient *Trichogramma* in the target region in China, two pilot *Trichogramma* production facilities were established, one in Yunnan and one in Guangxi, using equipment designed and assembled locally. Designated staff at the facilities were trained by project staff, according to the training concept and curricula developed beforehand and based on tailor-made training material. Documents including an owner agreement and management and productions plans were developed and will be important in guiding facility staff and making *Trichogramma* rearing facility operation sustainable.

A major activity in the third project year was establishing 10-ha IPM demonstration plots in one- and two-season rice in Guangxi and Yunnan provinces, with project partners supporting the farmers to implement IPM measures and collect a substantial amount of data, which were analysed during joint project meetings. Results indicate that IPM implementation led to a slightly higher yield, reduced pesticide use, more natural enemies and overall higher cost efficiency. Not surprisingly, very positive feedback was obtained from farmers involved. Farmers requested more training so they could better manage this new IPM technology themselves, and this will be provided in the next year, in line with project planning documents.

Significant progress was made with the transfer of technology to Myanmar and Lao PDR. Successful national workshops were held in both countries during which the rice 'IPM Technical Guideline' and additional documents were reviewed and adapted to specific conditions in these countries. The first *Trichogramma* production facilities in Lao PDR and Myanmar were designed and all *Trichogramma* production processes and necessary equipment extensively reviewed.

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Project staff reviewing PM demonstration plots (photo: D. Babendreier)

strengthening maize producing farming communities in the Greater Mekong Subregion

Maize plays a key role in rural livelihoods in the Greater Mekong Subregion. It is grown as a cash crop and for human consumption and animal feed. However, pest problems, unstable markets and lack of investment contribute to overall low productivity and profitability. Funded by DG DEVCO EuropeAid, collaborative action aims to improve agricultural productivity of smallholder farmers through the effective transfer of a validated and sustainable plant protection technology.

The project is based on the establishment of village-level production facilities for a *Trichogramma* egg parasitoid, which will be used to protect maize crops from the destructive Asian corn borer, *Ostrinia furnacalis* (ACB). These production facilities will make the control method affordable and available to smallholder farmers. Building on prospective improvements for farming communities, the project is further supporting these communities to improve market linkages in joint village-level interventions.

In 2013, pilot production facilities were established in each of the countries the project is working in: Myanmar, Lao PDR and China (Yunnan Province). In order to improve ownership by and involvement of community representatives, local implementation groups (LIGs) have been created by the communities for organizing facility establishment at a local level. Village-specific construction plans for the *Trichogramma* facility have also been elaborated, defining contributions from the community and project, taking into account available village resources and skills. The communities also selected the personnel to be in charge of the new facilities. A strong capacity building component will ensures that the technology transfer is successful. Concepts for knowledge transfer have been developed for the countries that summarize training activities, define training objectives, outline training curricula and define the didactic materials and information resources for the extensive training activities.

Training began with courses at a state-of-the-art production site at Hengshui in China for the appointed managers and technicians from Myanmar, Lao PDR and Yunnan, who received training in production technology and management. Subsequently, rearing of the beneficial insects started in the three pilot facilities, and specialists from Hengshui visited each site to give additional practical training.

Further technical issues addressed included the establishment of demonstration plots in each pilot village to show the advantages of releasing beneficial insects for ACB control. The plots were also used to fine-tune release strategies, design of egg cards, etc. In order to learn more about the occurrence and development of ACB populations during the agricultural season, surveys using pheromone traps were designed and conducted in the three countries.

Additional villages for collaboration in the project were selected through a multi-step selection process: maize producing regions with ACB problems were screened for villages showing genuine interest in and willingness to contribute towards improving livelihoods through the production of a biological pest control agent and later towards improved market linkages. A multi-disciplinary team carried out participatory rural appraisals (PRAs) in these villages. Involving communities from the first project interventions onwards is assuring ownership by the beneficiaries from the outset and will be key to ensuring sustainability of the project outputs and thus lead to improvements for communities in the Greater Mekong Subregion.

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Funded by: the EC through DG DEVCO EuropeAid (DCIFOOD/ 2010/230-238) with co-funding from IPP-CAAS and the MoA-CABI Joint Laboratory in China.

PRA activities with farmers at Shakhantar village in Northern Shan State, Myanmar (photo: Yee Yee Myint, Plant Protection Division, Ministry of Agriculture and Irrigation, Myanmar)

Heavy damage from the Asian corn borer on maize in the Dehong area of Yunnan Province, China (photo: U. Wittenwiler)

Improving livelihoods of farming communities in the Greater Mekong Subregion will assure a good future for the younger generation (photo: M. Grossrieder)

Checking for damage in a maize field in Karshi village, Northern Shan State, Myanmar (photo: M. Grossrieder)

Jeanette Jung (ZEPP) in conversation with participants of the Pest Monitoring and Forecasting Workshop, AAS, Pyongyang (photo: K. Holmes)

Benno Kleinhenz (ZEPP) with Ri Gang Nam and Chae Chun Sik (AAS) inspect a field pest monitoring site at AAS, Pyongyang (photo: K. Holmes)

ensuring future food security through the strengthening of research capacity in DPR Korea

This DG DEVCO EuropeAid-funded project, which aimed to strengthen the knowledge and in-house applied research capacity of AAS for solving agricultural problems, continued in 2013 as the result of a project extension agreed with the donor.

