CABI Annual Report Switzerland 2012

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

This annual report was prepared by the staff of CABI's centre in Switzerland and covers activities in 2012. Images are attributed to the photographers as far as is known and are by CABI staff unless specified.

Front cover photo – Alicia Leroux looking at damage by the fly *Euphranta connexa*, a potential biological control agent of swallow-wort, an invasive plant in North America (photo: A. Gassmann)

Inside front cover photo – Tim Haye collecting eggs of the brown marmorated stinkbug, *Halyomorpha halys*, in the Fragrant hills park, Beijing, China (photo: Zhang J.)

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preface

It was a great honour to write the preface for the 2012 Centre Annual Report for CABI in Switzerland. It was particularly timely as this year was a very special one for China-CABI relations with Ulrich Kuhlmann receiving the Chinese government's Friendship Award in September. This was not only a great honour for himself but also demonstrated significant recognition of the ever-strengthening China-CABI partnership. The Chinese Academy of Agricultural Sciences has been working together with CABI for over 30 years and during this time we have been jointly developing and implementing many fruitful projects in the field of sustainable agriculture. CABI is highly recognised in China for the support it has provided over the decades. Major milestones in the continually strengthening CABI-China collaboration have included the opening of the CAAS-CABI project office in 2002 and the establishment of the MoA-CABI Joint Laboratory for Bio-safety at the Institute of Plant Protection-CAAS, of which I and Ulrich Kuhlmann are Co-Directors, in 2008. Since its inauguration, the Joint Laboratory has been enabling Chinese scientists, together with CABI scientists from the Switzerland and UK centres, to work on a wide variety of successful research and international development projects on the prevention and management of invasive alien species, integrated pest management and bio-safety assessment of genetically modified organisms. For example, through the Joint Laboratory, we have developed alternatives to the chemical control of *Apolygus lucorum*, a major pest of cotton on China that can cause yield losses of 20-30%. Significant progress has also been made on biological control of several invasive species, such as the box tree caterpillar, the brown marmorated stink bug and Canada thistle. Every year, the Joint Laboratory has been proud to host CABI scientists from the Switzerland and UK centres to work together with Chinese scientists on research and training activities. Several Chinese junior scientists have also benefitted from visits to CABI in Switzerland where they have improved their capability on agricultural research through valuable hands on experience and professional training by scientists at CABI.

As testament to the strong partnership between China and CABI, in 2011, CAAS was very pleased to have been awarded for the first time a significant grant from DG DEVCO EuropeAid to implement a 5-year project in partnership with CABI on rice IPM in Greater Mekong Subregion. This was closely followed by another grant in 2012 for a 3-year project on maize IPM, also in the Greater Mekong Subregion. Both of these projects are being operated out of the Joint Laboratory in close collaboration with CABI staff from the Switzerland and China centres. Chinese partners are also going to work together with CABI on a new EU-funded project, PROteINSECT, investigating how flies can contribute to the growing demand for protein in animal feed, which will start in 2013.

I feel extremely close to the CABI centre in Switzerland having visited it on several occasions. The last of these visits was in February of 2012 for the Steering Committee of the Joint Laboratory. During this visit I was, as always, deeply impressed with the professionalism and dedication of the staff there. It is an honour for my organisation to be working in close collaboration with such a team of highly qualified and enthusiastic scientists.

Finally, I would like to say that the partnership between China and CABI could not have developed to be so productive and successful without the keen involvement of great number of dedicated people. I am looking forward to see how the relationship grows and strengthens even further over the next years through both the implementation of on-going research and international development projects as well as the further development of joint project opportunities.

Professor Wu Kongming
Vice President, Chinese Academy of Agricultural Sciences

introduction

It has been a varied and productive year, with much to show for the continued enthusiasm and efforts of the centre's staff. The income to the centre has continued to grow this year, reflecting our strength in both obtaining and implementing research and development projects. We have thus been able to reinvest in the building again, including the refurbishment of two offices as well as initial work to improve the outdoor communal dining area next to the kitchen. We have also had the opportunity to install a videoconferencing facility at the centre, which will not only enhance our capacity to communicate with partners and colleagues around the world but will also potentially reduce the amount of travel, and associated time and costs, required of our staff.

This year brought success in obtaining two new major projects for the centre. Firstly, we won a grant from the European Union for the PROteINSECT project in which CABI, together with 12 other partners from Europe, China and West Africa, will assess the feasibility of the use of maggots and maggot-derived proteins in animal feed. Secondly, we were awarded another DG DEVCO EuropeAid Partnership Project to support the Democratic People's Republic of Korea's recently established Department of Plant Protection within the Ministry of Agriculture and help to advance plant protection capacity within the country. Both of these projects will commence in 2013 with Marc Kenis and Keith Holmes as the respective project managers. A major EuropeAid-funded maize integrated pest management project that we obtained in 2011 got underway this year. This three-year project is being implemented in Lao People's Democratic Republic, Myanmar and south-western China to promote the establishment of mass-production facilities for a *Trichogramma* biological control agent in 21 villages across the three countries.

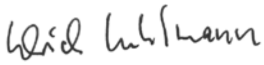
Our research programmes at the centre also continue to thrive, with new projects being obtained in 2012 for work on the invasive weeds tutsan (*Hypericum androsaemum*), funded by Landcare Research New Zealand, and *Fallopia*, supported by the Swiss Federal Office for the Environment. As in previous years, the centre also generated an impressive publication output. Our staff and students authored or co-authored a total of 27 peer-reviewed publications in 2012 – over a quarter of the total number of peer-reviewed publications generated by CABI worldwide. I am very proud of this achievement and it reflects the importance of our centre's expertise in applied research.

We have had a few additions to our staff this year. In view of the increasing project work being undertaken by the Integrated Crop Management team, I was pleased to welcome on board three new members to the group. Melanie Bateman, Erica Chernoh (both from the USA) and Frida Rodhe (from Sweden) all bring with them a significant amount of experience that will strengthen the capacity of the team to carry out project work in the area of plant health and sustainable agriculture. All three have already contributed significantly to the implementation of ongoing projects and have been instrumental in developing and implementing a training course on pest management decision guides.

I am very pleased to report on important progress made this year in further developing the partnership between CABI, the University of Neuchâtel and the Canton Jura. Under this partnership, it has been agreed that the Canton Jura will support a variety of teaching and research activities that will take place at the University of Neuchâtel and in the Canton Jura to promote sustainable agriculture. Under this partnership, several students from the University of Neuchâtel have already successfully completed a research programme at CABI in 2012, and in 2013 work will commence on an exciting new initiative to develop a Master of Advanced Studies course in integrated crop management. This postgraduate programme, to be implemented from 2014 onwards, will be developed by staff at our centre and directed by Professor Ted Turlings from the University of Neuchâtel. It is anticipated that it will be aimed primarily at international students and will comprise both taught and research components that will be led by CABI staff and invited experts.

Finally, on a personal note, I was deeply honoured this year to be recognized by the Chinese Government for my involvement in building cooperation between CABI and China in the area of sustainable agriculture. In September I was awarded the 'Friendship Award', the highest honour awarded by the Chinese Government to foreign experts. Even though this award was presented to me as an individual, I am keen to emphasise that I view it as more of a recognition of the strong and trusting partnership that has been developing over the last ten years between CABI, the Chinese Ministry of Agriculture (MoA) and the Chinese Academy of Agricultural Sciences. This partnership was instrumental in the establishment of the MoA-CABI Joint Laboratory for Bio-safety in 2008, and has enabled its successful operation since then. I am looking forward to seeing how the Friendship Award benefits the Joint Lab and the CABI–China partnership as a whole.

I hope you enjoy reading about the progress and achievements of the centre in 2012. I am, as always, very grateful to the centre's staff for their dedication and hard work and I am looking forward to another interesting and rewarding year ahead.



Dr Ulli Kuhlmann
Regional Director

project highlights

a new weed project for New Zealand

Tutsan, *Hypericum androsaemum*, is an evergreen or semi-evergreen shrub of European origin, which has become a common weed in higher rainfall areas in New Zealand. Tutsan is shade tolerant, unpalatable to livestock and tends to infest areas in which mechanical and/or chemical control options are impractical. In 2009, a report prepared by Landcare Research New Zealand Ltd for the Tutsan Action Group revealed few arthropod and fungal pathogens in tutsan's native range, most with too broad a host range to be considered for biological control. 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's centre in Switzerland was asked by Landcare Research to conduct field surveys in the area of origin of tutsan with the main objectives of collecting leaf and rust samples from tutsan for molecular analyses and surveying tutsan for phytophagous arthropods and fungal pathogens, and then evaluate their potential as biological control agents. In spring 2012, MSc student Elena Olsen was engaged for the project and work commenced. During several field trips to the UK, Ireland, France and Spain, 68 tutsan sites were found and samples taken; insects and fungal pathogens found will be sent in for identification. (See p. 40).

Tutsan, *Hypericum androsaemum*, during a survey in the UK (photo: H.L. Hinz)

Five nymph instars and adult of the knotweed psyllid, *Aphalara itadori* (photo: G. Cortat)

research on the Japanese knotweed psyllid in Switzerland

Japanese knotweed, *Fallopia japonica*, a perennial in the family *Polygonaceae*, is considered to be one of the worst plant invaders in Europe and temperate North America. In 2010, after many years of pre-release studies conducted by CABI's centre in the UK, the psyllid *Aphalara itadori* was released as a biological control agent against this weed in the UK. If *A. itadori* proves to be able to weaken the vigorous growth of Japanese knotweed there, it is likely that other European countries will follow suit and contemplate the release of this biological control agent.

In June 2012, the Swiss Federal Office for the Environment (FOEN) approved a two-year project, proposed by CABI's Swiss centre, that aims to assess the risks of a deliberate or accidental introduction of *A. itadori* into Switzerland. The main goal of the project is to conduct additional host-specificity studies testing (i) plant species in the family Polygonaceae that are native to Switzerland and that have not been tested so far, and (ii) a variety of genotypes of the hybrid *Fallopia* × *bohemica*, which is at least as aggressive an invader in central and eastern Europe as *F. japonica*. An additional project goal is to launch a public discussion on the risks and benefits of implementing classical biological control against Japanese knotweed or other invasive plants in Switzerland.

PROteINSECT: using flies for animal nutrition

In 2012, CABI and 12 other partners from Europe, China and West Africa won a €3 million grant from the European Union (EU) to assess the feasibility of using maggots and maggot-derived proteins in animal feed, focusing particularly on fish, poultry and pigs. CABI scientists in Switzerland and China will be mainly involved in the development of rearing methods for various fly species. The project includes evaluation of quality and safety along the food chain and examination of the use of waste streams for insect rearing. The project's final goal is economic viability, i.e. optimized and sustainable production systems of flies for adoption in Asian, African and European countries. The project will start in early 2013 and last three years.

Ghislaine Cortat checking a Japanese knotweed plant for immature stages of the psyllid (photo: C. Closca)

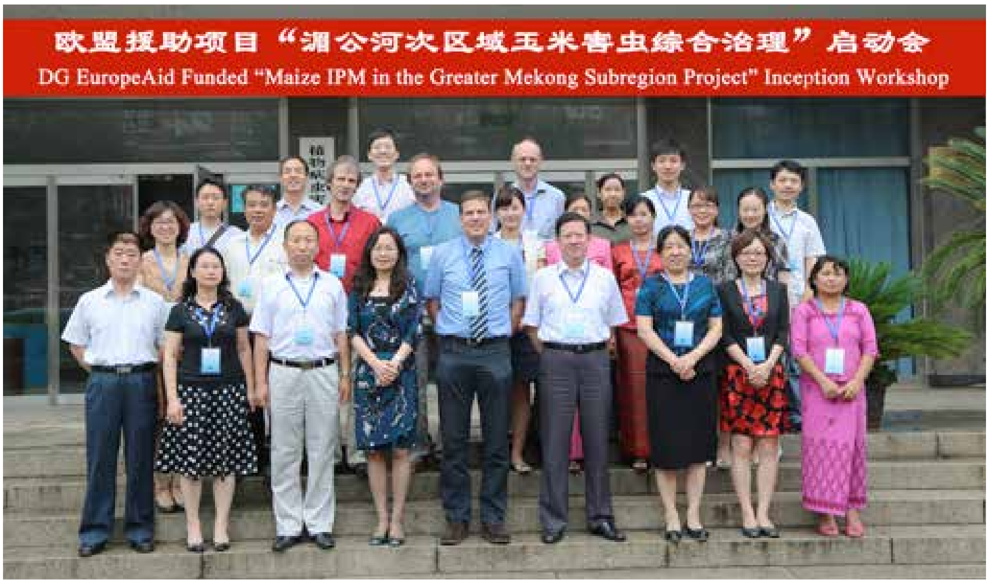
inception workshop for an IPM project in the Greater Mekong Subregion

A five-day inception workshop was held on 26–30 June in Beijing to kick off the Directorate-General for Development and Cooperation (DG DEVCO) EuropeAid-funded project 'Intra-regional transfer of biologically-based plant protection technology to improve livelihoods of smallholder maize farmers in the Greater Mekong Subregion.'

This is a three-year project (April 2011 – March 2015), being implemented in three countries: Lao People's Democratic Republic (Lao PDR), Myanmar and south-western China. The project will promote the establishment of *Trichogramma* mass-production facilities in 21 villages in the three countries. Around this technical component, capacity building for extension and production personnel, nurturing and empowering of grassroots organizations and developing market linkages will be in the focus of activities.

The workshop was hosted by the Institute of Plant Protection of the Chinese Academy of Agricultural Sciences (IPP-CAAS), the project applicant, and invited delegations from the Plant Protection and Quarantine Station in Yunnan, China, the Plant Protection Centre in Vientiane, Lao PDR, and the Plant Protection Division in Yangon, Myanmar, to engage in project planning processes to guarantee smooth project implementation. Representatives from the Delegation of the EU to China and Mongolia were present as well as technical experts from a biological control company, Tianyi Biological Control Company Ltd (TBCC) based in Hengshui, China, which will provide technical support and training during the project implementation in its role as a project associate.

Through the participatory planning approach, partners' and associates' perceptions of project details became reflected in the jointly developed project documentation. Activities were regionally synchronized for the project year. Workshop participants also gained valuable experience in management and planning as well as the opportunity for intra-regional networking and knowledge sharing. The capacity and information acquired will be useful not only during the project period but also in future activities carried out by the partner institutions.



Participants at the inception workshop for the DG DEVCO EuropeAid-funded maize IPM project in the Greater Mekong Subregion (photo: IPP-CAAS)

Mr Chae Gwang (left), Director of MoA-DoPP and Mr Ri Chol Hun of the International Cooperation Office (MoA) (photo: M. Grossrieder)

supporting plant protection in DPR Korea through partnership with the Ministry of Agriculture

In recognition of the strong and productive relationship between CABI and the Ministry of Agriculture (MoA) in the Democratic People's Republic of Korea (DPR Korea) DG DEVCO EuropeAid awarded the partners a new Partnership Project in December 2012. This three-year project entitled 'Building plant protection capacity for improved food security in DPR Korea' will commence in April 2013.

The MoA will be represented in the project by the recently established Department of Plant Protection (MoA-DoPP). CABI, through its previous project activities and support to crop protection had been instrumental in raising the profile of plant protection in DPR Korea and will continue to do so via this new project. This development in the MoA is considered a major advancement for the cause of plant protection in DPR Korea and further strengthens the relationship between CABI and DPR Korea as a member country.

The project aims to support improvement of 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. This will be achieved through a range of activities, including participation in international study tours, technical training workshops and optimization of the department's operational and management infrastructure. These activities will draw on the knowledge and experience of the Chinese MoA, represented by their Plant Protection and Quarantine Division, and other international organizations such as IPPC (International Plant Protection Convention).

It is expected that by the end of the project MoA-DoPP will be in a stronger position to establish and improve national approaches to plant protection and food production.

Equipment in the warehouse waiting to be loaded in Beijing (photo: Li H.M.)

7.5 tonnes of equipment for biocontrol agent production facilities delivered to Pyongyang

Equipment for seven biological control agent mass-production facilities was shipped to DPR Korea as part of the DG DEVCO EuropeAid project 'Sustainable reduction of crop yield losses through on-farm availability of biological plant protection agents against soil-borne insect pests for strengthened food security in DPR Korea' (DCI-FOOD/2010/231-927). The shipment, organized by Li Hongmei at the CABI office in China and Stefan Toepfer and Keith Holmes at its centre in Switzerland, began its journey by road from Beijing to Dandong, on the China – DPR Korea border, on the back of two 12-metre-long trucks. It had to wait outside Dandong railway station until floodwaters from recent heavy rains subsided and the rail yard could be reached. Once there, it was transferred to a railway container wagon and sent on via Sinuiju to Pyongyang railway station where, despite delays caused by the passage of Typhoon Bolaven (aka 'number 15'), it finally arrived on 29 August 2012, two weeks after leaving Beijing. Wagon number P63-101241 contained 427 boxes with a total weight of 7650 kg, including equipment and tools to mass produce entomopathogenic (insect-killing) nematodes. This equipment was distributed, with support from Mr Pak Song Gun of the Central Plant Protection Station (CPPS) of the MoA in DPR Korea, to the county plant protection stations and co-operative farms, where mass-production facilities are being established as part of the ongoing project to provide nematodes as biological control agents against soil-borne insect pests, a major cause of crop loss for farmers in DPR Korea. It is expected that the use of the nematodes will in the future contribute to improved food security in DPR Korea.