This additional time allowed us to build on the achievements of the main implementation phase of the project. Following the 'Joint AAS-CABI Scientific Symposium in Pest Monitoring and Forecasting' held in 2012 (see CABI Switzerland Annual Report 2012), AAS and participants at the symposium expressed an interest in more technical training in this area.

Consequently, a workshop was organized in collaboration with AAS and ZEPP (Central Authority of the Länder for Computerized Decision Support Systems and Programs in Plant Protection, Bad Kreuznach, Germany) on 'Pest Monitoring and Forecasting in Agriculture'. The workshop, led by Benno Kleinhenz and Jeanette Jung of ZEPP, took place on 21 and 22 May 2013 in the Agricultural Information Technology Institute of AAS (AITI-AAS) with 30 participants from six AAS institutes in Pyongyang and the counties and from the Pyongyang Agricultural University of Kim Il Sung University (PAU).

Workshop participants were provided with information and hands-on training on the development, validation and adoption of models for pest and disease monitoring and forecasting. A number of models for key pest and disease species such as late blight of potato caused by *Phytophthora infestans* were presented. Participants focused in particular on the collection of data, model development and exercises in analysis and interpretation of data. Utilization and adaptation of these methods for DPR Korea were discussed. They gained extensive practice and experience in data handling for modelling purposes. Post-workshop feedback indicated that the participants considered the workshop a success and felt they had learnt a considerable amount in a short time, and expressed a strong interest in further training.

A project development workshop held on the following day was attended by representatives of the recently formed MoA-DoPP, the MoA Central Plant Protection Station (MoA-CPPS), the Plant Protection Institute of AAS (PPI-AAS), AITI-AAS and PAU. Participants developed ideas with potential for project development with a focus on the development of an improved pest monitoring and forecasting system in DPR Korea.

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Trainers and participants of the Pest Monitoring and Forecasting Workshop at AAS in Pyongyang (photo: Ri H.C., KECCA)

enhancing capacity for crop protection through partnership with MoA DPR Korea

This three-year DG DEVCO EuropeAid-funded Partnership Project, which began in April 2013, aims to support the efforts of the recently formed MoA-DoPP to address food security challenges by enhancing its institutional and technical capacity, as well as its ability to collaborate on a national and international level.

The initial focus of the project has been on investigating the organizational structure, objectives and activities of plant protection departments in other countries. An awareness raising study tour to China took place between 28 June and 6 July 2013. The delegation from DPR Korea consisted of five participants from MoA-DoPP and MoA's Department of Science and Technology Transfer (MoA-DoS&TT). The aim of the study tour was to begin expanding our partners' professional network of contacts and to gather information from the Plant Protection and Quarantine Division of the Ministry of Agriculture in China (MoA-PPQD-CN) regarding its management and organizational structure, terms of reference, main responsibilities and activities. The study tour also facilitated discussion on national and international pesticide legislation, policies for pest management and best agricultural practices (see Highlights, p.11). The preparatory study tour was followed by a small workshop where the current situation of MoA-DoPP was mapped, identifying its current mandate and objectives. This study tour helped to prepare the project partners for the inception workshop and facilitate further project planning and project adjustments.

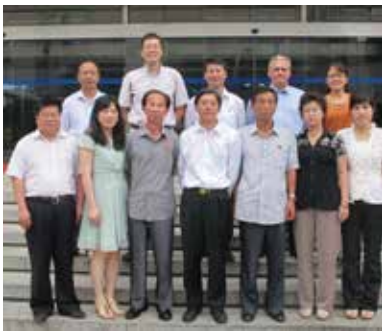
The successful inception workshop took place in Pyongyang on 10–11 July 2013 with five participants from MoA-DoPP, MoA-DoS&TT and MoA's Department of Foreign Affairs (MoA-DoFA). During the workshop, CABI and national partners worked collaboratively to develop the project planning documents (see Highlights p.11).

To facilitate a review and possible adaptation of the objectives and terms of reference of MoA-DoPP, a stakeholder questionnaire was developed in November 2013, in collaboration with MoA-DoPP. This will be used in a stakeholder survey to review stakeholder expectations and needs in early 2014.

To enhance the operational ability of MoA-DoPP the working environment of the department will be improved, and in particular the internal communication infrastructure of MoA will be enhanced to enable more effective interaction; the process of reviewing needs is ongoing. In addition, access to information is being improved through identification and collation of information materials, both hard copy and electronic, for use by MoA-DoPP.

The project will, by optimizing the structure of MoA-DoPP as well as its technical knowledge, management and operational capacities, ensure that it is capable of carrying out its overall function and fulfilling its national and international responsibilities in a more efficient and effective way. This will enable it to better support improved agricultural production, in terms of yield and quality, for the ultimate benefit of the farmers, farming communities and other consumers across DPR Korea.

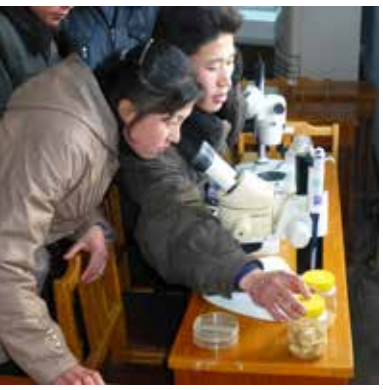
K. Holmes (k.holmes@cabi.org), **M. Bateman**, **Zhang F.**, **Tang R.** and **U. Kuhlmann**, in collaboration with MoA, DPR Korea. Funded by: the EC through DG DEVCO EuropeAid (DCI-FOOD/2012/309-173).



Representatives of the ministries of agriculture for China and DPR Korea after their meeting in Beijing (photo: Tang R.)

Delegates and staff of Wuhan Provincial Plant Protection Station at Hubei, Wuhan Province, China (photo: K. Holmes)

Delegates from MoA, DPR Korea meeting in Beijing with representatives of MoA, China (photo: K. Holmes)



Nematode expert Kang Chung Hyo from AAS-PPI training during a ToT workshop for nematode mass production in Pyongyang in March 2013 (photo: S. Toepfer)

Participants in the ToT for field application of beneficial nematodes assess the viability of nematode infective juveniles before applying them against soil pests at Up cooperative farm in Ongjin, South Hwanghae Province (photo: K. Holmes)

increasing food production in DPR Korea by sustainably reducing the impact of soil-borne insect pests

Soil insect pests are an ongoing threat to agricultural production in DPR Korea. DG DEVCO EuropeAid provides funding for CABI and local partners to implement locally sustainable pest control tools, based on mass rearing and application of beneficial entomopathogenic nematodes (EPNs) against soil pests.

Following the construction of three county and three cooperative farm biocontrol agent mass production facilities in 2012, a Training of Trainers (ToT) on the mass production of beneficial nematodes was carried out in early 2013 at the training facility and the newly established national Experimental Nematode Production Facility of AAS-PPI in Pyongyang. In total, 25 participants from province and county plant protection stations as well as cooperative farms were trained by AAS-PPI and MoA-CPPS experts, CABI and Andermatt Biocontrol AG in the *in-vitro* and *in-vivo* mass production of nematodes. In May 2013 another training course at the Anak County Competence Centre (CCC) focused on in-vivo nematode mass production. A key aim was to ensure the county nematode production staff were able to provide effective training, in view of their future role as master trainers. Similar training in in-vitro and in-vivo nematode mass production took place in September 2013 at Sinwon CCC.

Research field trials at two cooperative farms were carried out by AAS-PPI and MoA-CPPS to assess appropriate application methods and application rates for different species/strains of nematodes against specific soil pests, such as wireworms, cutworm and grubs.

Another ToT workshop took place at Ongjin CCC, and Up cooperative farm in South Hwanghae Province in August 2013 on application methods and decision tools for the effective use of beneficial nematodes in the field by farm staff.

New provincial nematode mass production facilities were established at three provincial plant protection stations and six at county plant protection stations. Some 12.5 tonnes of equipment was transported from China and distributed to the new facility locations for installation in September 2013.

It is envisaged that the beneficial nematodes produced and applied through this project will contribute to a reduction in the volatility in the nation's food production.

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Funded by: the EC through DG DEVCO EuropeAid (DCI-FOOD/2010/231-927).

Participants in a ToT for field application of nematodes assess the feasibility of application methods for beneficial nematodes at Up cooperative farm in Ongjin, South Hwanghae Province (photo: K. Holmes)

steering CABI's flagship programme: Plantwise

Plantwise is a global programme, led by CABI, to increase food security and improve rural livelihoods by reducing crop losses. Working in close partnership with relevant actors, Plantwise strengthens national plant health systems from within, enabling countries to provide farmers with the knowledge they need to lose less and feed more. This is achieved by establishing sustainable networks of local plant clinics, run by trained plant doctors, where farmers can find practical plant health advice. Plant clinics are reinforced by the Plantwise Knowledge Bank, a gateway to online and offline actionable plant health information, including diagnostic resources, pest management advice and front-line pest data for effective global vigilance.

The Plantwise programme was implemented in 31 countries across Africa, Asia, Latin America and the Caribbean in 2013. For each country, there is a dedicated CABI Country Coordinator and who is responsible for the day-to-day management and implementation of the programme activities in the country. The CABI Country Coordinator is supported by additional CABI staff or associates in the region and/or one of the CABI centres in the UK or Switzerland. Further support is provided at the regional level by the relevant Plantwise Regional Team Leader (= Regional/Centre Director) and Plantwise Regional Coordinator.

Plantwise is coordinated globally by the Plantwise Programme Board (PWPB), the members of which are distributed across CABI's centres in Switzerland, the UK, Kenya, Pakistan and India. The Plantwise Programme Executive (Ulrich Kuhlmann) and Plantwise Programme Support Manager (Wade Jenner) are based in the Swiss centre. The PWPB meets quarterly for face-to-face discussions on programme progress (successes and challenges) and ways forward. To help manage the ever-growing programme, two Plantwise Regional Coordinators (one for Africa and one for Asia) were recruited in 2013. These individuals are members of the PWPB and serve as an important conduit for the exchange of information between the PWPB and the regional teams.