Equipment waiting to be loaded in Beijing, China (left); container wagon arrives in the rail yard in Pyongyang, DPR Korea (right) (photos: Li H.M. and Pak S.G., CPPS-MoA, DPR Korea)

developing decision guides to improve plant clinic advice

As a component of CABI's global Plantwise programme, funded by multiple international donors, the Integrated Crop Management (ICM) team developed a workshop-based training programme to introduce and develop pest management decision guides with national partners in Plantwise target countries. The training workshops were piloted by CABI staff based in Switzerland along with regional team members and were held in Bolivia, Cambodia, Honduras, Nicaragua, Peru, Sierra Leone and Tanzania. Workshop participants included national experts from the ministries of agriculture with expertise in integrated pest management (IPM) and pesticide regulation, university and research institute representatives, plant doctors, and other extension representatives.

The pest management decision guides uses 'Green and Yellow List' concept as a way of enabling sustainable pest management strategies to be planned and implemented. These country-specific documents comprise a comprehensive list of locally relevant preventive and curative control methods for specific pest–crop combinations. They are designed to act as step-by-step tools for formalising the IPM thought process for managing pests.

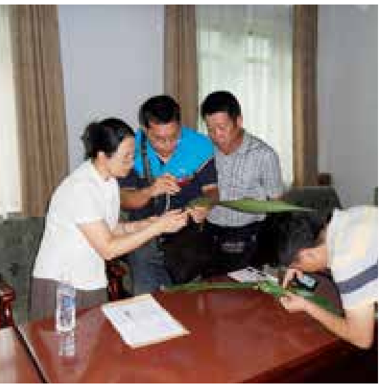
The workshops use a participatory approach to develop decision guides that help plant doctors give farmers sustainable plant health management advice following the principles of IPM, as stated in the Plantwise policy statement on the use of pesticides. Under this policy, plant doctors are advised to recommend only locally-registered and available pesticides, and avoid pesticides that are subject to international restrictions.

Through the workshops, the technical experts in the seven countries developed 144 pest management decision guides to address more than 50 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 keeps pesticide usage to the lowest effective level and ensures minimal risk to human health and the environment.

A participant presents a draft pest management decision guide in Nicaragua (photo: M. Bateman)

Tanzanian participants prepare pest management decision guides for distribution to plant clinics (photo: M. Bateman)

A group of agricultural experts from government and research institutions participating in the workshop to develop pest management decision guides in Dar es Salaam, Tanzania (photo: M. Bateman)



Participants study *Trichogramma* infested egg masses of Asian corn borer at the Academy of Agricultural Sciences (AAS) (photo: K. Holmes)

raising awareness in China and DPR Korea

As part of the DG DEVCO EuropeAid-funded project 'Intra-regional transfer of biologically-based plant protection technology to improve livelihoods of smallholder maize farmers in the Greater Mekong Subregion' (DCI-ASIE/2011/261-127), an awareness creation study tour was organized by IPP-CAAS, China, in collaboration with CABI in Switzerland. The study tour took place between 17 and 25 August 2012 in China and DPR Korea. Participants included representatives of technical advisors and farmers from the target regions in Lao PDR and Yunnan Province, China.

The aim of the tour was to provide an overview of the production system for *Trichogramma* (a beneficial, natural enemy of the Asian corn borer, *Ostrinia furnacalis*), and how it could be adapted from a high-technology approach to a low-level locally adapted system. To facilitate this, the group first visited the state-of-the-art facilities in China at Tianyi Biological Control Company (TBCC) in Hengshui. To provide a contrast and to illustrate how *Trichogramma* production could be adapted to suit local conditions the group then travelled to DPR Korea. A study tour to DPR Korea is considered highly unusual, and organizing it was an achievement in its own right. In DPR Korea the group first visited the Plant Protection Institute of the Academy of Agricultural Sciences (PPI-AAS) for a detailed introduction to the process by which the Chinese production system was adapted to one more appropriate to the conditions within DPR Korea. The group then visited the production facility where they were shown at first hand the production process and the adaptations to equipment and materials. A visit to CPPS-MoA provided an insight into the development of design and production for locally adapted equipment including a visit to the CPPS-MoA workshop. To reinforce the concept of adaptation and to illustrate how this can lead to a functioning production facility a visit was made to Anak County Plant Protection Station *Trichogramma* Production Facility where the group were shown further adaptations to the production equipment, which had been developed by the local technicians. At the end of the awareness creation tour the participants from Lao PDR and China were satisfied that they now had an excellent understanding of the *Trichogramma* production process and had many useful ideas on how they could adapt it to their own local conditions.

Tour participants examine a maize field in Anak County, DPR Korea, where *Trichogramma* has been released (photo: K. Holmes)

IPM maize awareness creation tour participants and staff of the Anak County Plant Protection Station *Trichogramma* Production Facility in DPR Korea (photo: Bai S., IPP-CAAS, China)

the ICM team expands

The ICM team grew in 2012, with three new members coming on board to help implement the increasing number of projects being managed by the group: Melanie Bateman and Erica Chernoh (both from the USA) and Frida Rodhe (from Sweden).

Erica has over ten years of experience working in sustainable agriculture and the organic farming industry in project management, extension, certification, farm management and research positions. She has worked in Guatemala, China, the Philippines, Italy, Turkey and Mexico. Frida has an academic background in environmental science, agricultural development and tropical agronomy, and she has experience from working on projects in Africa, Asia, Latin America and Europe. Her particular focus and field of interest is the environmental and social sustainability of the projects implemented by CABI. Melanie is trained as an entomologist, and over the course of her career has carried out studies and supported capacity building activities for plant health in more than 20 countries in Africa, Asia, central Asia, central Europe, Latin America and the Middle East. Through previous work with the International Plant Protection Convention (IPPC) Secretariat, she also has experience supporting international cooperation to limit the spread and impact of plant pests.

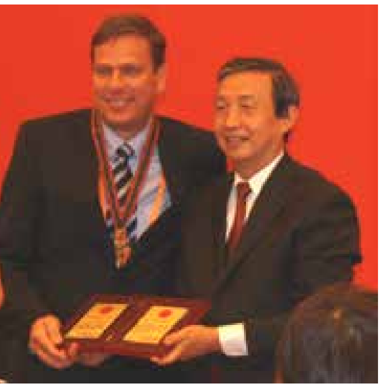
As ICM advisors, the new team members work directly with farmers, extension workers, researchers, government representatives and other plant protection stakeholders to develop and implement sustainable solutions to agricultural problems. This involves developing frameworks for the implementation of ICM, production guidelines, curricula for farmer training programmes using participatory approaches, locally adapted strategies for capacity building and technology/knowledge transfer and soil management practices.

Erica Chernoh
(photo: G. Grosskopf-Lachat)

Frida Rodhe (photo: E. Gerber)

Melanie Bateman (photo: E. Gerber)

chinese friendship award for Ulrich Kuhlmann



Ulli Kuhlmann receives the Chinese Friendship Award (photo: H. Kuhlmann, Delémont)

Ulrich Kuhlmann was honoured with the Chinese government's Friendship Award for his many years of dedication to fostering cooperation between CABI and China in the area of the sustainable agriculture.

The Friendship Award, set up in 1991, is the highest honour awarded to foreign experts who contribute to the economic, scientific and social development of China. On Friday 28 September 2012 in Beijing, State Councillor Ma Kai presented the award, consisting of a medal and a plaque, to 50 foreign experts, representing 22 countries, including Ulli, one of three award winners based in Switzerland. Together with the other award winners, Ulli also met the Premier of the State Council of the People's Republic of China, H.E. Wen Jiabao on Saturday 29 September in the Great Hall of the People. After this reception, Wen Jiabao invited the experts and their families to attend a state banquet to mark the 63rd anniversary of the foundation of the People's Republic of China. Ulli received the award in recognition of his contributions to agriculture in China, particularly in the establishment and successful operation of a joint research laboratory by MoA and CABI, located in IPP-CAAS.

Dr Ulrich Kuhlmann says:

> *'I feel extremely honoured to have received this prestigious award from the Chinese Government. However, I see this award more as a recognition of an entire team. It demonstrates to me that CABI has a tremendous amount of support within MoA and CAAS and therefore it is an appreciation of the entire partnership between CABI, MoA and CAAS. The Joint MoA-CABI Laboratory will benefit from this award which in turn will help to further strengthen the CABI–China collaboration.'*

Official group photo with Chinese Premier of the State Council, H.E. Wen Jiabao, and the Friendship Award winners. Ulli Kuhlmann and his wife Heike are in the centre of the fourth row (photo: Government of P.R. China)

Stefan Toepfer receives adjunct professorship at the Agricultural University of Gödöllő in Hungary

Stefan Toepfer was appointed as adjunct professor at the Agricultural University in Gödöllő in June 2012. CABI in Switzerland has a more than ten-year history of collaboration with the Plant Protection Institute of the university, namely with the team of Prof. Jozsef Kiss. Several joint projects have been implemented for the management of invasive alien species in central and eastern Europe, such as the western corn rootworm in maize production. Stefan Toepfer has for several years been co-supervising joint BSc, MSc and PhD students from the University of Gödöllő. The title of adjunct professor confers membership of the PhD school of the university and allows the supervision of PhD students as main supervisor. Most joint research work with the University of Gödöllő is conducted at CABI's laboratory at the Plant Protection Service in Hodmezovasarhely in southern Hungary. CABI and the University of Gödöllő hope to further strengthen their collaboration in the management of pests and diseases.

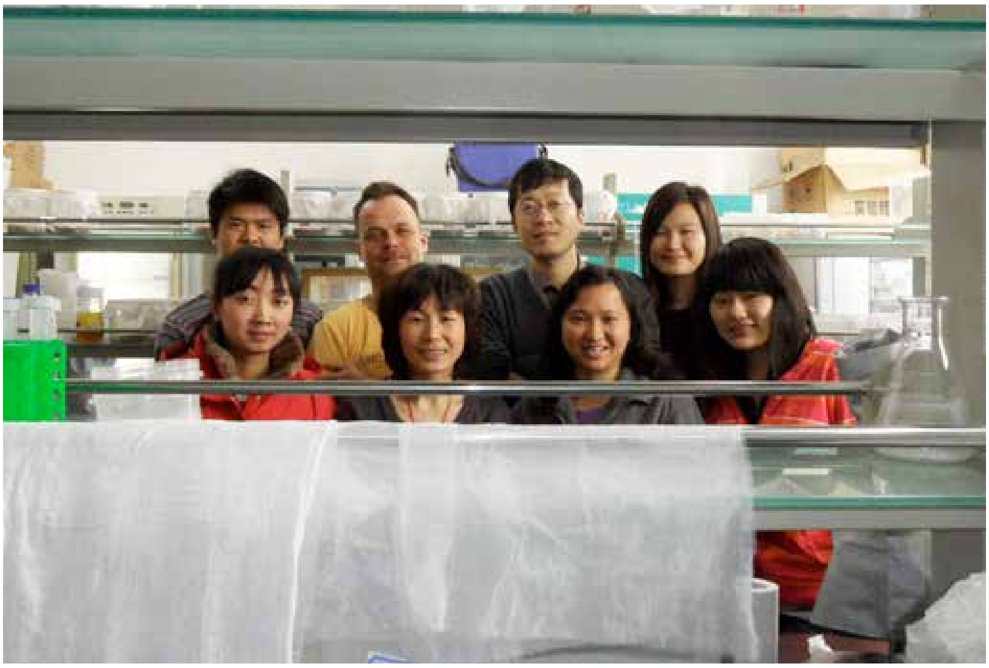
Mark Szalai (left), a PhD student jointly supervised by Prof. Jozsef Kiss and Stefan Toepfer, successfully completed his PhD in December 2012; in the middle: summer student Ferenc Koncz (photo: S. Toepfer)

Stefan Toepfer from CABI in Switzerland receives the title of adjunct professor from the Agricultural University of Gödöllö in Hungary in June 2012 (photo: I. Toepfer, Hungary)

Prof. Jozsef Kiss, Plant Protection Department, University of Gödöllő, Hungary, has been collaborating with CABI for more than ten years (photo: J. Komaromi, University of Gödöllő)

Stefan Toepfer seconded for six months to CABI in China

Stefan Toepfer was seconded, accompanied by his family, to the MoA-CABI Joint Laboratory for Bio-safety at IPP-CAAS in Beijing between January and June 2012. Stefan joined the research team of the Joint Laboratory, but was also frequently in contact and collaboration with the staff of the CABI office at the CAAS campus in the centre of Beijing. Stefan had a chance to follow up with Li Hongmei (MoA-CABI Joint Laboratory) on a French-led research project on the basic ecology and population genetics of biological invasions based on intentional and unintentional insect introductions. He also had the opportunity to gain insights into several ongoing research projects at the Joint Laboratory, including: Luo Shuping's work on the biological control of herbivores in cotton and Chinese dates (a project with Prof. Wu Kongming of IPP-CAAS and CABI's Tim Haye in Switzerland); the work of Wan Huanhuan on fungal biological control agents of Canada thistle (a project with Prof. Chen Wanquan and Dr Liu Taiguo of IPP-CAAS, and CABI's Harry Evans and Carol Ellison based in the UK, and Hariet L. Hinz in Switzerland); and the work of Li Hongmei and Wan Huanhuan on the biological control of the box tree caterpillar (a project with Prof. Wan Fanghao of IPP-CAAS, and CABI's Tim Haye and Marc Kenis in Switzerland). The secondment was partly funded by the CABI bursary as well as by a short-term international short visit from the Swiss National Science Foundation (SNSF).



Stefan Toepfer from CABI with scientists and summer students at the Joint Laboratory for Bio-safety, IIP-CAAS, in Beijing (photo: IPP-CAAS)

CABI hosts visiting scientist Luo Shuping and Wan Huanhuan

Luo Shuping from the MoA-CABI Joint Laboratory for Bio-safety in Beijing visited CABI in Switzerland from 30 July to 14 August 2012 to receive training in rearing techniques for mirid bugs and their parasitoids and identification of *Lygus* parasitoids. In addition, she joined field surveys in the German Rhine Valley to collect European *Lygus* parasitoids for importation into China. Her work supports the CABI and MoA collaborative biological control programme against mirid pests in Chinese cotton.

Wan Huanhuan, also from the Joint Laboratory, visited the centre in Switzerland from 12 to 27 May 2012 to receive training in arthropod and weed biological control. Since Huanhuan is involved in our work on biological control of the box tree moth, whose home range includes China, he joined the Arthropod Biological Control team to help with field surveys in Germany and Switzerland to identify parasitoids attacking the invasive pest in Europe. Huanhuan is also involved in a joint project between our Swiss and UK centres and the Joint Laboratory to investigate the potential for classical biological control of Canada thistle using pathogens (see p. 32). During his visit, Huanhuan gained insights into conducting weed biological control projects, especially host-specificity testing methods, test plant selection and insect rearing.

Visiting scientist Luo Shuping (photo: T. Haye)

retirement reception for Prof. Neil Holliday: over 15 years of fruitful collaboration

A retirement reception to honour Prof. Neil Holliday's contributions to the collaboration between CABI and Canada in the field of classical biological control of arthropods and weeds over the last 15 years was organized on 12 September 2012. Prof. Holliday, from the Department of Entomology, University of Manitoba, Canada, supervised a number of Canadian MSc and PhD students who came to CABI during the summer months to conduct field work as part of their research. Alicia Leroux has started a Master's degree on the biology and host range of the seed-feeding fly, a potential biological control agent for swallow-worts. Lars Andreassen, Kim Riley and Hemachandra K.S. investigated parasitoids of the *Delia* root maggot, while Heather White and Nicole Lauro studied parasitoids of *Lygus* plant bugs.

Visiting scientist Wan Huanhuan (photo: T. Haye)

Ulli Kuhlmann thanks Prof. Neil Holliday (left) for over 15 years of dedicated collaboration (photo: W. Jenner)

Students of the University of Neuchâtel setting up an experiment (photo: H.L. Hinz)

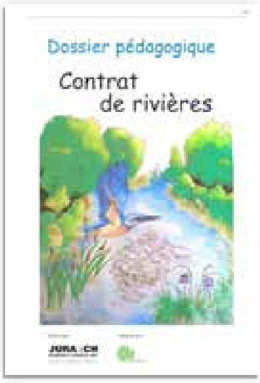
tripartite collaboration between CABI, the University of Neuchâtel and the Canton Jura

Several meetings were held in 2012 to lay the foundations for a partnership agreement between CABI, the University of Neuchâtel and the Canton Jura. The aim of this partnership is to promote sustainable agriculture through research and teaching activities at the University of Neuchâtel and in the Canton Jura. The Canton Jura is providing a total of CHF 300,000 over two years from 2013 to support this initiative.

A major component of the agreement established between CABI, the University of Neuchâtel and the Canton Jura is the development of a Master of Advanced Studies (MAS) course in ICM to be implemented from 2014 onwards. This postgraduate programme will be developed and organized in 2013 by CABI in Switzerland and directed by Prof. Ted Turlings from the University of Neuchâtel. It is anticipated that the MAS will be aimed primarily at international students and will comprise graduate courses, led by CABI staff and invited experts, as well as a research component. 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).

Under the research component, two PhD students will be hired to carry out projects in the field of sustainable agriculture. The students will be based at Delémont and will commence their research in early 2013.

In 2012 CABI, for the first time, became a host institute to bachelor's students taking a problem-based learning (PBL) course at the University of Neuchâtel. Five students spent almost three weeks at CABI (24 February – 16 March) working on the PLB project 'Risk assessment of weed biological control agents: *Ceutorhynchus cardariae* against whitetops'. Very positive feedback was received from these students, particularly regarding the preparation and supervision provided by CABI staff. Four students were given the maximum score of six in their oral examination and the other student received five. The PBL course will be repeated in 2013 and CABI will also increase its contribution to other bachelor's courses at the University of Neuchâtel.