As part of steering the programme, PWPB members are engaged in a wide range of activities outside the quarterly meetings, such as developing programme policies, building high-level partnerships, capturing and sharing lessons learned within the programme, promoting Plantwise globally, and strengthening links with donors.

In 2013, seven Plantwise policies were established to ensure that programme activities are implemented in accordance with international standards. The policies cover (i) international transfer of biological specimens for identification, (ii) pest reporting, (iii) use of plant clinic data on pests, (iv) personal data protection, (v) pesticide use, (vi) engaging with agro-input suppliers, and (vii) principles and ethics of fundraising. Plantwise staff in CABI are expected to follow these policies and to encourage programme partners, where relevant, to do the same.

The PWPB has been continuing to actively strengthen linkages with other international organizations throughout the year. For instance, the Pesticide Management Group of the Food and Agriculture Organization of the United Nations (FAO) has been engaged to discuss best practices for pest management. In addition, the Plantwise programme has been a catalyst to stimulate cooperation between CABI and the Secretariat of the International Plant Protection Convention (IPPC) for issues relating to pest monitoring and reporting through national plant protection organizations (NPPOs). CABI hosted a side event at the Eighth Session of the Commission on Phytosanitary Measures (CPM), which is organized by the IPPC Secretariat. The side event was intended to provide information on Plantwise and to gather feedback on how CABI's flagship programme can help to support NPPO activities and the mission of the IPPC. Later in the year, a member of the Plantwise Knowledge Bank development team was seconded to the IPPC Secretariat for two short stays and a joint CABI-IPPC technical working group was established to facilitate collaboration between both parties.

A plant doctor (right) interviews a farmer about a problem on carrot in Kenya (photo: U. Scheidegger, Bern University of Applied Sciences, Switzerland)

Invited speakers Dr Yubak Dhoj, Mr Fabian Mkondo and Dr Ibrahim Shamie at the Plantwise side event during the Eighth Session of the Commission on Phytosanitary Measures (photo: J. Dennis)

The 31 countries, grouped by region, where Plantwise was operating in 2013

CABI Plantwise staff explore and discuss new features of the Plantwise Knowledge Bank (photo: H. Kuhlmann, KCS)

CABI staff and donors discuss the Plantwise programme at the annual Donor Forum meeting (photo: J. Dennis)

In August 2013, an external evaluation of the Plantwise programme was commissioned by one of the programme's key donors, SDC. The evaluation team assessed the central coordination of the programme and the Knowledge Bank, and also visited Kenya, Tanzania and Rwanda to observe implementation on the ground. The overall feedback from the evaluation was that Plantwise is 'a highly relevant, effective, efficient, well-managed programme' and 'a truly global programme which benefits the local farmers'. Some suggestions to further strengthen the programme were also reported. These were shared with all Plantwise staff at the year-end Plantwise implementation team meeting, held in central Switzerland in November, and have been addressed in the 2014 implementation plans.

The PWPB, through the CABI Key Account Managers, maintains strong contact with current and potential Plantwise funding sources. The donors contributing to Plantwise in 2013 included DFID, DG DEVCO EuropeAid, SDC, the International Fund for Agricultural Development (IFAD), Irish Aid, the Australian Centre for International Agricultural Research (ACIAR), the Directorate-General for International Cooperation in the Netherlands (DGIS), the MoA of China, and Hunger Solutions of Dow Agrosciences.

Once each year, the major Plantwise donors convene with a group of PWPB members to assess programme progress and discuss priorities and emerging opportunities. The 2013 Donor Forum meeting was held on 3 October at the CABI office at Leusden in the Netherlands and was attended by five of the key donors (DFID, DG DEVCO EuropeAid, SDC, DGIS and Irish Aid). The feedback provided by the donors at the meeting was, overall, very positive. They were pleased with the results of the external evaluation. One key action agreed upon was that there would be further external evaluations conducted and these should be designed and implemented in a harmonized way to make the results more powerful for a global analysis and allow comparisons between regions and over time. The next external evaluation will take place in Africa in mid-2014, followed by one in Asia in late 2014, and one in Latin America and the Caribbean in early 2015.

Looking ahead, two major questions were posed by the donors to the PWPB at the 2013 Donor Forum meeting: (i) How will CABI's role in Plantwise change when the programme activities in a country move into a more scaled-up scenario? and (ii) What are the short- and long-term goals of the Plantwise Knowledge Bank and how can CABI ensure the sustainability of its service? These and other questions will become focal discussion points for the PWPB in 2014 and beyond as the programme continues to build partnerships and chart its course in diverse countries with equally diverse challenges and opportunities.

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Participants at the year-end Plantwise implementation team meeting at Flüeli-Ranft near Lucerne in Switzerland – a workshop attended by 56 CABI staff from around the world who are involved in implementing the programme (photo: H. Kuhlmann, KCS)

supporting implementation of IPM and rational pesticide use in the Plantwise programme at a national level

In 2013, members of the ICM team supported implementation of the Plantwise programme and the development of the Plantwise policy on pesticide use. Through this policy, the Plantwise programme endeavours to promote sustainable plant health management following the principles of IPM. Plant doctors are advised to recommend only locally registered and available pesticides, and avoid pesticides that are subject to international restrictions.

In 2012, the ICM team developed and piloted a workshop-based training programme to introduce and develop pest management decision guides (PMDGs) with national partners in Plantwise countries. The PMDGs use the 'Green and Yellow List' concept as a way of enabling sustainable pest management strategies to be planned and implemented at plant clinics. These country-specific documents comprise a comprehensive list of locally appropriate preventive and curative control methods for specific pest–crop combinations. They are designed to act as step-by-step tools for formalizing the IPM thought process for managing pests and enabling plant doctors to give IPM-based recommendations to farmers.

In 2013, the ICM team led the roll-out of this workshop on a worldwide scale: Plantwise staff at CABI's centres in the UK and Kenya were introduced to the material in a ToT, and the PWPB agreed that PMDGs would be the primary extension material to support plant doctors giving recommendations. Workshops to develop PMDGs took place in 17 countries, with ten of the workshops facilitated by members of the ICM team. Workshop participants included national experts from the ministries of agriculture with expertise in IPM and pesticide regulation, university and research institute representatives, plant doctors, and other extension representatives. The ICM team carried out a final technical review of each of the lists, and a total of 150 PMDGs have been finalized. These documents address more than 100 pests affecting key crops. The workshops have proven to be a conduit for bringing together plant health experts from various organizations to share their expertise and knowledge. The final outcome is a document that enables plant doctors to give recommendations based on IPM practices and local knowledge, and that helps keep pesticide usage to the lowest effective level to ensure minimal risk to human health and the environment.

At a national level, ICM team members helped the regional teams to carry out Plantwise activities on the ground in ten countries, including China, Honduras, Nicaragua, Sierra Leone, Sri Lanka, Tanzania, Thailand, Zambia, and, on an ad hoc basis, Kenya and Rwanda. These activities included facilitating training workshops for plant doctors and other key national partners on plant clinic operation, pest diagnoses and advice, data management and plant clinic performance monitoring.

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Workshop participants in Kenya (photo: E. Chernoh)

Stefan Toepfer explains differences between maize lethal necrotic disease and maize streak virus in a maize field near Arusha in Tanzania (photo: J. Mwangi, Ministry of Agriculture, Food Security and Cooperatives, Tanzania)

Participants at a workshop in Sri Lanka to develop extension materials following IPM principles (photo: Sri Lankan Plant Protection Service)

Workshop participants discuss the merits of preventive measures for a PMDG (photo: E. Chernoh)

PMB field technicians learning good *Eucalyptus* management practices through field exercises (photo: Y. Colmenarez)

Field technician inspecting and learning about good quality seedlings (photo: F. Rodhe)

Estimating wood quantities in Rio Grande do Sul, Brazil (photo: F. Rodhe)

sustainable forest management for fuelwood production in Brazil

In 2013 CABI started a new collaborative initiative with Philip Morris International (PMI) and Philip Morris Brazil (PMB) in Brazil on sustainable fuelwood and forest management. CABI was specifically asked by PMI to develop the training component for sustainable fuelwood management and reforestation for Philip Morris field technicians.

As a cash crop, tobacco is the major income source for many farmers in southern Brazil. Farmers cure the harvested tobacco leaves before they market them. To cure the leaves they use wood, mainly from exotic tree species, such as *Eucalyptus*, that are produced on-farm or bought from sources in the area. In 2013 PMI started a major initiative to increase the sustainability of fuelwood production for tobacco curing. The aim is to increase the level of self-sufficiency in fuelwood and encourage sustainable reforestation with native and exotic tree species through raising awareness of the potential benefits of on-farm fuelwood production and good management practices as well as the benefits and importance of reforestation and agroforestry systems. With good management practices, wood yield and profitability can be significantly improved, diversifying and increasing the income of the tobacco producers. At the same time, with good agroforestry techniques and management, the environmental sustainability is enhanced, restoring degraded areas and increasing on farm biodiversity.

For the development of the training component, CABI staff based in Switzerland and Brazil have been working in close collaboration with PMI, the International Union for Conservation of Nature (IUCN), Philip Morris Latin America (PM-LA) and PMB as well as with local specialists in forestry. The training course consequently covers a broad range of activities and topics.

Good management practices for different commonly grown tree species such as appropriate soil preparation, planting, pruning, nutrient and pest management together with the economic significance for on-farm fuelwood production for farmers.

The complex Brazilian forest law and the legal requirements regarding planting, cutting and integrating trees on property.

Reforestation for sustainability, agroforestry, using native species, restoration of degraded areas, increased biodiversity and protection of ecologically sensitive areas.

Practical tools and methods for the technicians to transfer the knowledge to tobacco producers.