Manual adapted to raise awareness about river-ecosystems and restoration of degraded rivers in the Canton Jura (photo: CABI)

CABI - Canton Jura collaboration to educate school children about the importance of conserving and restoring natural river ecosystems

A service contract was ratified in January 2012 between CABI and the Department of Education, Culture and Sports of the Canton Jura covering work to be carried out by CABI over two years from 2012. The contract covers several educational components worth a total of CHF 130,000 and includes CHF 70,000 core funding and CHF 30,000 on demand. In 2012, we adapted a 200-page manual on the functioning of river ecosystems to be used for teaching primary school children in the Jura. The effectiveness of this manual will be tested in eight classes during 2013 under the supervision of our centre.

New road sign indicating the way to CABI (photo: A. Gassmann)

new signs lead the way to CABI

In 2012, permission was granted by the town of Delémont to place signs pointing the way to CABI along the road from the edge of town. Three industry-style signs were therefore installed in October along the Route de Domont, so newcomers to CABI will no longer have any difficulty locating the centre. Permission was also granted to install a big CABI sign at the top of the driveway, making it clear to all those passing by who the building at the edge of the forest belongs to.

new internet connection and video conferencing facilities

The capacity of CABI staff to communicate with partners and colleagues around the world became significantly more advanced at the end of 2012 with the installation of a videoconferencing facility at the centre. This facility, consisting of a camera and large viewing screen will enable virtual 'face-to-face' meetings with up to three other parties. Before it could be set up, a significant amount of work was needed to dig up the road leading to CABI and lay a 3-km fibre-optic cable in order to allow the necessary upgrade to our internet connection.

Digging a trench for the fibre-optic cable (photo: A. Gassmann)

renovations in and around CABI

A year would not be complete without some sort of renovation happening within the centre. This year saw the renovation of two offices; Marc Kenis' office was re-painted, re-floored and re-furnished, and one of the Arthropod Biological Control laboratories was moved to the room next door, while the empty room was converted into an office for Melanie Bateman, Erica Chernoh and Frida Rodhe (the new ICM team recruits). Work is also underway to improve the outdoor communal dining area next to the kitchen. The roof will be replaced and the whole area will be expanded to ensure that more people can sit out there together at mealtimes and for special events.

New office space (photo: W. Jenner)

Videoconferencing facility (photo: P. Häfliger)

Carole Rapo successfully defended her PhD thesis

In April 2012, Carole Rapo successfully defended her PhD thesis entitled 'Phenomics: a new tool in the prediction of host-specificity in classical biological control of weeds?' Carole was enrolled at the University of Idaho in the USA, where she was supervised by Prof. Sanford Eigenbrode and Prof. Mark Schwarzländer, in collaboration with CABI in Switzerland, where her work was supervised by Drs Hariet L. Hinz and Urs Schaffner. Carole assessed how well primary and secondary metabolites help explain the host choice by, and host suitability for, *Ceutorhynchus cardariae*, a gall-forming weevil which is being studied as a potential biological control agent for hoary cress (*Lepidium draba*) (see p. 28). Her results indicated that at least the feeding pattern of adult weevils appears to be better explained by the glucosinolate, amino acid and amine profiles of test plants than by their phylogenetic relatedness to *L. draba*. This is a first step towards a mechanistic understanding of the disjunct host range of this weevil under no-choice conditions.

Carole Rapo (photo: H.L. Hinz)

Vera Wolf obtains a PhD on *Tanacetum vulgare*

In 2012, Vera Wolf successfully defended her PhD thesis entitled 'Chemotypic variation of *Tanacetum vulgare* L. (Asteraceae), its role in invasiveness, and implications for biological control' at the University of Bielefeld, Germany. This work was supervised by Dr André Gassmann from CABI in Switzerland and Prof. Caroline Müller from the University of Bielefeld. Three publications have resulted from the work.

Vera Wolf after her successful PhD defence. From left to right: Urs Schaffner, CABI, Caroline Müller, University of Bielefeld, Vera Wolf and André Gassmann, CABI (photo: H. Wolf, Germany)

Saidou Nacambo successfully defends MSc thesis

Saidou Nacambo, a veterinary surgeon with a strong interest in entomology, successfully completed his MSc at the University of Neuchâtel in 2012. He carried out research at CABI for his thesis entitled: 'Parasitism, development, climatic model and the impact of the box-tree moth *Cydalima perspectalis* in Europe'. The work was conducted in collaboration with Dr Tim Haye and supervised by Dr Marc Kenis at CABI and Prof. Bruno Betschart of the Laboratory of Molecular Parasitology at the University of Neuchâtel. In 2013, Saidou will start working on the new EU-funded project PROteINSECT, where he will develop methods to rear flies for animal feed.

Saidou Nacambo (photo: CABI)

Paul Abram defends his MSc thesis and wins President's prize

In 2012, Paul Abram successfully defended his MSc thesis entitled 'The parasitoid complex associated with the invasive swede midge, *Contarinia nasturtii*, in Europe: prospects for classical biological control in North America' at Carleton University, Ottawa, Canada. This work was supervised by Prof. Naomi Cappucino (Carleton University), Dr Guy Boivin (Agriculture and Agri-Food Canada – AAFC, St-Jean-sur-Richelieu), Dr Peter Mason (AAFC, Ottawa) and Dr Tim Haye (CABI). Paul's work helped to evaluate the potential of classical biological control of swede midge in North America by investigating the parasitoid complex on swede midge in Europe and elucidating the biology of the most promising biological control agent, *Synopeas myles*. As an outcome of Paul's research, two research papers have been published in peer-reviewed international journals. In addition, Paul's presentation of his research at the Annual Meeting of the Entomological Society of Canada in Edmonton, Alberta, was awarded the President's Prize for the Society in the category 'Agriculture'.

President's Prize winner Paul Abram (photo: T. Haye)

Elena Olsen, a new MSc student for weed biological control

In spring 2012, we had the pleasure of welcoming a second MSc student, Elena Olsen, into the Weed Biological Control research group at Delémont. Elena did her undergraduate studies at Cornell University, USA, and worked for Prof. Dick Casagrande at the University of Rhode Island, USA, where she was introduced to weed biological control. Elena will do her MSc within the framework of the new tutsan (*Hypericum androsaemum*) project (see p. 40). Tutsan is a shrub of European origin, which is invasive in New Zealand. Elena is enrolled at the University of Fribourg in Switzerland, where she is being supervised by Prof. Heinz Müller-Schärer, and is conducting her research at CABI, where she is supervised by Dr Hariet L. Hinz. Elena is proving to be very flexible since she has been travelling back and forth between Fribourg and Delémont and has also conducted field surveys in the UK, Ireland, France and Spain with more to follow in 2013.

Elena Olsen (photo: E. Gerber)

DPR Korea and CABI hold joint symposium on pest monitoring and forecasting

The First AAS-CABI Joint Scientific Symposium was held at AAS, Pyongyang, DPR Korea, on 28–30 August 2012. The topic of the symposium was 'Pest monitoring and forecasting', and it was organized as part of the DG DEVCO EuropeAid-funded Partnership Project, 'Strengthened knowledge and research capacity to sustainably increase agricultural productivity and food security in DPR Korea', with the aim of identifying potential areas for development and collaboration to address food security in DPR Korea, through improved pest monitoring and forecasting of national pest problems.

More than 60 participants attended the symposium, including five international speakers from three CABI member countries (Canada, China and Switzerland), CABI and Germany. Local participants were from various DPR Korean institutions, including MoA-DoPP, CPPS-MoA, Pyongyang Agricultural College, Kim Il Sung University and various institutes and provincial branches of AAS.

Overall the symposium was regarded as having been extremely successful, providing an excellent opportunity for local partner scientists to discuss the topic of pest monitoring and forecasting with international experts. In addition, it was a useful and timely forum to formulate ideas for future development of this activity within DPR Korea.

Participants at the first AAS-CABI joint symposium on pest monitoring and forecasting, Pyongyang, DPR Korea (photo: Hou M., IPP-CAAS)

International speakers visit Chang Chon Co-operative Farm field site (photo: K. Holmes)

Plantwise CABI Country Coordinators unite in Delémont

In early December 2012, Delémont became the global hub for the annual meeting of Plantwise, the global flagship programme led by CABI. Over 35 scientists and international development professionals gathered at the Centre St François to discuss challenges and solutions to the Plantwise programme's issues. They also took with them a branded Plantwise pocket knife made at the Wenger factory in Delémont. Some researchers from warmer countries were able to view their first snowfall and hope to return to Delémont for future exchanges with fellow Plantwise members.

Colleagues learn more about CABI's activities in Switzerland (photo: J. Dennis)

Steering Committee Meeting of the MoA-CABI Joint Laboratory for Bio-safety

The Fourth Steering Committee Meeting of the MoA-CABI Joint Laboratory took place at CABI in Delémont on 22–23 February. Representatives from the international collaborations departments from China's MoA, CAAS and CABI Head Office as well as scientists from IPP-CAAS and CABI (China, Switzerland and UK) discussed issues including the management of the Joint Laboratory, project implementation and development, and major upcoming events. A technical discussion was also held as part of the meeting during which the progress of individual research and development projects was reported on and analysed. The Joint Laboratory is currently implementing three research projects (on *Apolygus* plant bugs, the box tree moth and Canada thistle) as well as two DG DEVCO EuropeAid-funded international development projects (on rice IPM and maize IPM in the Greater Mekong Subregion), and is also involved with the implementation of Plantwise.

Plantwise pocket knife produced at Delémont (photo: G. Grosskopf-Lachat)

Participants at the Fourth Steering Committee Meeting of the MoA-CABI Joint Laboratory for Bio-safety (photo: D. Babendreier)

introduction

In 2012, I had the pleasure of welcoming yet another MSc student, Elena Olsen, into the Weeds group. Elena did her undergraduate studies at Cornell University, USA, and worked for Prof. Dick Casagrande at the University of Rhode Island, USA, where she was introduced to weed biocontrol. Elena will do her MSc research on tutsan (*Hypericum androsaemum*) (see p. 40), a new project we started on behalf of Landcare Research New Zealand Ltd. Elena will be enrolled at the University of Fribourg in Switzerland under the supervision of Prof. Heinz Müller-Schärer.

At the same time, two PhD students, Carole Rapo (University of Idaho, USA) and Vera Wolf (University of Bielefeld, Germany), who conducted research for their theses within the framework of the hoary cress (*Lepidium draba*) and common tansy (*Tanacetum vulgare*) projects, respectively, successfully defended their PhDs in April 2012.

A second new project that I am quite excited about aims to assess the potential risks of introducing the psyllid *Aphalara itadori* into Switzerland to control Japanese knotweed, *Fallopia japonica* (see p. 41). The psyllid was released in the UK in 2010 and established at several release sites. Capitalizing on the know-how of the Weeds group in the UK, we will conduct additional host-range studies with plant species in the same family as Japanese knotweed (i.e. Polygonaceae) that are native to Switzerland, local varieties of two crop species and various genotypes of the highly invasive *Fallopia* × *bohemica*. The two-year project is financed by FOEN.

With new projects starting, old ones are ending. Two longstanding biological control projects will terminate in 2012–13: common buckthorn (*Rhamnus cathartica*) (see p. 33), and sulphur cinquefoil (*Potentilla recta*) (see p. 39). It is rare that we terminate projects without releasing agents; however, in these two cases either most potential agents have proven not specific enough or problems surrounding the screening of the remaining agents simply appeared too difficult to justify continuation.

We have still not given up hope of finding a specific fungal pathogen for classical biological control of Canada thistle, *Cirsium arvense* (see p. 32). The project, conducted with the MoA-CABI Joint Laboratory for Bio-safety in Beijing, China, and our centre in the UK, has prioritized the white blister 'rust' (*Pustula spinulosa*) as a potential candidate. Since the pathogen was difficult to work with, Wan Huanhuan from the Joint Laboratory received training in pathogen techniques at our UK centre. This proved to be fruitful, since Huanhuan was then able to successfully inoculate *C. arvense* of Chinese origin with the rust under laboratory conditions, which is an important step forward in this project.

Since two more of our projects have a pathogen component, a job application from pathologist Chantal Morin was very timely, and we now employ her as an external consultant to help with various aspects of pathogen work within the tutsan and hawkweed (*Pilosella* spp.) projects. Chantal is originally from Canada, but now lives in France, close to the Swiss border.

Dr Hariet L. Hinz, Head of Weed Biological Control (h.hinz@cabi.org)

Weed Biological Control team, 2012. Back row (from left to right): Cornelia Cloşca, Elena Olsen, Esther Gerber, André Gassmann, Pablo Pardo, Ali Sultani; middle row: Janine Brooke, Alicia Leroux, Lizzie Kirby, Natalia Medeiros de Souza, Ariel Firebaugh, Ghislaine Cortat, Hariet Hinz, Clesson Higashi, Patrick Häfliger; front row: Evan Esch, Saidou Nacambo, Urs Schaffner, Sonja Stutz and Christian Leschenne; not pictured: Florence Willemin (photo: R. Eschen). Note that some students are shared between Weed Biological Control and Ecosystems Management

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

Rhinusa pilosa (photo: I. Toševski)

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 (*L. dalmatica*), and a type that appears to be morphologically intermediate. Eight agents of European origin have been accidentally or deliberately introduced into North America for biological control of toadflaxes to date. A molecular study has shown that the shoot-boring weevil Mecinus janthinus, introduced into North America in 1991, is actually composed of two cryptic species: *M. janthinus* from *L. vulgaris* and *M. janthiniformis* from *L. genistifolia*. Of the two species, *M. janthiniformis* has been reported to have a significant impact on Dalmatian toadflax.

Morphological and molecular work has revealed the occurrence of cryptic speciation and a high degree of host plant specialization in the weevil genera *Rhinusa* and *Mecinus* associated with toadflaxes in Europe. Molecular work on toadflaxes is ongoing to determine the exact European origin of the invasive toadflaxes in North America.

A petition for field release of the shoot-galling weevil *Rhinusa pilosa* against *L. vulgaris* in Canada and the USA was submitted in March 2012.

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

Between 2006 and 2012, 81 plant species or populations were included in gall induction tests with *R. brondelii* from *L. genistifolia*, 46 of which were native North American species in 36 genera. Results suggest that *R. brondelii* is to be even more specific than *R. pilosa*; no oviposition and gall induction were recorded on the native North American species *Nuttallanthus canadensis* and no larval development occurred on another North American species, *Sairocarpus virga*.

In 2012, additional no-choice larval development tests were conducted with the shoot-mining weevils *Mecinus heydeni* from *L. vulgaris* and *M. laeviceps* from *L. genistifolia*. In total, 80 and 84 plant species or populations, respectively, have been exposed so far, the majority native to North America. For *M. heydeni*, development to the adult stage has been found to occur on the native North American species *Epixiphium wislizenii*, *Maurandella antirrhiniflora*, *N. canadensis* and *S. virga* and for *Mecinus laeviceps* on *N. canadensis* and *S. virga*.

Work in 2013 will focus on completion of host-specificity tests with *R. brondelii* and on continuing studies with *Mecinus* spp. We plan to prepare and submit a petition for field release of *R. brondelii* in Canada and the USA in collaboration with our North American partners in winter 2013/14.

I. Toševski, A. Gassmann (a.gassmann@cabi.org), **M. Mitrović, O. Krstić** and **J. Jović**, in collaboration with **R. Caldara** (Milan, Italy) and **B. Emerson** (University of East Anglia, UK). Funded by: Wyoming Biological Control Steering Committee, USDA-APHIS-CPHST (US Department of Agriculture – Animal and Plant Health Inspection Service – Centre for Plant Health Science and Technology), USDA Forest Service, Montana Noxious Weed Trust Fund through Montana State University, and Colorado Department of Agriculture/APHIS Western Region Biological Control through Colorado State University, USA; British Columbia Ministry of Forests, Lands and Natural Resource Operations, Canada.

Oliver Krstić working in the molecular laboratory in Serbia (photo: I. Toševski)

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

Containers used for *Mogulones borraginis* pupation: vial filled with a mixture of fine vermiculite and quartz sand for shipment to the USA (left); cup filled with sifted garden soil for rearing at CABI (right) (photo: H.L. Hinz)

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

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 states of the adjacent 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.

In the last few years, our work has concentrated on the seed-feeding weevil *Mogulones borraginis*, which is by far the most specific agent on houndstongue, with development restricted to the genus *Cynoglossum*. In 2012, we successfully maintained the rearing colony of *M. borraginis* at CABI and 600 mature larvae emerged from plants. About half were placed into vials filled with a mixture of fine vermiculite and quartz sand instead of sifted garden soil in order to be able to ship pupae to the USA. Prof. Mark Schwarzländer (University of Idaho, USA) hand-carried weevils to the quarantine facility in Pullman, Washington, three times during 2012, where PhD student IkJu Park is conducting tests on the visual and olfactory host-finding behaviour of *M. borraginis*.

Due to continuing problems germinating houndstongue, we had only a few reproducing plants available in spring 2012, which were supplemented by 60 plants sent from the University of Idaho.

In an overwintering experiment conducted in 2011/12 using three different constant temperatures (–0.5°C, –1.0°C and –1.5°C), 80–90% of weevils successfully emerged. An additional experiment was established in autumn 2012 with constant temperatures ranging between –2.0°C and –3.0°C. Results will be available in spring 2013.

Results of all host-range tests and biological and impact studies, conducted with *M. borraginis* between 1993 and 2011, have been summarized and sent to Mark Schwarzländer who is preparing a petition for field release.

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

PhD student IkJu Park (University of Idaho) collecting headspace volatile organic compounds from the native North American *Cynoglossum grande* in the field in Washington (photo: J. Rendon, University of Idaho)

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 British Columbia, Canada. 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 2013.