The training course thus increases knowledge of PMB field technicians in diverse but critical areas, and they are also trained in how to transfer this knowledge in a simple and effective form to the producers.

A first pilot training course was held for technicians from the three tobacco producing states in southern Brazil (Paraná, Santa Catarina and Rio Grande do Sul) and a management group from PMI-LA, PMI headquarters in Switzerland and PMB, IUCN Brazil and the Çarakura Institute at Florianópolis in Santa Catarina. The collaboration will continue in 2014 with the implementation of training for all Philip Morris field technicians in Brazil and the development of information and training materials on sustainable reforestation and fuelwood management for both field technicians and tobacco producers

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Field day with Philip Morris field technicians at Afubra, Rio Grande do Sul, Brazil (photo: A. Brandão, Brazil)

implementation of best management practices and IPM in oriental tobacco in Turkey

In 2013 CABI worked with four oriental tobacco leaf supplier companies in Turkey on a programme that focused on the implementation of best management practices and IPM in the production of oriental tobacco. The overall objective of the programme was to reduce the inappropriate use of crop protection agents (CPAs), while sustaining or improving crop yields and quality. The 2013 programme focused on three key components: agronomy research trials, the establishment of model farms for technology transfer, and training in IPM for the supplier companies' tobacco leaf experts who are responsible for advising farmers. CABI provided support to the leaf suppliers in programme planning, monitoring and implementation, as well as technical expertise.

Twelve model farms were established by the leaf suppliers in the Aegean and Black Sea regions in order to demonstrate the on-farm implementation of IPM and best management practices in the seedbed and field stages. The focus was on reducing inappropriate CPA use through monitoring pest incidence, implementing new technologies that improve production and reduce labour, and increasing yields while maintaining quality. The model farms were monitored and data collected to determine the impact the practices had on yield, quality and cost. Furthermore, model farmers were interviewed to obtain qualitative data and farmer perspectives on the impact of this programme in terms of adoption of new practices and reduction of CPA use.

Agronomy research trials were established at trial farms to study new technologies. One trial focused on the use of carpet seedbed paper for sowing tobacco. This technique has been successfully used in other cropping systems, and tobacco seedbed paper was developed for the trials by a company in Turkey. The trial studied the effect of carpet sowing on tobacco seedling quality and uniformity, seedbed labour and costs, as well as yield and quality compared with low density and high density sowing methods. A second trial was established to determine the effect of topping on yield and quality, and to study its cost–benefit. Topping is a method used in other tobacco producing regions worldwide to prolong growth and increase yields; however it is important to understand the impact it has on the quality of oriental tobacco and whether or not the gains in yield outweigh the additional labour required. CABI provided technical support in experimental design, statistical analysis and reporting.

To increase the knowledge of leaf experts, who provide technical support to farmers, in IPM and non tobacco related material, training was given to more than 160 leaf experts in the Aegean and Black Sea regions. CABI worked with the trainers from leaf supplier companies to develop the curriculum and ensure participatory training methods were used. The training was largely field based and focused on monitoring and identification of key pests, prevention and cultural practices, and safe use of pesticides. Furthermore, CABI supported the revision of 'Green and Yellow Lists' for key pests and the CPA list of registered products. A total of 62,500 copies of each list were printed by the leaf supplier companies and distributed to farmers and leaf experts in Turkey.

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Funded by: the four partner oriental tobacco leaf supplier companies above.

Engin Fidan monitors a CPA calendar with a farmer in the Black Sea region (photo: A. Bora, CABI Associate, Turkey)

Leaf experts learn to identify key pests during a field training exercise (photo: A. Bora, CABI Associate, Turkey)

Model farmers in Sındırgı, Turkey (photo: E. Chernoh)

Tobacco plants in a field trial (photo: E. Fidan, Socotab, Turkey)

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Kenis, M., Péré, C. and Jactel, H. (2013) Will climate change affect parasitism in natural habitats? A meta-analysis of the effect of elevation on parasitism. 4th International Symposium on Biological Control of Arthropods, Pucón, Chile, 4–8 March 2013.

extension material

CABI (2013) La pyrale du buis *Cydalima perspectalis* – une espèce nuisible envahissante en Suisse et dans le Jura.

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about CABI

what does CABI do?

CAB International (CABI – www.cabi.org), originally established in 1910, is a not-for-profit science-based development organization. It operates under an international treaty agreement amongst its, currently 49, member countries, that is registered with the United Nations. It has a Headquarters Agreement with the Government of the UK and operates through a network of centres located around the world. CABI's mission is to improve people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment. CABI has over 400 staff operating from bases in ten countries and working in more than 70. Our activities include:

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We produce key scientific publications including CAB Abstracts, the world-leading database covering agriculture and the environment, and Global Health, the definitive bibliographic database for public health information. We also publish multimedia compendia, books, eBooks and full text electronic resources which support the practical application of the results of research.

international development

Our staff research and find solutions to agricultural and environmental problems. We use science, information and communication tools to help solve issues of global concern. Our work is arranged around four core themes:

Commodities: we work to enable smallholder commodity farmers to compete in global markets. We diagnose and control plant pests and diseases, and help farmers get a better price for their crops. We work on crops such as coffee, cocoa, wheat, rice and cotton.

Invasive Species: we are helping to reduce the spread and impact of invasive weeds such as Japanese knotweed and water hyacinth and insects such as coffee berry borer and cocoa pod borer. We also advise countries at a policy level about agriculture, trade and the environment.

Knowledge for Development: we work with farmers, extension workers, researchers and governments to deliver agricultural knowledge and develop communication strategies and systems. We provide information and support for community-style telecentres, and facilitate the establishment of plant clinics around the world to help farmers identify pests and diseases affecting their crops.

Knowledge Management: we use information and communication technologies to provide farmers, researchers and policy makers with the information they need to make informed decisions and to lift people out of poverty. We produce interactive databases and encyclopaedic compendia that give access to detailed and easy-to-search information on subjects like crop protection and animal health.

For more information about CABI please visit the website **www.cabi.org**

CABI in Switzerland

One of the unique advantages that CABI has in carrying out its mission is its global network of Regional Centres, one of which is in Switzerland, in Delémont, the capital of the Canton Jura. By being present in Switzerland, CABI has been able to develop numerous relationships with national ministries, scientific institutions, universities, development cooperation agencies, and the plant protection industry. These valuable links have all been strengthened further by Switzerland's accession to CABI as a member country in 2000. Close ties are also constantly evolving between CABI and the Canton Jura.

Established in 1948, CABI's centre in Switzerland has for many years been a leading international research-based institution in the management of invasive weeds and insect pests through the promotion of biological control. Biological control is the use of natural enemies (parasitoids, predators and diseases) to control pests, including insects, diseases and weeds. Many of the most damaging of these pests are alien species that have been accidentally introduced through trade and travel. Alien pests often arrive in a new area without their natural enemies, which normally keep them in check in their region of origin. Hence, much of the centre's work has been based on classical biological control, i.e. the control of introduced pests in one area by the introduction of natural enemies from the pest's area of origin. Naturally, this approach depends upon a careful study and evaluation of the risks before any natural enemy can be introduced, and this is a major focus of the centre's work.

Because of the centre's substantial activities in biological control, it is not surprising that its staff play an active role in CABI's contribution to aspects of biological control policy, linking with organizations such as FAO, OECD (Organisation for Economic Co-operation and Development), EPPO (European and Mediterranean Plant Protection Organization), IOBC (International Organization for Biological Control) and national authorities such as FOAG and FOEN, to provide inputs to protocols and guidance documents required for regulation. We also carry out cutting edge research on the development of methods to assess risks associated with potential biological control agents.

The centre's research also contributes to methods to assess the risks and impacts of invasive alien insects. We are developing inventories of invasive alien insects and have contributed to the establishment of a 'Black List' of alien animal species that require particular attention and regulation owing to their current or potential environmental impact. By doing this, the centre contributes to the development of regional and national strategies for prevention and management of invasive species in Europe.

In order to support a better understanding of how biodiversity can be conserved, the centre's research also places emphasis on assessing multi-trophic interactions below- and above-ground, as well as nutrient cycling in the context of biological invasions, land-use change and climate change. In the context of climate change, the centre is studying interactions between global warming and biological invasions, and assessing the possible impacts of climate change on agricultural production and ecosystems through its effect on pests and insect–plant interactions.

A large proportion of the centre's work is less research-based and more focused on providing technical support and facilitating activities to improve agricultural practices in a number of developing, transitional and developed countries around the world. This work is in response to the strong current global movement towards agricultural development and the need to tackle environmental issues, alleviate poverty and enable food security. It also addresses the requirement for farmers around the world to adopt good agricultural practices (GAP) and elevate standards of food production because of market globalization and growing consumer concerns about food safety and environmental health. Our centre's ICM team is therefore conducting a number of consultancy-based projects in which it is promoting the appropriate use of natural resources and supporting the implementation of IPM in order to reduce unnecessary use of pesticides.

CABI staff based in Switzerland annually offer international student placements through which biology and agriculture students receive hands-on training in practical aspects of applied biological control research, working in project teams with high-impact outcomes. There is also a graduate student programme, with links to universities around the world. As a result, this is a truly international centre, normally with staff and students from more than a dozen countries working together each summer.