The gall wasp *Aulacidea subterminalis*, which attacks stolons of *Pilosella officinarum* (syn. *Hieracium pilosella*, mouse-ear hawkweed) and *P. aurantiaca* (syn. *H. aurantiacum*, orange hawkweed) was released in the field in the USA (2011) and Canada (2011–12). Establishment has not yet been confirmed, but monitoring is ongoing and more releases are planned. Mass rearing is being maintained at CABI in Switzerland to complement North American cultures.

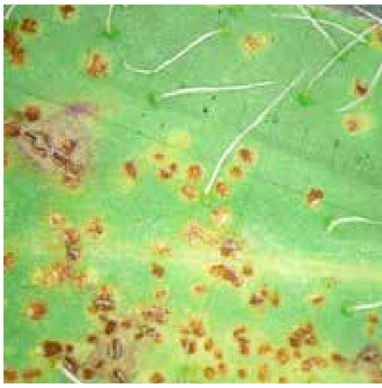
Two populations of another gall wasp, *Aulacidea pilosellae*, are being investigated at CABI. Studies conducted by Chandra Moffat (University of British Columbia) in collaboration with Drs Kevin Floate and Rosemarie De Clerck-Floate (AAFC), indicate that *A. pilosellae* collected from *P. officinarum*, regardless of location, are of a different lineage to *A. pilosellae* collected from *P. caespitosa* (syn. *H. caespitosum*, meadow hawkweed), *P. glomerata* (syn. *H. glomeratum*, yellowdevil hawkweed) and *P. piloselloides* (syn. *H. piloselloides*, tall hawkweed). She also suggests that host use by *A. pilosellae* ex *Pilosella* spp. could be a combination of selection of the most abundant *Pilosella* species in the field and a preference for *P. caespitosa* and *P. glomerata*.

Tests conducted with *A. pilosellae* between 2003 and 2012 on 38 and 27 test plant species, subspecies and populations for *A. pilosellae* ex *Pilosella* spp. and *A. pilosellae* ex *P. officinarum*, respectively, revealed that while the two wasp populations differ in their host preferences, they both appear to have a restricted host range. Few native *Hieracium* species were attacked in no-choice tests and only one to a limited degree under choice conditions. Tests will be continued in 2013.

Fungal pathogens, especially rusts, can be much more host specific than insects. *Puccinia hieracii* var. *piloselloidarum*, a rust that was first evaluated for controlling *Pilosella officinarum* in New Zealand, was found on *P. officinarum* in Switzerland, and collected from *P. aurantiaca* and *P. caespitosa* in eastern Europe. Samples were sent to Dr Rosemarie De Clerck-Floate at AAFC, where studies in quarantine will be initiated. Additional field collections and shipments are planned for 2013.

G. Cortat (g.cortat@cabi.org), **C. Higashi, C. Morin** and **A. Sultani**. Funded by: British Columbia Ministry of Forests, Lands and Natural Resource Operations and AAFC, Canada; Montana Weed Trust Fund through Montana State University and USDA-APHIS-CPHST, USA.

Galls induced by *Aulacidea pilosellae* (photo: G. Cortat)



Puccinia hieracii var. *piloselloidarum* on *Pilosella officinarum* (photo: G. Cortat)

Clesson Higashi collecting *Aulacidea pilosellae* galls in eastern Germany, June 2012 (photo: G. Cortat)

Test plants (here *Centaurea cyanus*) were inoculated with the mite *Aceria acroptiloni* by pinning open, mite-infested flower heads of *Acroptilon repens* onto leaves or shoots of the test plants (photo: G. Asadi, Mashhad University)

Russian knapweed plants infested by *Aceria acroptiloni* remain stunted and produce few flower heads (photo: U. Schaffner)

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

Russian knapweed, *Acroptilon repens*, is a herbaceous perennial that is native to Asia. The plant was accidentally introduced into North America in the late 19th century as a contaminant of alfalfa seed. To date, it 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 2012, field-collected galls of the gall wasp *Aulacidea acroptilonica* and the gall midge *Jaapiella ivannikovi* were sent to quarantine facilities in North America to maintain ongoing rearing programmes. Both species have established in the USA and in Canada, and a large distribution programme covering eight states has been initiated for the gall midge by USDA-APHIS.

In collaboration with Dr R. Petanovic (University of Belgrade, Serbia) and Dr P. Chetverikov (Russian Academy of Sciences, St Petersburg), significant progress was made in 2012 in separating the different *Aceria* species associated with Russian knapweed by morphological and molecular means. Analysis of an impact experiment set up in Iran in 2011 revealed that *Aceria acroptiloni* makes up more than 95% of the mites found in flower heads of Russian knapweed, and that this species reduces above-ground biomass by 55–75% and seed output by 95–97%.

Together with Dr R. Ghorbani, Dr G. Asadi (both Mashhad University, Iran) and Dr M. Cristofaro (Biotechnology and Biological Control Agency, Rome, Italy – BBCA) we explored new ways to assess the host range of the mite. The goal was to increase the attack rate on control plants while keeping attack by other mites at as low a level as possible. Growing test and control plants under greenhouse conditions and transplanting them into the field at the rosette stage resulted in a high attack rate on the control plants by *A. acroptiloni* (90%). Two test species, i.e. safflower, *Carthamus tinctorius*, and *Centaurea cyanus* also revealed signs of mite attack, but morphological and molecular analyses showed that these plants were attacked by other mite species.

During field surveys in Uzbekistan, only a few larvae of the chrysomelid *Galeruca* sp. were found. Therefore, continuation of no-choice host-range testing was postponed to 2013.

Work in 2013 will focus on shipping material of the gall wasp *Aulacidea acroptilonica* and the gall midge *J. ivannikovi* to North America, on clarifying the taxonomy and continuing host-range testing for the mite *Aceria acroptiloni*, and on assessing the host range of the *chrysomelid* species found in Uzbekistan.

U. Schaffner (u.schaffner@cabi.org) and **E. Esch**, in collaboration with **M. Cristofaro**, (BBCA), **R. Ghorbani** and **G. Asadi** (Mashhad University), **A. Khamraev** (Uzbek Academy of Sciences), **T. Rajabov** (University of Samarkant, Uzbekistan) and **J. Littlefield** (Montana State University, USA). Funded by: Wyoming Biological Control Steering Committee, USDA-APHIS-CPHST and Montana Weed Trust Fund through Montana State University, USA.

Dr G. Asadi inoculating test plants with the mite *Aceria acroptiloni* (photo: R. Ghorbani, Mashhad University)

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

Garlic mustard, *Alliaria petiolata*, is a biennial cruciferous plant of European origin 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 (Cornell University, 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, as required by some of the reviewers of the petition, was submitted at the beginning of September 2011. To date, no response has been received from TAG.

Two test plant species, *Rorippa sinuata* and *Lobularia maritima*, had supported limited adult development of the shoot-mining weevil *C. alliariae* under no-choice conditions. An open-field test conducted in 2012 revealed some attack on these species under more natural conditions. However, the level of attack on non-target plants was very low. For one of these two species, the North American *R. sinuata*, an impact experiment showed that *C. alliariae* attack does not negatively affect plant vigour and reproductive output, suggesting that *C. alliariae* has no negative impact on the demography of *R. sinuata*. We are planning to conduct a similar test with *L. maritima* in 2013.

None of the test species exposed to *C. constrictus* in no-choice oviposition and development tests in 2012 was attacked. Two adults had been successfully reared from larvae retrieved from *Brassica juncea* in 2011, indicating that this test plant species is within the fundamental host range of *C. constrictus*. Additional single-choice field cage tests conducted with *B. juncea* in 2012 revealed, however, no attack on this test plant species when exposed to the weevil in the presence of *A. petiolata* in a field cage. Overall, our data indicate that the risk of *B. juncea* being attacked by *C. constrictus* under natural condition is very low to negligible. To further confirm this, we are looking into possibilities of conducting an open-field test in 2013 to test the acceptance of *B. juncea* by *C. constrictus* under the conditions that the plant is grown as a crop.

In summary, work on garlic mustard progressed well in 2012. Work in 2013 will concentrate on tests with *C. constrictus* and *C. alliariae*. In addition, a shipment of *C. constrictus* to the quarantine facility at the University of Minnesota, USA, is scheduled for spring 2013, where additional tests with North American species will be conducted.

E. Gerber (e.gerber@cabi.org), **H.L. Hinz** and **A. Hach**. Funded by: USDA Forest Service, Minnesota Department of Natural Resources and USDA-APHIS-CPHST, USA.

Ceutorhynchus constrictus (photo: G. Krumm, Bötzingen, Germany)

Single-choice test with *Ceutorhynchus constrictus* (photo: E. Gerber)

André Hach collecting *Ceutorhynchus alliariae* (photo: E. Gerber)

Set-up to test the oviposition behaviour of *Ceutorhynchus assimilis* (photo: H.L. Hinz)

Three oviposition holes made by *Ceutorhynchus assimilis* in a rhizome of *Lepidium draba* (photo: C. Cloşca)

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 2012, we concentrated our work on three potential biological control agents.

On 13 December 2011, a petition for field release of the gall-forming weevil *Ceutorhynchus cardariae* was submitted to TAG. We nevertheless continued no-choice oviposition and development tests, since we had many native North American species available that we had not been able to obtain previously. Of the 15 species tested this year, four supported gall development, and one adult development. At the end of November 2012, we received TAG's comments, which suggest that additional tests are needed before the petition for *C. cardariae* can be reconsidered.

No-choice oviposition tests were continued with the seed feeder *Ceutorhynchus turbatus* in 2012. Apart from *L. draba*, eggs were found in one replicate of the native North American species *Nasturtium gambelii*.

A multiple-choice field cage and/or open-field test planned for the stem-mining weevil *Ceutorhynchus merkli* and a selected number of critical test plant species in southern Russia in 2012 could unfortunately not be conducted, since not enough adult weevils were found.

We also started work on the root-galling weevil *Ceutorhynchus assimilis*. Although this weevil is recorded as a pest of several Brassicaceae crops, preliminary host-range tests and molecular analyses conducted by the USDA-ARS (Agricultural Research Service) European Biological Control Laboratory (EBCL) indicate that a type host specific to *L. draba* exists in southern France. Over 200 adults emerged from galls collected in the area around Montpellier and brought back to CABI. After a short feeding period, weevils aestivated, re-started feeding in September and started laying eggs on 1 October. We started collecting data on the weevil's oviposition behaviour and phenology and developed a method for oviposition tests. In first no-choice oviposition tests conducted with 19 test species, 13 were accepted for egg laying. Seven test species, for which we had plants available, were subsequently set up in no-choice development tests. Results will become available in spring 2013.

In 2013, we are planning to conduct additional tests with *C. cardariae*, as required by TAG, continue testing of *C. turbatus*, re-attempt testing of *C. merkli*, and continue collecting data on the host range and biology of *C. assimilis* in cooperation with USDA-ARS.

H.L. Hinz (h.hinz@cabi.org), **C. Cloşca** and **P. Pardo**, in collaboration with **A. Diaconu** (Institute of Biological Research, Iaşi, Romania) and **M. Dolgovskaya** (Russian Academy of Sciences, Zoological Institute, St Petersburg). Funded by: Wyoming Biological Control Steering Committee; Montana Weed Trust Fund through Montana State University; USDA-APHIS-CPHST; USDI BLM (US Department of the Interior – Bureau of Land Management), Oregon, through the Hoary Cress Consortium administered by the Panhandle Lakes RC&D, Idaho; all USA.

Lepidium draba plants galled by *Ceutorhynchus assimilis*: growth is almost completely inhibited (photo: H.L. Hinz)

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 BBCA.

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 15 other species support adult development. Several of these have already been tested in multiple-choice cage tests in southern Russia. Tests in 2012 showed that the native North American species *Lepidium latipes* was attacked in multiple-choice cage tests, but not in open-field tests. Only *L. perfoliatum*, a species native to Europe, was attacked in the open-field test and appears in fact to be an alternative host for *C. marginellus*.

No-choice larval transfer tests with *P. reitteri* advanced very well in 2012 and further confirmed the wide physiological host range of larvae of this species when tested under laboratory conditions. However, it turned out to be much more specific when tested in the field. Of the 17 test plants exposed in the field so far, only three *Lepidium* species were attacked in multiple-choice cage tests. In a subsequent open-field test, only *L. perfoliatum* was attacked – as found for *C. marginellus*.

Multiple-choice cage tests were carried out to investigate acceptance of five critical test plant species by *Melanobaris* sp. n. pr. *semistriata* and the gall-forming mite *Metaculus lepidifolii*. While we were able to infest PPW plants with *M*. sp. n. pr. *semistriata* in the field for the first time, no attack by *Metaculus lepidifolii* was detected.

Host-specificity testing will continue in 2013, both in quarantine and in the field. Field tests in Turkey are essential at this point to decide if prioritized agents are host specific enough to be further considered. We will therefore continue our efforts to optimize collaboration with our local partners and have established additional contacts with colleagues at a local university.

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Multiple-choice cage test with *Phyllotreta reitteri* and *Ceutorhynchus marginellus* in southern Russia (photo: S. Reznik, Russian Academy of Sciences, Zoological Institute, St Petersburg)

Ceutorhynchus marginellus (photo: L. Parson)

Franca Di Cristina and Marcello Barlattani releasing *Melanobaris* sp. n. pr. *semistriata* into a multiple-choice cage in Turkey (photo: E. Gerber)

Pablo Pardo collecting *Ceutorhynchus rusticus* in southern Germany (photo: H.L. Hinz)

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

Dyer's wood, *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 wood. 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*.

For *C. peyerimhoffi*, we successfully maintained our rearing colony with 1700 adults emerging in 2012, and over 2500 individuals currently overwintering. Additional no-choice oviposition tests were set up with 32 test species, 20 native to North America. Apart from dyer's wood, eggs were found in five test species, but at much lower numbers than in dyer's wood. In subsequent larval development tests with ten plant species previously accepted for oviposition, only the target weed supported development of larvae to maturity, confirming the narrow host range of *C. peyerimhoffi.*

Set-up for no-choice oviposition test with *Ceutorhynchus peyerimhoffi* (photo: H.L. Hinz)

In autumn 2011, no-choice development tests were set up with *C. rusticus* on 27 test plant species, 24 native to North America. In 2012, two adult weevils emerged from *Descurainia californica*, and live larvae were found in seven other species. Two federally listed test plant species and two Brassica crop species showed no signs of attack. In autumn 2012 additional no-choice tests as well as an open-field test were established. Results from the latter were similar to last year. All dyer's wood control plants were heavily attacked (c. 50 eggs/plant), while only two plants of two test species were attacked, and to a limited degree (< 2.0 and 0.3 eggs/plant). Since the native North American species *Stanleya viridiflora* has proven to be a critical test plant species, a second open-field test was established, exposing test and control plants at increasing distances from a central weevil release point. Of eggs laid, 95% were found on dyer's wood and only 5% on *S. viridiflora*. Whether or not this weevil attack impacts on the non-target species is unknown although the low rate and level of attack suggest it may not.

Additional no-choice larval transfer tests with *P. isatidis* confirmed its relatively wide larval host range. However, none of four test species exposed to egg-laying females of *P. isatidis* in autumn 2011 was found to be attacked in spring 2012. We therefore set up additional tests in autumn 2012 using the same method and 26 additional test plant species, 16 native to North America. Results will not be available until 2013.

In 2013, host-range tests will concentrate on *C. peyerimhoffi*, since it is the most specific of the three agents, and but will also be continued with *C. rusticus* and *P. isatidis*.

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Cornelia Cloşca searching for *Ceutorhynchus rusticus* marked with fluorescent powder during the open-field test with the native North American test plant *Stanleya viridiflora* (photo: A. Leroux)

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 four shoot-mining noctuid moths, *Archanara geminipuncta*, *A. dissoluta, A. neurica* and *Arenostola phragmitidis*. Although all four 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.

In March 2012, we shipped 500 eggs of both *Archanara geminipucta* and *A. neurica* to the University of Rhode Island in the USA for additional host-specificity tests in quarantine.

Due to limited funding, the focus this year was on maintaining rearing colonies of *A. geminipuncta* and *A. neurica*, and on preparing plants to be used in additional open-field oviposition tests in 2013. We multiplied plants of different populations and subspecies of *P. australis*, and we currently have about 150 plants ready for tests in 2013 (representing eight populations each of European, native North American and introduced reed). More pots could be prepared in spring 2013 if necessary. The plan is to repeat the open-field oviposition test carried out in 2011 with more vigorous plants and to release 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 *A. geminipuncta* and *A. neurica*.

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Oviposition cages for *Archanara geminipuncta* and *A. neurica* (photo: P. Häfliger)

Archanara geminipuncta eggs in a Petri dish, ready for overwintering (photo: P. Häfliger)

Newly repotted plants of *Phragmites australis* from different populations (photo: P. Häfliger)

Germinated zoosporangia of the white blister 'rust' (photo: Wan H.)

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 this weed 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 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 for Bio-safety in Beijing.

During surveys in 2010, different pathogens had been collected on *C. arvense*, and a white blister 'rust' in the genus *Pustula* identified as the most promising pathogen. Recent molecular phylogenetic and morphological studies clearly showed that the *Pustula* lineage, usually referred to as *P. tragopogonis* s.l., can be differentiated into several distinct species, including *P. spinulosa* on *Cirsium* spp., which is distinct from the species attacking *Helianthus annus* (sunflower). It is posited that different pathotypes of *P. spinulosa* have evolved that are specific at the species level. This would be a necessary requirement if this pathogen is to be considered for introduction into North America.

Cirsium arvense leaf successfully infected with the white blister 'rust' (photo: Wan H.)

After unsuccessful attempts to develop an inoculation method during 2011, Wan Huanhuan from the Joint Laboratory in China spent six weeks in spring 2012 at our UK centre, receiving training in spore germination and inoculation techniques. In August 2012, fresh material of *C. arvense* infected with *P. spinulosa* was collected in the provinces of Xinjiang and Gansu in north-western China. Laboratory-based studies established that it was critical to inoculate plants with freshly field-collected zoosporangia, and also that infected plants need to be maintained under controlled conditions similar to those in the field; 22°C/16°C (day/night) and relative humidity of 85%. Full symptoms developed after 17 days. This was an important step forward in this project.

The next step is to achieve consistent and reliable infection under controlled conditions in order to establish a 'rust' culture, and then to inoculate *C. arvense* of US origin. If the plants from the USA are susceptible, host-specificity tests with *Cirsium* species native to North America will then be started.

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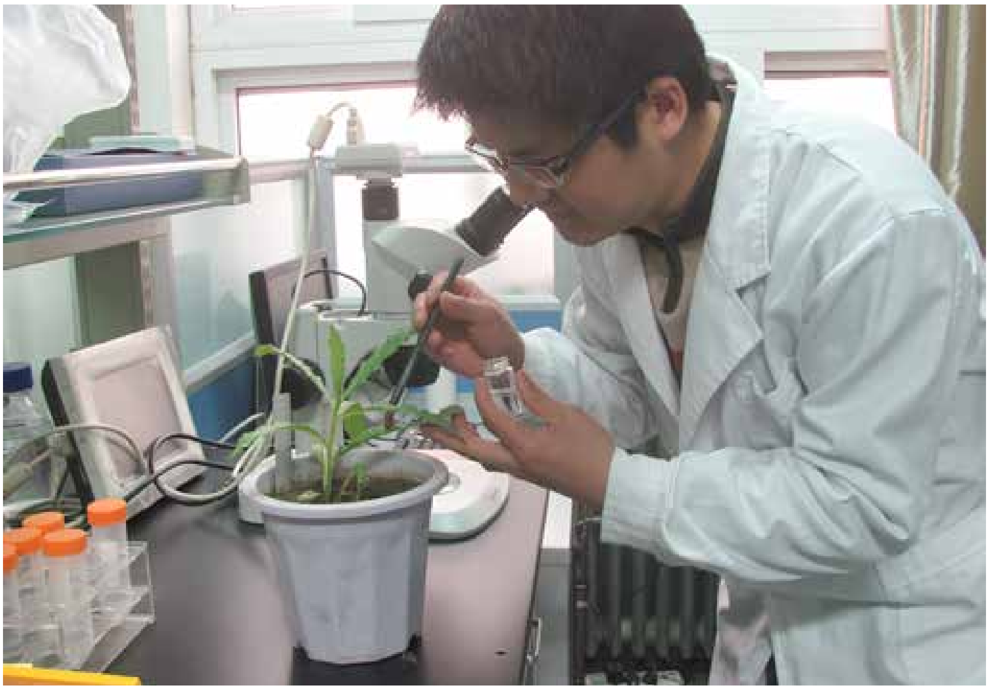

Wan Huanhuan inoculating a *Cirsium arvense* plant with the white blister 'rust' (photo: Li H.M.)

controlling common buckthorn, *Rhamnus cathartica*, in the USA

Rhamnus cathartica is a shrub or small tree native to Europe and western Asia that has successfully invaded many habitats in North America, causing significant economic and environmental damage. In 2001, a biological control project was started by Dr Luke Skinner (Minnesota Department of Natural Resources, USA).

Candidate biological control agents should be monospecific to *R. cathartica* or their host ranges restricted to a few non-native species in the genus *Rhamnus*. Over 30 specialized insects were identified from the literature as potential candidates for biological control of *R. cathartica* including 21 Lepidoptera (moths), six Hemiptera (bugs), two Diptera (flies), one Coleoptera (beetle), and three Acari (mites). Some species known from the literature could not be found during surveys, and many of the others did not appear to be specific to common buckthorn. After preliminary tests, eight species were discarded due to lack of host specificity. Two psyllids, *Trichochermes walkeri* and *Cacopsylla rhamnicolla*, were promising in terms of host specificity, but did not inflict obvious damage on buckthorn. In addition, both insects harbour a plant disease, '*Candidatus Phytoplasma rhamni*' (buckthorn witches' broom), which is not present in the USA. We believe that it would therefore be difficult to obtain approval for field release of either of the psyllids. A final potential biocontrol insect, the seed-feeding midge *Wachtiella krumbholzi*, proved too difficult to work with in a research setting. In addition, it was not possible to obtain fruiting trees of native North American *Rhamnus* species for testing in Switzerland.

Another area of research concerned potential negative plant–soil feedback by mature *R. cathartica* trees on conspecifics, which could explain the low seedling numbers of *R. cathartica* in the native range. No negative feedback was found, however, making it unlikely that there are soil-borne fungal pathogens that could be exploited as potential biological control agents. However, fungi attacking the above-ground parts of common buckthorn have not been studied to date.

After 11 years of searching for an insect biological control agent for common buckthorn it was concluded that most agents are not specific enough to be considered and that problems surrounding the testing of the remaining potential agents appear too difficult and time consuming to justify continuation. It was therefore decided bring the project to a close. A manuscript wrapping up work done from 2001 to 2012 will be prepared during 2013.

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Leaf galls induced by *Trichochermes walkeri* on *Rhamnus cathartica* (photo: A. Gassmann)

Adult *Trichochermes walkeri* on *Rhamnus cathartica* leaf (photo: A. Gassmann)

André Gassmann looking for leaf galls of *Trichochermes walkeri* (photo: L. Skinner, Minnesota Department of Natural Resources)

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

André Gassmann searching for *Platyptilia ochrodactyla* (photo: A. Leroux)

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 2012 focused on the stem-boring weevil *Microplontus millefolii*, the leaf-feeding beetle *Cassida stigmatica* and the shoot-boring moth *Platyptilia ochrodactyla*.

Under no-choice conditions, *M. millefolii* accepted the native North American species *Tanacetum camphoratum* for oviposition and completed its development in it. The plant was also attacked in a single-choice field cage test. A second native North American *Tanacetum species, T. huronense*, was much less readily accepted for oviposition, and no attack by *M. millefolii* was recorded on this species in an open-field test carried out in Russia. After extensive surveys, *M. millefolii* has also been found in north-eastern Romania, the first record of the weevil from this country. Specimens from Romania show 2.8–3.3% genetic divergence from those from Russia, Ukraine and northern Germany, indicating that they may also differ in biological features from the other populations.

Common tansy shoot damaged by the larva of *Platyptilia ochrodactyla* (photo: A. Gassmann)

Complete larval development of *C. stigmatica* has been recorded on native North American species in the *Tanacetum huronense – T. camphoratum complex*, as well as on *T. parthenium* and *T. balsamita*. A little and inconsistent larval development was also recorded on *Chamaemelum nobile* and one North American population of *Achillea millefolium*. All species suitable for larval development were accepted for oviposition under choice conditions. Prospects for the use of *Cassida stigmatica* for biological control of *T. vulgare* are therefore poor.

In 2012, we tried to find specimens of *P. ochrodactyla* for the first time. Larvae mining and damaging developing stems of *T. vulgare* were found in western Germany. Of the 120 attacked stems collected, stem growth was interrupted in 74% of them.

In 2013, we will focus work on host-range and biological studies with *M. millefolii* from Romania, and an open-field test with this species in Russia. The oviposition behavior of *P. ochrodactyla* will be studied and preliminary host-range tests will be conducted. In addition, initial surveys will be carried out in northern Germany for the stem, leaf and flower head gall midge *Rhopalomyia tanaceticola*.

A. Gassmann (a.gassmann@cabi.org), **A. Leroux, J. Brooke, A. Firebaugh, J. Jović** and **I. Toševski,** in collaboration with **M. Dolgovskaya** and **S. Reznik** (Russian Academy of Sciences, Zoological Institute, St Petersburg), **S.L. Mosyakin** and **A. Mosyakin** (M.G. Kholodny Institute of Botany, Kiev, Ukraine), **A. Diaconu** (Biological Research Institute, Iaşi, Romania) and **G. Schmitz** (University of Konstanz, Germany). Funded by: Montana Noxious Weed Trust Fund through Montana State University, USA; Canadian Agricultural Advancement Program (through Agriculture and Food Council of Alberta), Saskatchewan Agriculture and Food (Agriculture Development Fund), British Columbia Ministry of Forests, Lands and Natural Resource Operations, TransCanada Canadian Pacific, Cenovus FCCL Ltd. and Enbridge Pipelines Inc.

Janine Brooke preparing *Tanacetum* plants for host-range tests (photo: A. Leroux)

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, five potential insect biological control agents have been investigated in collaboration with Prof. Richard Casagrande, University of Rhode Island, USA, and Dr Robert Bourchier, AAFC, i.e. the leaf-feeding noctuids *Abrostola asclepiadis* and *Hypena opulenta*, the leaf-feeding chrysomelid *Chrysolina aurichalcea asclepiadis*, the root-feeding chrysomelid *Chrysochus asclepiadeus* (=*Eumolpus asclepiadeus*) and the seed-feeding tephritid *Euphranta connexa*. In 2011, a petition for field release of *H. opulenta* had been submitted to TAG. Based on TAG comments, some larval feeding and development tests were repeated in the University of Rhode Island's quarantine facility.

Work on *Chrysolina aurichalcea asclepiadeus* has been suspended because test results showed that the larvae can develop on several native North American non-target plants: *Asclepias fascicularis, A. incarnata, A. speciosa, A. tuberosa* and *A. syriaca*. Very occasionally larval development may also occur on *Apocynum cannabinum* and *Cephalanthus occidentalis*. 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*. In 2012, adult and larval survival was confirmed on another native North American species, *Cynanchum* leave.

Alicia Leroux from the University of Manitoba, Winnipeg, in Canada started her Master's research on the biology of *E. connexa* in 2011. This includes studies of (i) post-diapause development time at different temperatures, (ii) the impact of larval mining on the seed production of the two target species *V. nigrum* and *V. rossicum* and the natural host of *E. connexa, V. hirundinaria*, and (iii) the impact of host *Vincetoxicum* species on the fecundity of *E. connexa*. No-choice oviposition tests were started with native North American and economically important plant species. Of six species tested so far, oviposition only occurred on three out of ten replicates of the ornamental *Asclepias curassavica*. No oviposition occurred on 22 replicates of the native North American species *A. tuberosa*. Host-range testing will continue in 2013.

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Ariel Firebaugh collecting seed pods of *Vincetoxicum hirundinaria* (photo: A. Leroux)

Feeding damage by *Euphranta connexa* on *Vincetoxicum* seed (photo: A. Leroux)

Vincetoxicum hirundinaria site in the Alps (photo: A. Leroux)

Dieback of Russian olive shoots infested with *Ananarsia eleagnella* (photo: U. Schaffner)

Unidentified weevil feeding on Russian olive in eastern Uzbekistan (photo: U. Schaffner)

stemming the spread of Russian olive, *Elaeagnus angustifolia*

Russian olive, *Elaeagnus angustifolia*, a small tree native to south-eastern Europe and Asia, has been widely propagated in North America for erosion control, as a shade tree and as a nectar source for honey bees. To date, Russian olive has become an aggressive invader of natural and semi-natural riparian habitats. In 2007, an initiative was launched to study the potential for classical biological control of Russian olive, concentrating on biological control agents that attack its reproductive capacity or seedlings so as to slow its spread without harming established trees.

In 2012, CABI and BBCA continued with field studies in Turkey, Iran and Uzbekistan. Emphasis was put on further assessing the host range of the shoot-tip attacking eriophyid mite *Aceria angustifoliae*. At CABI in Switzerland, 14 different test plant species were tested under quarantine conditions. In collaboration with colleagues from Mashhad University, Iran, we also continued with a host-range test in which test and control trees growing in a common garden are repeatedly inoculated with *A. angustifoliae*. The results obtained in 2012 confirm previous findings indicating that this mite has a very narrow host range.

To assess the impact of the mite on the reproductive output of Russian olive, we re-inoculated ten trees at the University of Mashhad's experimental field station that had already been inoculated with *A. angustifoliae* in 2011. We expect to be able to record impact from 2013 onwards, provided that the mite populations build up further.

In summer 2012, we explored new ways of testing the host range of the fruit-attacking moth *Ananarsia eleagnella*. In Iran, adult *A. eleagnella* were experimentally transferred into mesh bags, enclosing fruit-bearing branches of test and control trees. Unfortunately, none of the fruits dissected 2–3 weeks after exposure to *A. eleagnella* were attacked by larvae. Nevertheless, we will continue with this experimental approach since it would allow host-range testing under as natural conditions as possible.

In spring, adults of a leaf-feeding weevil were collected on Russian olive in eastern Uzbekistan and hand-carried to CABI in Switzerland. Mating and feeding by the adults were observed on several test plants. This does not necessarily mean, however, that this species is truly polyphagous. In general, the larval host range of weevils tends to be far more specific than the adult host range.

In 2013, we will continue with host-specificity and impact studies for the mite *Aceria angustifoliae* and the moth *Ananarsia eleagnella*, and will further explore the biology of the leaf-feeding weevil found in Uzbekistan. In addition, we will help to finalize preparations for a stakeholder meeting on Russian olive to be held in early 2014.

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Funded by Wyoming Biological Control Steering Committee, Montana Noxious Weed Trust Fund through USDA Forest Service, and USDI BLM Havre, Montana, USA.

Drs Massimo Cristofaro and Reza Ghorbani recording mite damage on a test plant species (*Elaeagnus umbellata*) in the open-field host range test with *Aceria angustifoliae* at Mashhad University's experimental farm, Iran (photo: G. Asadi, Mashhad University)

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 2012, additional no-choice larval development tests were conducted with the root-mining tortricid moth *Dichrorampha aeratana*. Most of the 35 test plant species and varieties that have been tested so far have not shown any signs of larval attack. Larvae were found on all four tested Shasta daisy varieties (*Leucanthemum* × *superbum*) and on three other test plant species. However, the only native North American species that was attacked is an annual plant and therefore unlikely to support complete larval development. In a multiple-choice oviposition test in field cages, significantly more eggs and more larvae were found on oxeye daisies than on Shasta daisies.


Multiple-choice cage test with *Dichrorampha aeratana* (photo: S. Stutz)

An impact experiment set up in 2011 revealed that *D. aeratana* had a small impact on the biomass of potted oxeye daisy plants after one year of larval attack. The experiment will be continued in 2013 to allow its impact to be assessed after a second year of attack.

In addition, we started investigations on the biology and the oviposition behaviour of the root-mining weevil *Apion stolidum* and the flower head-attacking fly *Tephritis neesii* and increased our rearing colonies of both species.

In 2012, we found, for the first time, reasonably large field populations of the rare root-feeding weevil *Cyphocleonus trisulcatus* in southern France; a total of 17 adults emerged from infested field-collected plants.


Adult of the root-feeding weevil *Cyphocleonus trisulcatus* (photo: S. Stutz)

To clarify the taxonomy of invasive oxeye daisies, we continued collecting seeds and DNA samples from oxeye daisy populations in North America and Europe. Ploidy analyses, which were continued in collaboration with Prof. Heinz Müller-Schärer, University of Fribourg, Switzerland, confirmed that invasive oxeye daisies are mainly represented by the diploid *L. vulgare*, whereas the tetraploid species, *L. ircutianum*, seems to be much less abundant. In collaboration with Dr John Gaskin, USDA-ARS Sidney, Montana, and Prof. Christoph Oberprieler, University of Regensburg, Germany, we continued with molecular analyses in order to identify genetic variation in oxeye daisy in the native and introduced ranges.

In 2013, we will continue with studies on the host range and impact of *D. aeratana* and start host-range testing of *T. neesii* and *A. stolidum*. We will also collect additional larvae and adults of *C. trisulcatus* and will try to establish a rearing colony at CABI.

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Valentine Renevey (University of Fribourg, Switzerland) collecting roots infested with *Cyphocleonus trisulcatus* in southern France (photo: S. Stutz)

Melanagromyza albocilia mating pair (photo: G. Cortat)

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 field bindweed. Two biological control agents were released, the gall mite *Aceria malherbae* and the bindweed moth *Tyta luctuosa*. The gall mite became established although its impact under field conditions varies, while establishment of the bindweed moth has never been confirmed. Therefore, the project has been revived, and 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 no-choice larval transfer and multiple-choice tests established in 2010 and 2011, *L. pellucidus* was able to develop on several native North American plant species. Preliminary no-choice tests with the closely related *L. rubiginosus* yielded similar results. An open-field test was therefore established in summer 2011 at a site where both flea beetles occur. In 2012, *L. pellucidus* emerged only from *C. arvensis*. However, since few adults emerged, the results were not conclusive and the test would need to be repeated. In contrast, besides *C. arvensis*, *L. rubiginosus* emerged from the two North American natives *C. equitans* and *Calystegia macrostegia*. This flea beetle is therefore not deemed specific enough to be further considered as a potential biological control agent for field bindweed in North America.

Cylinders for trials with *Melanagromyza albocilia* (photo: G. Cortat)

In 2012, we also continued observing the behaviour of the agromyzid fly *M. albocilia*, investigating its longevity, and establishing sequential no-choice oviposition tests using cut plant parts. Females lived on average 15.6 ± 3.9 days (range: 3–59) and laid on average 20.9 ± 8.9 eggs (range: 0–73) during their lifetime. Eggs were found on four of eight exposed test plant species. A similar number of eggs was laid on the target *Convolvulus arvensis* and on the native North American species *Calystegia soldanella*, although the number of feeding marks was 50% less. In contrast, feeding and oviposition were relatively uncommon on the remaining species. Potted plants exposed in development tests did not yield satisfactory results with only one out of four controls attacked.