acronyms

AAFC	Agriculture and Agri-Food Canada
AITI-AAS	Agricultural Information Technology Institute, AAS (DPR Korea)
AAS	Academy of Agricultural Sciences (DPR Korea)
AAS-PPI	Plant Protection Institute, AAS (DPR Korea)
ABS	Agrobusiness School Korçë (Albania)
ACB	Asian corn borer (*Ostrinia furnacalis*)
ACIAR	Australian Centre for International Agricultural Research
AGES	Austrian Agency for Health and Food Safety
ALIEN CHALLENGE	European information system for alien species (COST Action)
APHIS	USDA Animal and Plant Health Inspection Service
ARS	USDA Agricultural Research Service
BBCA	Biotechnology and Biological Control Agency, Rome (Italy)
BLM	USDI Bureau of Land Management
Bt cotton	cotton genetically modified to contain *Bacillus thuringiensis* toxin(s)
CABI-MoA Joint Laboratory	CABI – Chinese Ministry of Agriculture Joint Laboratory of Bio-safety, Beijing
CAAS	Chinese Academy of Agricultural Sciences (part of MoA)
CATT	Centre for Agricultural Technology Transfer (Albania)
CCC	County Competence Centres (DPR Korea)
CFIA	Canadian Food Inspection Agency
COST	European Cooperation in Science and Technology (EU)
CPA	crop protection agent
CPHST	USDA-APHIS Center for Plant Health Science and Technology
CPM	Commission on Phytosanitary Measures
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CTI	Swiss Commission for Technology and Innovation
DFID	Department for International Development (UK)
DPR Korea	Democratic People's Republic of Korea
DG DEVCO	Directorate-General for Development and Cooperation (EC)
DGIS	Directorate General for International Cooperation (the Netherlands)
DR Congo	Democratic Republic of the Congo
DROPSA	Strategies to develop effective, innovative and practical approaches to protect major European fruit crops from pests and pathogens (FP7)
EBCL	USDA-ARS European Biological Control Laboratory
EC	European Commission

ECTS	European Credit Transfer and Accumulation System
ENEA	National Agency for New Technologies, Energy and Sustainable Economic Development (Italy)
EPN	entomopathogenic nematode
EPPO	European and Mediterranean Plant Protection Organization
ERA-ARD	European Research Area – Agricultural Research for Development (FP6)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
Fera	Food and Environment Research Agency (UK)
FOAG	Federal Office for Agriculture (Switzerland)
FOEN	Federal Office for the Environment (Switzerland)
FP6	RTD Sixth Framework Programme (EU)
FP7	RTD Seventh Framework Programme (EU)
FRI	Fondation Rurale Interjurassienne (Switzerland)
ICM	integrated crop management
IFAD	International Fund for Agricultural Development
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias (Mexico)
IOBC	International Organization for Biological Control
IPM	integrated pest management
IPP-CAAS	Institute of Plant Protection, CAAS (China)
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
ISEFOR	Increasing sustainability of European forests: modelling for security against invasive pests and pathogens under climate change (FP7)
JATROPHABILITY	Investigating impacts of *Jatropha curcas* production (ERA-ARD, FP6)
IUCN	International Union for Conservation of Nature
KECCA	Korean–European Cooperation Coordination Agency
Lao PDR	Lao People's Democratic Republic
LfL	Bayerische Landesanstalt für Landwirtschaft (Germany)
LIG	local implementation group
MAS	Master of Advanced Studies
MoA	Ministry of Agriculture (China or DPR Korea depending on context)
MoA-CPPS	Central Plant Protection Station, MoA (DPR Korea)
MoA-DoFA	Department of Foreign Affairs, MoA (DPR Korea)
MoA-DoPP	Department of Plant Protection, MoA (DPR Korea)
MoA-DoS&TT	Department of Science and Technology Transfer, MoA (DPR Korea)
MoAI	Ministry of Agriculture and Irrigation (Myanmar)
MoA-PPQD-CN	Plant Protection and Quarantine Division, MoA (China)

NCCR	National Centres of Competence in Research (Switzerland)
NGO	non-governmental organization
NPPO	national plant protection organization
NPARL	USDA-ARS Northern Plains Agricultural Research Laboratory
OECD	Organisation for Economic Co-operation and Development
PAU	Pyongyang Agricultural University of Kim Il Sung University (DPR Korea)
PBL	problem-based learning
PERMIT	Pathway evaluation and pest risk management in transport (COST Action)
PMB	Philip Morris Brazil
PMDG	pest management decision guide
PMI	Philip Morris International
PM-LA	Philip Morris Latin America
pPPS-CN	Provincial Plant Protection Station (China)
PPW	perennial pepperweed, *Lepidium latifolium*
PRA	participatory rural appraisal
PROteINSECT	Enabling the exploitation of insects as a sustainable source of protein for animal feed and human nutrition (FP7)
PWPB	Plantwise Programme Board
RTD	EU Research, Technological development and Demonstration (Framework Programmes)
SAG	Servicio Agrícola y Ganadero (Chile)
SCOPES	Scientific Co-operation between Eastern Europe and Switzerland
SDC	Swiss Agency for Development and Cooperation
SER	Swiss Department for Education and Science
SMAGE	Syndicat Mixte d'Aménagement et de Gestion Equilibrée (France)
SMARTER	Sustainable management of *Ambrosia artemisiifolia* in Europe (COST Action)
SNSF	Swiss National Science Foundation
TAG	USDA-APHIS Technical Advisory Group
TBCC	Tianyi Biological Control Company Ltd (China)
T&E	threatened or endangered [species]
ToT	Training of Trainers
UNESP	Universidade Estadual Paulista Júlio de Mesquita Filho (Brazil)
USDA	US Department of Agriculture
USDI	US Department of the Interior
ZEPP	Central Authority of the Länder for Computerized Decision Support Systems and Programs in Plant Protection, Bad Kreuznach (Germany)

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