In 2013, we will focus on no-choice development tests, using potted plants, with *M. albocilia.* We will also try to establish an open-field test with two additional potential agents, the defoliating moth *Emelia trabealis* and the defoliating chrysomelid beetle *Hypocassida subferruginea*, in the Slovak Republic in collaboration with Dr Peter Tóth (Slovak Agricultural University, Nitra).

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Natalia Meideros de Souza during mass collection of *Melanagromyza* in southern Germany (photo: G. Cortat)

biological control of sulphur cinquefoil, *Potentilla recta*

Sulphur cinquefoil, *Potentilla recta*, is a perennial native to Eurasia that was introduced into North America over a hundred years ago. It has invaded disturbed habitats, e.g. roadsides and pastureland, but also semi-natural habitats such as open forests. There is concern that *P. recta* may become a vector for pests of economically important plant species (notably strawberries). A biological control project that had started in 1992 came to a premature end in 2002 owing to both the uncertainty of finding a host-specific candidate biological control agent and the funding situation. The root-mining clear-wing moth *Tinthia myrmosaeformis* and the flower-bud attacking weevil *Anthonomus rubripes* were studied in depth, but specificity was not satisfactory. In 2008, the project was revived on behalf of the British Columbia Ministry of Forests, Lands and Natural Resource Operations, Canada, and a report summarizing data from previous research was prepared. Work on three species that were previously prioritized as potential agents was restarted.

Janetiella potentillogemmae on *Potentilla recta* (photo: G. Cortat)

Between 2009 and 2011, several attempts to elicit gall induction by two cynipid gall wasps, *Diastrophus* sp. near *mayri* from Turkey and *D. mayri* from Ukraine, were not successful and work was discontinued with these species.

Janetiella potentillogemmae, a gall midge species from Turkey recently described by Dr Marcela Skuhravá (Czech Republic), was collected during a field trip to Turkey in 2011. Galls were overwintered either as rooted gall-bearing plants in pots placed in an unheated glasshouse or garden bed, or as cut gall-bearing shoots placed in plastic containers with vermiculite and kept in an outdoor shelter. Between April and May, 117 females and 30 males emerged from 235 galls. While no mating was observed, eggs were found on cut shoots and females were subsequently offered potted plants in no-choice tests. *Potentilla recta* of five different origins, including one European population, and five North American native *Potentilla* species were exposed. Eggs were found on some of the *P. recta* from Turkey, but unfortunately no galls developed.

Gall of *Janetiella potentillogemmae*, Turkey (photo: G. Cortat)

After discussion with our sponsors and collaborators in Canada, it was finally decided to bring the *Potentilla* project to a close. A wrap-up publication will be prepared summarizing work on the project and lessons to be learned from the study.

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Ali Sultani looking for galls of *Janetiella potentillogemmae* (photo: G. Cortat)

Chrysolina larva feeding on tutsan (photo: E. Olsen)

Excised leaves of tutsan from two different New Zealand populations, West Coast (left) and Otago, Dunedin (right), inoculated with the rust *Melampsora hypericorum* at the same time. The West Coast population appears to be susceptible to this rust strain, while the Dunedin population appears to be resistant (photo: E. Olsen)

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

Tutsan, *Hypericum androsaemum*, is an evergreen or 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 in which 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's centre in Switzerland was approached by Landcare Research New Zealand Ltd to conduct field surveys in the area of origin of tutsan with the main objectives of collecting leaf samples from tutsan and the rust for molecular analyses, surveying tutsan for phytophagous arthropods and fungal pathogens, and evaluating their potential as biological control agents.

In spring 2012, MSc student Elena Olsen from the USA was engaged on the project. Two field trips were conducted in the UK and Ireland, and one field trip to France and Spain. A total of 68 tutsan sites were found, although many had very few (fewer than ten) plants. Tutsan appeared to be fairly common in more humid habitats of north-eastern Spain and south-western France. At all sites, plant samples were taken for molecular analyses and plants were inspected for herbivores and fungal pathogens. Quantitative field sampling was conducted at ten sites. This included measuring population and individual plant parameters, recording insect and fungal damage in a standardized way, and quantitatively sampling insect herbivores. Rust infection was present at approximately half of all sites. Other possible signs of pathogen infection included leaf spots, leaf necrosis and stunted shoot growth. Potential fungal pathogens were isolated from eight sites and will be sent for identification.

Two chrysomelid beetle species, *Chrysolina varians* and *C. brunsvicensis* were collected in Spain and the UK. The former were subjected to preliminary host-specificity tests with two *Hypericum* species native to New Zealand. Feeding on the native New Zealand species was reduced compared to tutsan and larvae took longer to develop and had higher mortality. Several moth species were found during surveys all of which are known to be not species specific. Other insects of potential interest that await identification include a few additional moth species, beetles, and seed-feeding hemipterans. Common generalist herbivores collected were aphids, whiteflies, froghoppers (nymphs and adults), slugs, snails and katydids.

In July, Chantal Morin was also engaged on the project to provide expertise in isolation and inoculation of plant pathogens. An inoculation method for the rust has been developed and infection was achieved with nine different rust strains. Rust pustules developed on only one of the two New Zealand tutsan populations tested. Cultivation of 2–3 rust strains will be maintained to test virulence on additional New Zealand tutsan populations and to conduct preliminary host-specificity tests with New Zealand native and ornamental *Hypericum* species.

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Elena Olsen taking plant measurements on tutsan at a field site in Scotland (photo: P. Pardo)

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's approval its field release was 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 closely related plant species native to the UK, they did not include related plant species native to other parts of Europe.

In spring 2012, the 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. Capitalizing on the know-how of CABI's Weed Biological Control group in the UK, we will conduct host-specificity studies 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.

In addition, we will assess variation in resistance to *Aphalara itadori* in the highly invasive *F.* × *bohemica* (a hybrid of *F. japonica* and *F. sachalinensis*) by assessing the growth rate and survival of the psyllid on replicated clones of genotyped hybrids. The results of this study will be of relevance for continental Europe, since the hybrid is considered to be at least as aggressive an invader as Japanese knotweed.

In early June, *A. itadori* was hand-carried from the CABI centre in the UK to CABI in Switzerland, and a rearing colony of the psyllid was successfully established in quarantine.

Between August and December 2012, no-choice oviposition and development tests were established with three *Rumex* species native to Switzerland, with *F. japonica* as the control. Potted plants were each exposed to five pairs of psyllid adults for five days. Eggs were laid on all control plants and the survival rate to adult was about 40%. Eggs were also laid on some replicates of the *Rumex* species, but far fewer than on *F. japonica* (420 vs 8–14 eggs on average) and when eggs on the *Rumex* species hatched, nymphs died before they reached the second instar.

In 2013, we will continue assessing the suitability of test plants native to Switzerland for oviposition and larval development by *A. itadori*, and we will start assessing variation in performance of the psyllid on various genotypes of *F.* × *bohemica*.

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Funded by: FOEN.

Fourth and fifth instar nymphs of *Aphalara itadori* feeding on *Fallopia japonica* (photo: G. Cortat)

No-choice cage tests with *Fallopia japonica* (left) and *Rumex patienta* (right) (photo: G. Cortat)

Cornelia Cloşca measuring a test plant (photo: G. Cortat)

arthropod biological control

introduction

The Arthropod Biological Control programme is led by Drs Tim Haye and Ulli Kuhlmann with additional CABI scientists based at CABI joint laboratories in Hungary (Dr Stefan Toepfer) and China (Drs Li Hongmei and Zhang Feng). Our team researches natural enemies, such as insect parasitoids and predators, and their suitability as potential biological control agents of insect pests. Our expertise spans the exploration for natural enemies of designated target insect pests, as well as the characterization of their identity, life history parameters, ecology, behaviour and impact. We have significant experience in conducting field and laboratory studies to assess the effects of exotic biological control agents on non-target native species and also offer this service to biological control SMEs (small and medium-sized enterprises). Recently, we started to investigate the impact of climate change on agricultural pests and their natural enemies. We work in partnership with a wide range of organizations and have particularly close links with AAFC and Canadian universities.

In 2012, our Swiss team was joined by three students from Canada who carried out research focused on the biological control of insect pests in Canadian canola (*Brassica napus* and *B. rapa*), such as cabbage seedpod weevil (*Ceutorhynchus obstrictus*), swede midge (*Contarinia nasturtii*) and plant bugs (*Lygus* spp.). In addition, we started to work on two new targets, the red clover casebearer, *Coleophora deauratella*, and the brown marmorated stink bug, *Halyomorpha halys*. Stefan Toepfer and his team from the Joint Laboratory of CABI and the Plant Protection Directorate in Hodmezovasarhely in southern Hungary focused on the control of the invasive western corn rootworm (*Diabrotica virgifera virgifera*). Research focused on behavioural and biological investigations on *Diabrotica* adults and their offspring to improve understanding of the potential effects of pesticides, application techniques for beneficial nematodes against rootworm larvae, and the dispersal and oviposition behaviour of adult *Diabrotica* in non-maize crops.

Our MSc student Paul Abram (Carleton University, Ottawa, Canada) successfully defended his thesis entitled 'The parasitoid complex associated with the invasive swede midge, *Contarinia nasturtii*, in Europe: prospects for classical biological control in North America' in January 2012 and will continue his career in entomology at the University of Montreal in Canada, where he has been accepted as a PhD student. Paul presented his outstanding work at the Annual Meeting of the Canadian Entomological Society and was awarded the society's President's Prize in the category 'Agriculture'. PhD student Lars Andreassen (University of Manitoba, Canada) did not return to our centre this year, but continued the molecular analysis of field samples from Switzerland at the University of Manitoba which will allow him to finalize his thesis on biological control of *Delia* root maggots.

Luo Shuping (MoA-CABI Joint Laboratory for Bio-safety, Beijing, China) joined our team for two weeks in July/August to collect European *Lygus* parasitoids for controlling mirid pests in Chinese cotton. In return Tim Haye visited the Joint Laboratory in April and July to search for potential biological control agents of the box tree caterpillar, *Cydalima perspectalis*, and the brown marmorated stink bug, *Halyomorpha halys*.

As an outcome of our research projects in 2012, a number of research manuscripts have been published jointly with our international partners in peer-reviewed international journals, including BioControl, Biological Control, Entomologica Experimentalis et Applicata, Agricultural and Forest Entomology, Journal of Applied Entomology, Evolutionary Applications and PLoS ONE. Furthermore, our research was presented at international meetings, such as the Joint Meeting of the Entomological Society of Canada and the Entomological Society of Alberta in Edmonton, Canada, the Annual Meeting of the Entomological Society of Quebec in Montreal, Canada, the XXIV International Congress of Entomology in Daegu, Republic of Korea, the 58th German Plant Protection Meeting in Braunschweig, Germany, and the International Diabrotica Symposium in Berlin, Germany.

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Arthropod Biological Control team, 2012: Leah Hohman, Luo Shuping (CABI-MoA Joint Laboratory, Beijing), Letitia Da Ross, Tim Haye and Llewellyn Haines; not pictured: Ulli Kuhlmann and Stefan Toepfer (photo: T. Haye)

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

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 British Columbia, Canada, 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 Quebec in 2009. To date it remains unclear whether the parasitoid has the potential to spread and establish throughout the canola growing area of Canada.

Llewellyn Haines collecting cabbage seedpod weevil parasitoids emerging from samples collected across Europe (photo: T. Haye)

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 insects considered for classical biological control programmes may be successful against invasive pests. The objective of our study was to collect European distribution data for *T. perfectus* to develop bioclimatic models predicting the potential distribution and abundance of the parasitoid in North America.

Trichomalus perfectus, a parasitoid of the cabbage seedpod weevil (photo: T. Haye)

In 2012 surveys for cabbage seedpod weevil parasitoids were conducted in Spain, France, Italy, Switzerland, Germany, Denmark, Hungary and Romania to determine the distribution and abundance of *T. perfectus* in Europe. In total, more than 15,000 weevil larvae and 7000 parasitoids emerged from our collections. The most common parasitoids were *T. perfectus*, *Mesopolobus morys, Stenomalina gracilis* and *Eurytoma* spp. *Trichomalus perfectus* was found at 121 locations, and our preliminary data suggest that it is dominant in the northern parts of Europe, whereas *M. morys* is more common in the south. In 2013, surveys will be expanded to additional European countries.

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Llewellyn Haines, Leah Hohman and Letitia Da Ross collecting cabbage seedpod weevil parasitoids in a canola field at Courroux, Switzerland (photo: T. Haye)


Development of a gall at the growth point of a young canola plant (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 Ontario, Canada, 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. In 2012, the swede midge was also present in Canada in Quebec, Nova Scotia, Manitoba and Saskatchewan, as well as five American states: New York, Massachusetts, New Jersey, Connecticut and Ohio. Since the arrival of the swede midge 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.

Between 2008 and 2011 we comprehensively surveyed and identified potential classical biological control agents in Europe for introduction into North America. Four species of larval endoparasitoids attacking the swede midge were found: *Inostemma opacum, Macroglenes chalybeus, Synopeas myles* and *S. osaces*. Of these, *M. chalybeus* and *S. myles* were found throughout the surveyed range, and attacked every generation of the swede midge. Levels of attack, however, were typically less than 10%.


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

Since parasitoids do not seem to regulate the pest efficiently in Europe, we initiated life-table studies in Europe, which will allow us 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. Two different methods for studying life-table characteristics for swede midge were developed in 2012 and our preliminary results indicate that swede midge suffers from high egg mortality. Life-table studies in Switzerland will be continued in 2013.

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Swede midge life-table experiment in the CABI garden at Delémont (photo: T. Haye)

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

The brown marmorated stink bug, *Halyomorpha halys*, is native to eastern Asia and invasive in the USA, Canada and Switzerland. Due 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 North America it was first detected in 1996 in the US state of Pennsylvania, and is now present in 38 states in the USA. The stink bug quickly became a major nuisance pest in the Mid-Atlantic US region due to its habit of entering structures to overwinter. In Canada *H. halys* was first reported from Vancouver, British Columbia, where it was intercepted in 1993. In 2012, the first breeding population in Canada was found in Hamilton, Ontario, where the stink bug is now well established. Its discovery immediately raised concern among Canadian fruit growers because in 2010 *H. halys* caused severe losses in fruit production in the Mid-Atlantic states of the USA. It can be expected that in the coming years, *H. halys* will 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 halyomorphae* is the most promising candidate for biological control of brown marmorated stink bug in North America.

In 2012, field surveys were conducted in the Chinese provinces of Beijing and Hebei to assess the natural enemy assemblage of *H. halys* and non-target stink bugs and to define the field host range of *T. halyomorphae*. In total, six stink bug species were found, i.e. *H. halys*, *Dolycoris baccarum, Plautia* sp., *Eurydema* sp., *Stollia* sp. and *Erthresina fullo*. Egg masses of *H. halys* collected in orchards, botanical gardens and natural sites were heavily parasitized by *T. halyomorphae* and *Anastatus* sp., whereas non-target species were attacked by five different egg parasitoids from the genera *Trissolcus, Anastatus, Ooencyrtus* and *Telenomus*.

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

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

Zhang Jinping collecting stink bug egg masses in the Fragrant Hills, Beijing, China (photo: T. Haye)

Lygus plant bug nymph (photo: T. Haye)

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

impact of climate on *Lygus* parasitoids

Plant bugs of the genus *Lygus* are highly polyphagous pests of field and greenhouse crops throughout North America, including vegetable and fruit crops, alfalfa and canola. *Lygus* nymphs are commonly parasitized by various species of the genus *Peristenus*. In North America, overall parasitism by native parasitoids is insufficient to significantly suppress pest *Lygus* spp. populations; however, the level of parasitism of *Lygus* spp. in Europe was found to be much higher. Consequently, a neoclassical biological control programme was initiated to introduce European *Peristenus* species to North America for biological control of native *Lygus* pests. One of them, *Peristenus digoneutis*, was successfully released in the 1980s in the north-eastern USA, where it caused high levels of parasitism and a significant decrease in *Lygus* populations in alfalfa. Since its original establishment in the US state of New Jersey in 1984, *P. digoneutis* has continued to spread and is now present in 11 north-eastern US states and the Canadian provinces of Ontario, Quebec and Nova Scotia.

Although attempts were made to introduce *P. digoneutis* in western Canada, several releases between 1981 and 1997 failed to result in establishment. In terms of establishment and spread, parasitoid introductions in northern latitudes are often limited by overwintering survival. However, for *P. digoneutis*, it was suggested that establishment appeared to be limited by excessive summer temperatures. Furthermore, the distribution pattern of *P. digoneutis* in Europe indicated that its occurrence is strongly dependent on the presence of at least two *Lygus* generations per year and that climatically influenced annual fluctuations in the numbers of *Lygus* spp. generations per year could have prevented its establishment in western Canada.

In 2011/12 we developed a bioclimatic model to predict potential range and relative abundance of *P. digoneutis* and its host *Lygus* spp. based on European distribution data. The model will help to explain why releases in western Canada failed and how climate affects the status of biological control efforts to manage *Lygus* populations using *P. digoneutis* in North America. In 2013, we will investigate how climate change may affect the distribution of *P. digoneutis* in North America in the future.

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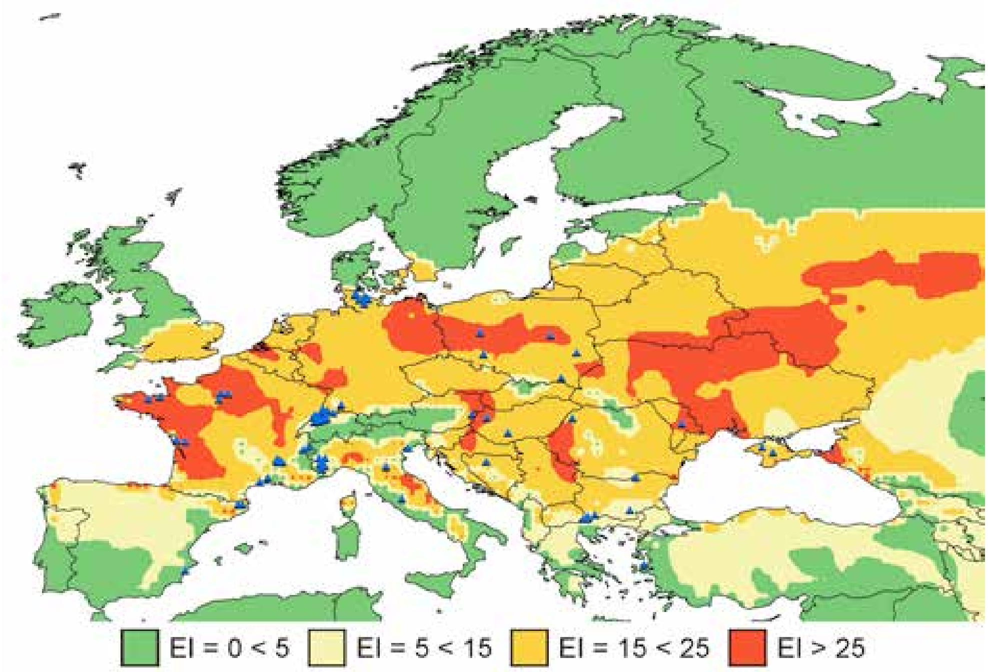

Predicted distribution and abundance of *Peristenus digoneutis* in Europe and locations where populations were reported to occur (blue triangles). Ecoclimatic index (EI) values are displayed in four categories: 'unfavourable' (EI = 0 to 5); 'suitable' (EI = 5 to 15); 'favourable' (EI = 15 to 25); and 'very favourable' (EI = more than 25) (map: R. Weiss, AAFC, Saskatoon)

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 within fields from bud to harvest, feeding upon florets and developing seed from mid-June until late September.

In Europe, *Coleophora* spp. are controlled by a complex of at least 17 parasitoids, which were studied by CABI scientists in the 1960s. Thousands of parasitoids 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 the *Coleophora* spp. population 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 the two 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 of protecting pollinator species for seed and honey production attracted interest in biological control from clover seed producers in Alberta. Since the impact of parasitoids, particularly of *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 2012, we started to survey for red clover casebearer populations in Switzerland, but densities were very low. In 2013, we plan to extend surveys to locations in Scandinavia, where parasitoid populations might be better adapted to climatic conditions in Canada.

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Agathis rufipalpis, a parasitoid of red clover casebearer (photo: T. Haye)

Red clover casebearer adult (photo: AAFC, Beaverlodge)

Red clover casebearer larva in an opened clover floret (photo: AAFC, Beaverlodge)

Luo Shuping rearing *Apolygus lucorum* at the MoA-CABI Joint Laboratory in Beijing (photo: T. Haye)

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, young squares and bolls, and various other tissues of this plant, often leading to bushy plants and abscission of squares and bolls. At high population density, it can also 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 targeted against the cotton bollworm. Since 1997, however, Chinese farmers have been increasingly adopting *Bt* cotton to combat the cotton bollworm, with resulting reductions in the amount of insecticides used in cotton production. This lowered 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.

Luo Shuping collecting *Lygus* parasitoids in the German Rhine Valley (photo: T. Haye)

During surveys for parasitoids native to China, which were started in 2009, more than 10,000 mirid nymphs were collected from infested alfalfa and cotton fields, and two native braconid nymphal parasitoids, *Peristenus relictus* and *P. spretus*, were identified as potential biological control agents. A mass-rearing system was developed for *P. spretus* at the MoA-CABI Joint Laboratory of Bio-Safety and investigations on its biology and ecology, e.g. parasitoid fitness and impact of the parasitoid under field conditions, were continued in 2012. Since Chinese *Lygus* parasitoids may prove ineffective in controlling *Apolygus* populations, European *Lygus* parasitoids were collected in the German Rhine Valley in August 2012 and imported to China for further host-range studies under quarantine conditions. Studies on the *Lygus* parasitoids' physiology and ecology will be continued in 2013.

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Zhang Jinping, Tim Haye, Luo Shuping and Li Hongmei visiting Langfeng Agricultural Station, Hebei Province (photo: T. Haye)

crop rotation to control *Diabrotica* in Germany and Hungary

Over the last 25 years, the North American maize pest *Diabrotica virgifera virgifera*, or western corn rootworm, has moved into Europe causing problems in maize production. This leaf beetle recently arrived in southern Germany, which has created problems for local farmers as they have to implement the binding European Commission (EC) decisions on eradicating or containing the new invader (i.e. obligatory rotation and pesticide applications). The German State of Bavaria therefore decided to fund a four-year multi-institutional project (2009–12) to seek new solutions for this pest and improve pest management strategies. CABI was tasked with providing the scientific basis for improving advice and guidelines for crop rotation in Bavaria.

Most damage attributed to this univoltine pest is due to larval feeding on maize roots, which ultimately causes plant lodging. The larvae are restricted to maize. Consequently, crop rotation is a powerful control strategy. *Diabrotica* beetles are, however, good flyers and tend to visit any nearby flowering crop or weed vegetation to feed. As they may also lay eggs into the soil of these food habitats, crop rotation may become less effective when a non-maize crop is succeeded by maize the following year.

CABI was therefore investigating the dispersal and oviposition behaviour of adult *Diabrotica* in non-maize crops typically grown in Bavaria. The field experiments were conducted near the Joint Laboratory of CABI and the Plant Protection Directorate in Hodmezovasarhely in southern Hungary because this location provides a combination of high pest populations, good conditions for field trials, and good local expertise on this pest.

Results suggest that, despite dispersal and oviposition of c. 5% of a *Diabrotica* population from maize into non-maize crops, economic thresholds are not likely to be quickly exceeded. In conclusion, any crop can be rotated with maize to control *Diabrotica* in Europe.

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Mass collection of *Diabrotica* beetles for release–recapture experiments on dispersal of this maize pest in southern Hungary (photo: S. Toepfer)

Stefan Toepfer collects adult beetles from emergence cages in plots of maize in southern Hungary, planted after a previous non-maize crop had potentially attracted egg laying by *Diabrotica* (photo: C. Pilz, Austrian Agency for Health and Food Safety, Vienna)

The 2012 *Diabrotica* team in Hungary: Ferenc Koncz (Hodmezovasarhely, Hungary), Stefan Toepfer (CABI) and Ferenc Kiraly (Szeged, Hungary) during placement of gauze cages to capture adult *Diabrotica* beetles; not pictured: Rajmond Stuber (Hodmezovasarhely, Hungary) (photo: R. Stuber)

An adult of the leaf beetle *Diabrotica virgifera virgifera* or western corn rootworm, a maize pest in North America and Europe (photo: A. Varga, Plant Protection Directorate, Hodmezovasarhely)

moving towards less hazardous pesticide use against *Diabrotica*

The maize pest *Diabrotica virgifera virgifera*, western corn rootworm, is among the pest insects to which greatest amounts of pesticides are applied annually in North America, and to an increasing extent also in Europe. Pesticides are usually applied either into the soil against the larvae, or with the help of high-wheel machinery across maize fields against the adults. This raises concerns about potential effects on the environment. Plant protection companies are therefore searching for novel and less toxic active ingredients for their products, or for application methods that allow a reduction of the dosages applied.

Syngenta Crop Protection AG Switzerland contracted CABI (2012–2013) to conduct behavioural and biological investigations on the effects of two novel products on *Diabrotica* adults and their offspring, aiming to better understand the whole picture of potential effects of pesticides on such an insect. These field and laboratory experiments are being conducted at the Joint Laboratory of CABI and the Plant Protection Directorate in Hodmezovasarhely in southern Hungary because this location provides a combination of high pest populations, good conditions for field trials, and good local expertise on this pest.

S. Toepfer (s.toepfer@cabi.org) and **U. Kuhlmann**. Funded by: Syngenta Crop Protection AG Switzerland.

Male and female *Diabrotica* beetles ready to be released in field cages in Hungary (photo: S. Toepfer)

Summer student Ferenc Koncz (Hodmezovasarhely, Hungary) and CABI's Stefan Toepfer sorting immature male and female beetles of the maize pest *Diabrotica* for insecticide field cage experiments in southern Hungary (photo: R. Stuber)

a nematode-based product for the biological control of *Diabrotica* in Europe

The western corn rootworm, *Diabrotica virgifera virgifera*, is one of the most destructive pests of maize in North America. It is a univoltine 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, it has moved into Europe causing major problems in maize.

Between 2004 and 2008, CABI, together with the University of Neuchâtel, the farmer association Landi REBA in Basel and Agroscope Reckenholz-Tänikon (ART) in Switzerland, as well as the Plant Protection Directorate at Hodmezovasarhely in Hungary and the nematode producer e-nema at Schwentinenthal in Germany, developed a nematode-based biological control product for pest larvae under a project funded by the Swiss Commission for Technology and Innovation (CTI), of the Federal Office for Professional Education and Technology. At the end of the project, the product remained in the pipeline for implementation by e-nema. However, the recent arrival of the invasion front of *Diabrotica* in southern Germany and the banning of several insecticide seed coatings due to bee toxicity have generated a strong resurgence of interest in the biological control product. Consequently, the State of Baden-Württemberg in southern Germany decided to fund a three-year project to further develop the nematode-based biological control of the rootworm larvae. Between 2010 and 2012, LTZ (Landwirtschaftliches Technologiezentrum) in Stuttgart, Germany, AGES (Austrian Agency for Health and Food Safety) in Vienna, and CABI tested several application techniques for the beneficial nematodes in maize fields in Germany, Austria and Hungary to improve existing application technologies, aiming for the farmer-friendliest and least-costly method.

Fluid and granular applications during sowing as well as seed coating with nematodes appeared technically possible, and all techniques achieved control of the pest's larvae. As a result, the nematode producer e-nema launched the nematode-based control product (DianemTM) for *Diabrotica* larvae in Germany and Austria in 2012.

S. Toepfer (s.toepfer@cabi.org), **T. Haye** and **U. Kuhlmann,** in collaboration with **P. Knuth** and **M. Glas,** LTZ, Stuttgart in Germany, R. Burger, Landi REBA, Basel in Switzerland, A. Peters, e-nema, Schwentinenthal in Germany, and the Plant Protection Directorate, Hodmezovasarhely in Hungary. Funded by: Ministry for Rural Areas and Consumer Protection, State of Baden-Württemberg, Germany, through LTZ, Germany.

The red colour of a larva of the maize pest *Diabrotica* originates from the symbiotic bacteria of the nematode that killed the larva (photo: S. Toepfer)

Nematode-based product for *Diabrotica* larvae launched on the webpage of the e-nema biological control company in Germany, www.e-nema.de/maiswurzelbohrer.php

CABI's Stefan Toepfer and summer student Ferenc Koncz (Hodmezovasarhely) assess root damage and yield losses from *Diabrotica* rootworm larvae during trials for the biological control of western corn rootworm in southern Hungary (photo: R. Stuber)

Parasitoid of *Cydalima perspectalis* (photo: T. Haye)

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

The box tree caterpillar, *Cydalima perspectalis*, an invasive alien species of Asian origin, was first reported from south-western Germany in 2006, from where 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. Box trees are commonly planted in European gardens for ornamental purposes, but native box trees (*Buxus sempervirens*) also grow in woodlands and forests as understorey shrubs. The introduction of *C. perspectalis* in Europe represents a severe threat to nurseries, parks and gardens, and natural *Buxus* stands. A project has been developed at the CABI centre in Switzerland to assess the current and potential ecological impact of the caterpillar and to evaluate the potential for biological control.

Since *C. perspectalis* was probably introduced from China, field surveys for natural enemies started in 2011 were continued in 2012 in the Chinese provinces of Shandong, Zhejiang and Anhui. The most common parasitoid was *Chelonus* sp., causing 3–17% parasitism. Surveys for natural enemies conducted in Switzerland and Germany in 2012 confirmed the results of our previous surveys in 2011. Parasitism rates were again very low and the only natural enemy found was the tachinid fly, *Pseudoperichaeta nigrolineata*. The low rates of parasitism in Switzerland and Germany suggest that so far native European parasitoids have not adopted the new host and, thus, *Cydalima perspectalis* is a good target for classical biological control.

Mature box tree caterpillar (photo: T. Haye)

Biological parameters such as diapause induction and the influence of temperature on the development of immature stages of the pest were investigated, as part of the MSc thesis of Saidou Nacambo, a student from the University of Neuchâtel. These parameters were used to develop a bioclimatic model, which predicts that the moth will spread to most European regions, but its damage will probably be higher in the Southern half of Europe where at least two generations can occur and where box grows naturally. The thesis also included an assessment of the ecological impact in natural box stands in north-western Switzerland, which showed that severely attacked plants do not regenerate.

In 2013, a long-term study in natural box tree stands in Switzerland to assess the impact of the insect on the plant will be continued as well as investigations on the biology of the candidate biological control agent *Chelonus* sp.

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Wan Huanhuan and Tim Haye collecting box tree caterpillars (photo: Li H.M.)

introduction

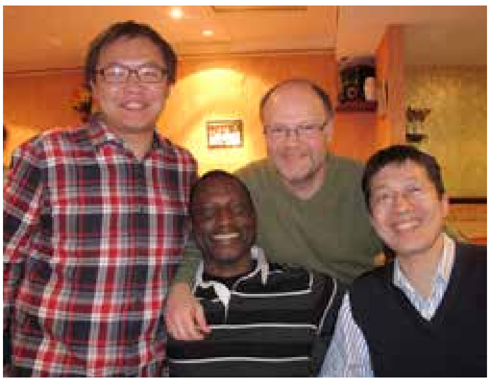
This was the last year for two important projects. BACCARA (Biodiversity and climate change, a risk analysis), funded by the EC Seventh Framework Programme (FP7), was considered very productive. The various guidelines and tools produced will help forest managers deal with climate change in European forests in the next decade. Research for three MSc theses was undertaken at CABI within the framework of the project and various publications are currently being written on the effect of climate change on forest pests. Another multi-partner project, JATROPHABILITY (Investigating impacts of *Jatropha curcas* production) ended with an intensive year of fieldwork in West Africa and Mexico, and a very successful workshop was co-organized in Nairobi, Kenya, in conjunction with two sister projects. Policy briefs, opinion papers and scientific papers are currently being produced on this highly debated crop.

In 2013, these projects will be replaced by another EC FP7 project, PROteINSECT (Enabling the exploitation of insects as a sustainable source of protein for animal feed and human nutrition), coordinated by Fera (Food and Environment Research Agency) in the UK, in which 12 European, Asian and African teams will assess the feasibility of using maggots and maggot-derived proteins in animal feed. Our section and the CABI-MoA Joint Laboratory for Bio-Safety in China will be particularly involved in the development of new fly rearing methods in China and West Africa. For this project, we have recruited a new team member, Saidou Nacambo, who did research for his MSc thesis with us in 2011–12 on the impact, developmental biology and biological control of the box tree caterpillar, *Cydalima perspectalis* (see the Arthropod Biological Control section, p. 52). Another student, Natália Medeiros de Souza from Brazil, worked with us this year, carrying out preliminary observations in Switzerland on the newly invasive fruit fly *Drosophila suzukii*. It is planned to further expand this project in the near future because the fly is likely to become a major threat to small fruit production in Europe.

In two other European projects (the FP7 project ISEFOR and the EU COST Action PERMIT), we are investigating the introduction of alien forest pests into Europe and, in particular, the trade in woody plants for planting, a major pathway of invasion for forest pests. Investigations are being carried out in collaboration with a large number of European and Asian partners and the principal investigator at CABI is René Eschen. René is also responsible for carrying out our field research on the ecological impact of the invasive harlequin ladybird (*Harmonia axyridis*) on indigenous ladybirds. Disturbing results are emerging, with the two-spot ladybird (*Adalia bipunctata*) having nearly disappeared from the Swiss Jura. Finally, I should mention that I had the pleasure of organizing a cycle of conferences in Switzerland, funded by FOEN, on the inevitable arrival of the Asian hornet (*Vespa velutina*) in the country. These conferences were targeted mainly at bee-keeper associations since the hornet is a serious predator of honey bees. A website was developed to keep bee-keepers and the general public informed about the status of the hornet in Switzerland (www.cabi-e.ch/Vespa/).

Dr Marc Kenis, Head of Risk Analysis & Invasion Ecology (m.kenis@cabi.org)

René Eschen looking for ladybirds using a beating tray (R. Eschen)



The PROteINSECT team with Rui Tang, Saidou Nacambo, Marc Kenis and Zhang Feng (Photo: R. Tang)

Elevation gradient in the Alps
(photo: N. Brinkmann)

Biodiversity And Climate Change, A Risk Analysis: BACCARA

BACCARA was an Integrated Project of the EC FP7 involving 15 European teams and one Chinese team, which ran from January 2009 to December 2012. Its main objective was to develop tools to allow forest managers and policy makers to evaluate the risks to European forest biodiversity and productivity loss that could arise from climate change. The aim was to construct a three-dimensional risk assessment model linking climate change, functional diversity and forest productivity.

Climate change is expected to have serious effects on forest biodiversity. In particular, it may affect insect pest populations directly through temperature increase, atmospheric CO2 increase and/or changes in precipitation patterns, and indirectly through changes in host–plant interactions and modification of natural enemy complexes. Within the BACCARA project, our team participated in an assessment of the likely effect of climate change on forest pest populations and the subsequent impact on forest productivity and biodiversity, using functional groups (i.e. species sharing common life traits) and elevation gradients as analogues for global warming. CABI also coordinated dissemination activities to fulfil the project's outreach function.

In this last year, work focused mainly on analysis of field data gathered by the project partners in previous years, especially data relating to insect herbivory along elevation gradients throughout Europe. Meta-analyses based on published and unpublished data for herbivory and parasitism along elevation gradients were carried out to complement the field data analysis. Together, the analyses showed highly variable reactions by insect species and functional groups to elevation and, thus, temperature, although a significant general decrease in herbivory with elevation could be detected in some groups and on some tree species. Parasitism and parasitoid richness generally decreased with elevation, particularly in relation to ectophagous herbivores.

The larch budmoth (*Zeiraphera diniana*) is moving towards higher elevations in the Alps because of climate change
(photo: N. Brinkmann)

Based on these data and others, several features have been identified for forest pest insects and pathogens that can explain and then predict their response to increasing temperature and drought. Using this classification, we have, with project partners, produced an electronic database in the form of 83 data sheets for the main European forest pests and diseases, in which we give an assessment of the actual and potential effects of climate change on distribution, abundance and damage.

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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 to prevent the introduction of potential invasive species, the number of exotic forest pests and diseases in Europe continues to rise. The large increase in trade volume over the past 15 years and changes in the identity and origin of traded plants are factors that affect the risk of new, previously unknown forest pests and pathogens becoming established in Europe. In addition, climate change may affect tree growth as well as their susceptibility to pests and diseases. An analysis of the trade in plants for planting and quarantine inspection procedures in Europe and elsewhere can assist quarantine authorities in tackling the risks associated with alien pests and pathogens.

The ISEFOR project (full title: 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 arriving and established alien pests and pathogens. The ISEFOR consortium comprises 17 partners from the EU, Russia and China and the research project is funded under the EC's FP7. CABI's input focuses on defining the threats of invasive species to European forests, based on current knowledge of pests and pathogens and their host plants, and on contributing to a critical assessment of the nursery trade and phytosanitary inspection procedures, mainly in Europe and China.

In collaboration with teams from various European countries, in 2012 we continued with a detailed assessment of the trade in plants for planting and the inspection procedures on import into the EU. We also analysed pest and pathogen distribution data from CABI's Crop Protection Compendium and the Plantwise Knowledge Bank in order to identify threats from 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. Two test 'sentinel' nurseries were set up in China, one close to Beijing managed by CABI's China office, as a new method to help assess the risk of live plant imports. The 'sentinel' trees are specimens of species commonly traded with Europe, which are regularly monitored to identify insects and pathogens that could be accidentally introduced on trees into Europe. A short-term output of this project will be diagnostic and pest-risk analysis tools for the plant health community in Europe.

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Species commonly exported to Europe growing in a sentinel nursery in China and managed by CABI (photo: R. Eschen)

The international trade in plants for planting is a major pathway for the introduction of invasive forest pests and diseases (photo: R. Eschen)

Anna Maria Vettraino (Tuscia University, Italy) and Li Hongmei inspect sentinel plants for the presence of pathogens (photo: R. Eschen)

Esther Abonyo and Alizèta Sawadogo, students at Faso Biocarburant, examining a damaged leaf of *Jatropha curcas* in Burkina Faso (photo: M. Kenis)

investigating impacts of *Jatropha curcas* production: JATROPHABILITY

Jatropha curcas is a member of the Euphorbiaceae, 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 worldwide, in particular in the four project countries: India, Mali, Burkina Faso and Mexico. However, little is so far known about basic agronomy and ecological impacts across different agro-ecoregions. JATROPHABILITY, funded by various donors under the ERA-ARD (European Research Area – Agricultural Research for Development) programme of the EC 6th Framework Programme (FP6) involves nine partner teams from India, Mali, Mexico, Belgium, Spain, Switzerland and the UK. The project, which runs from June 2009 to February 2013, aims to assess profitability, together with economic, social and environmental impacts, of the cultivation of *J. curcas* as a bioenergy crop. Using data obtained by the project partners, it aims 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 aims 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.

Studies on *J. curcas* started in Mexico (Chiapas and Veracruz states) and India (northern India and Orissa and Tamil Nadu states). Since 2010, work is also being carried out in southern and central Mali while activities in India have been reduced because of security issues in the areas of investigation. In 2012, because of the political situation in Mali, work moved to similar ecoregions in neighbouring Burkina Faso. We work along rainfall gradients in three ecoregions in each country.

Farmer collecting *Jatropha curcas* fruits in Mali (photo: M. Kenis)

CABI scientists based in Switzerland and the UK, in addition to coordinating the project, are mainly involved in environmental impact assessments. In Mexico, we are working with collaborators from INIFAP (Instituto Nacional de Investigaciones Forestales y Agropecuarias) to assess both yield constraints and energy and carbon balances in each of the identified sites and along rainfall gradients. We are also studying the effects of the plant on soil properties. Data collected in 2012 confirmed that yields are much lower than predicted in the literature in all ecoregions investigated, owing to low rates of fructification and to fruit abortion. Part of the problem is fruit pests such as true bugs, which may have a major impact on yields.

In 2012, work in West Africa was carried out in Burkina Faso, in collaboration with Faso Biocarburant, a sister organization of our project partner Mali Biocarburant. Our research in Burkina Faso focused largely on pests and diseases, which are seriously hampering *J. curcas* adoption and cultivation in the region. The main insect pest is a flea beetle, recently identified as *Aphthona whitfieldi*, which seriously reduces growth of young plants, sometimes even killing them. A new, very serious disease was discovered in September 2012, causing extensive damage in older plantations, killing branches and preventing fructification. The causal agent is presently being identified and management methods have been proposed.

A workshop, funded by the Swiss Agency for Development and Cooperation (SDC) and held in Nairobi, Kenya, in November 2012, was co-organized with partners of two other project in the ERA-ARD programme on *J. curcas*. During this meeting, major findings from the three projects were discussed and disseminated to stakeholders, and opinion papers and policy briefs were produced for wider dissemination.

Jatropha curcas hedge damaged by disease in Burkina Faso (photo: M. Kenis)

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. Swiss staff participation is funded by SDC.

Pathway Evaluation and pest Risk Management In Transport: PERMIT

The number of alien invasive pests and pathogens in European forests is steadily increasing, and plants for planting are recognized as a major pathway for their introduction. The trade volume is enormous, with many millions of plants for planting imported into Europe every year. The identification of pathways for the international movement of pests and pathogens, including species identity, known hosts and their 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, which could also mitigate the threat of new, hitherto unknown pests and pathogens.

The COST (European Cooperation in Science and Technology) action PERMIT is focused on reducing threats from exotic pests and pathogens through promoting enhanced pathway management. There are 24 participating countries and eight non-COST participants. One of the working groups, co-chaired by Marc Kenis, is focusing on the identification of pathways for the movement of forest pests and pathogens, finding evidence of their movement along these pathways, and analysing international trade patterns in relation to this pest and disease movement. Other working groups are focusing on the development of mitigation measures to reduce the movement of pests and pathogens along pathways and the level of education and awareness of risks associated with different pathways.

In 2012 we continued with an analysis of past interceptions of quarantine pests and diseases during European border inspections of plants for planting. We also started an analysis of the intra-European plant trade. Both analyses are aimed at describing the potential pathways for the spread of forest pests and pathogens and producing evidence for their movement along these pathways. This year has also seen a start being made on a comparison of plant health legislation in countries around the world, with the aim of identifying effective measures against the introduction of new pests and pathogens. The results will be used in the project to develop measures aimed at reducing the movement of pests and pathogens along the identified pathways.

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

In contrast to Europe, New Zealand requires imported live plants in most genera to undergo post-entry quarantine (photo: R. Eschen)

Anoplophora chinensis is an important quarantine pest that is commonly found on plants imported from east Asia (photo: R. Eschen)

The nursery trade is a pathway for the spread of invasive species (photo: R. Eschen)

Harmonia axyridis adults and larvae (photo: M. Kenis)

Adalia bipunctata has been seriously declining in Europe following the arrival of *Harmonia axyridis* (photo: R. Comont, Centre for Ecology and Hydrology – CEH, UK)

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

Harmonia axyridis, the harlequin ladybird, is a polyphagous predatory coccinellid, 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 due to its predatory and competitive abilities, impacting on many native species, including aphids, ladybirds and other aphidophagous insects but also other herbivorous insects. It may also affect humans directly 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 harvested and crushed with grapes.

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. A long-term study was set up in 2006, before *H. axyridis* arrived in Switzerland, to observe changes in populations of native ladybirds during and after the invasion of the Asian species. Data are being collected at 45 permanent field sites in north-western Switzerland, located in three habitats: broadleaved and coniferous woodlands and meadows.

In 2012, *H. axyridis* accounted for over half of all ladybirds found on broadleaved trees. Some native ladybird species living specifically on broadleaved trees have been severely affected, in particular the two-spot ladybird, *Adalia bipunctata*, which has only been found three times at our sites since 2010 although it used to be the dominant species in these habitats. The same signs of decline have been found throughout Europe. In the future we will specifically survey for the presence of *A. bipunctata* in Switzerland, making use of enquiries on our website (www.cabi-e.ch/harmonia/). *Harmonia axyridis* is also becoming more abundant on pine, causing concern for ladybird species living in this habitat.

M. Kenis (m.kenis@cabi.org) and **R. Eschen**. Funded by: FOEN.

The impact of *Harmonia axyridis* on native ladybirds is being investigated in grasslands and forest edges (photo: R. Eschen)

spread, abundance, host plants and parasitism of *Drosophila suzukii* in Switzerland

Drosophila suzukii is a highly polyphagous invasive vinegar fly native to Asia, which was found almost simultaneously in Europe and North America in 2008, where it rapidly began to inflict significant damage on a wide variety of soft- and stone-fruit crops. *Drosophila suzukii* is a particularly troublesome pest as it prefers undamaged ripening fruit, unlike other *Drosophila* spp. which infest only overripe or decaying fruit. The larvae feed and develop within the fruit, causing it to rot rapidly, resulting in reduced crop yields and significant financial losses. The fly was collected for the first time in southern Switzerland in 2011, causing serious concern among fruit producers. In 2012, CABI decided to carry out a study to assess its status in the Canton Jura as well as its abundance, wild host range and parasitoid complex in southern Switzerland.

Vinegar traps were placed at 14 forest sites in the Canton Jura and monitored from August to October 2012. The first sighting of *D. suzukii* was in October, when a total of four males were found at three sites, which represents the first record for the canton.

Wild fruits were collected during three surveys in August–September in the Canton Ticino in southern Switzerland. Twelve potential wild fruit hosts were sampled and brought back to the quarantine laboratory in Delémont. *Drosophila suzukii* adults emerged from six of these species. High numbers of flies were reared from blackberry (*Rubus fruticosus*) and elderberry (*Sambucus nigra*). At some sites, an average of four flies emerged per blackberry. No drosophilid parasitoids emerged from the thousands of *D. suzukii*, and very few predators were observed in the fruits, suggesting very poor control by natural enemies in Switzerland.

Drosophila suzukii was reared in the quarantine laboratory for several generations to allow us to develop rearing techniques and make preliminary observations on its basic biology, with a view to future research.

M. Kenis (m.kenis@cabi.org), **N. de Souza, F. Leuthardt** and **T. Haye**. Funded by: CABI.

Elderberry, a favourite fruit for *Drosophila suzukii* in Switzerland (photo: N. de Souza)

Drosophila suzukii being reared on banana (photo: N. de Souza)

Natalia de Souza installing pheromone traps (photo: N. de Souza)

The Asian hornet (*Vespa velutina*), an invasive insect assessed for the black list protocol (photo: C. Péré)

building a black list and a watch list for alien animals in Switzerland

In Europe and elsewhere, most countries are currently developing national and international strategies to assess the full scope of the danger presented by invasive non-indigenous species, and to take the necessary measures to prevent and manage the threat effectively. An important step is to establish 'black lists' and 'watch lists' of species requiring particular attention and regulation because of their current or potential environmental impact in the country. Such lists can be used for various purposes; for example, to prioritize actions to mitigate the spread of invasive species or to improve the legislative framework at local, national or regional level. Therefore, it is important that the selection of species to be placed on these lists is made using standard, objective and transparent methods, such as scientifically based environmental impact assessment procedures.

A few years ago, CABI and the University of Fribourg in Switzerland developed a protocol to assign alien animals in Switzerland to black lists and watch lists. Over 70 species were assessed and recommended, or not, for inclusion on these lists. Although the method was user-friendly and provided coherent results, it had one major weakness, i.e. it was not compatible with the existing method for assessing alien plant species in Switzerland. Furthermore, both methods were purely qualitative, largely based on experts' opinions. Recently, a working group started to modify the black list protocol for assessing alien plants in Switzerland, aiming to produce a semi-quantitative protocol. FOEN contracted CABI and the University of Fribourg to develop a new impact assessment protocol for assigning alien animals to black and watch lists in Switzerland, which was to be as compatible as possible with the semi-quantitative system presently being developed for alien plants. The practicability of the protocol will then be tested using a series of species and the results compared with those obtained with the previous protocol. The first draft and tests of the protocol will be ready in early 2013 and, if satisfactory, more animals will be screened at a later stage.

M. Kenis (m.kenis@cabi.org), in collaboration with **S. Bacher,** University of Fribourg. Funded by: FOEN.

The horse-chestnut leafminer (*Cameraria ohridella*), invasive in Switzerland (photo: C. Péré)

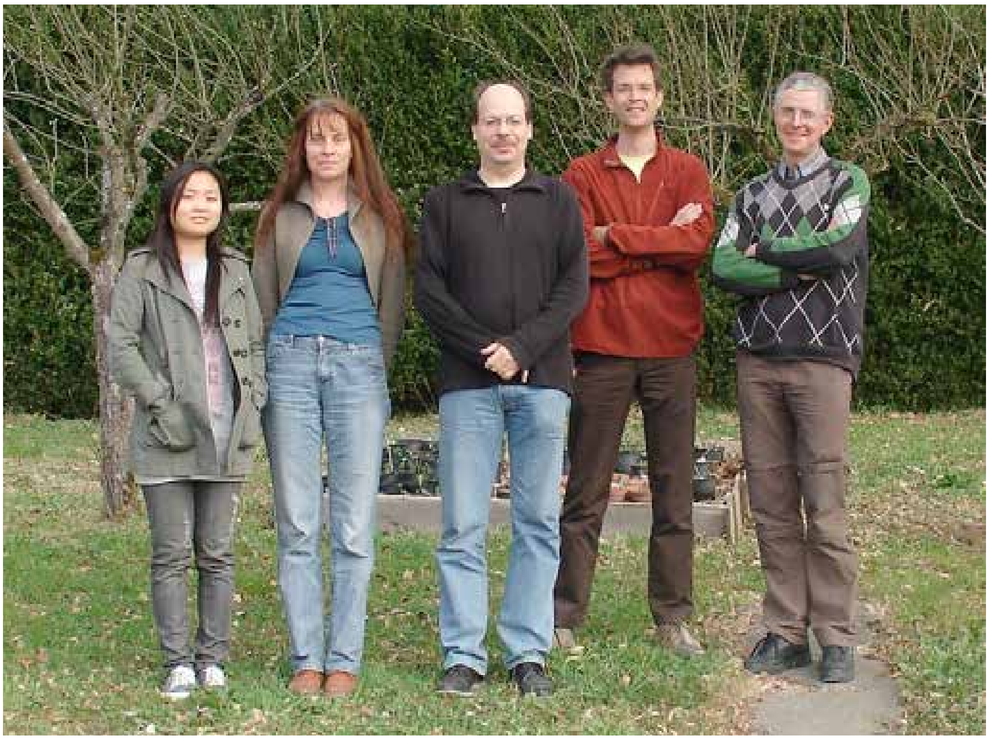
introduction

One of the highlights of 2012 was the approval of a new COST Action on 'Sustainable Management of *Ambrosia artemisiifolia* in Europe (SMARTER)'. The Action brings together experts on the biology and chemical and mechanical control of ragweed with experts in biological control and health care professionals, aerobiologists, economists, atmospheric and agricultural modellers and stakeholders from all over Europe. The goal is to develop habitat-specific and region-specific recommendations for integrated management of ragweed across Europe. Within CABI, this project provides a link to activities aiming to promote biological control as a management tool in Europe (led by CABI's centre in UK).

In 2012, we continued working on the environmental impact of invasive plants, 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 attained attack rates on *Rumex* by the native biological control agent *Pyropteron chrysidiforme* under field conditions that are, for the first time close to the targets required to make this approach efficient, which is a pre-requisite for its registration as a biological control product in Switzerland.

Last but not least, two students joined the Ecosystem Management group in 2012. Aline Junod, a student at the University of Fribourg, Switzerland, carried out research for a Master's thesis, in close collaboration with Yan Sun, on the impact of invasive plants in Europe. Kyle Landolt, a student of Texas A&M University in the USA, came to Switzerland to work during his internship with Prof. Heinz Müller-Schärer and us on the *Rumex* project. He helped with the rearing of *P. chrysidiforme* and conducted host-range tests under laboratory and field conditions. We would like to thank both students for their great commitment and excellent work.

Dr Urs Schaffner, Head of Ecosystems Management (u.schaffner@cabi.org)



Ecosystems Management team. Left to right: Sun Yan, Esther Gerber, Urs Schaffner, René Eschen and Patrick Häfliger (photo: P. Pardo)

Adult *Pyropteron chrysidiforme* female (photo: P. Häfliger)

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 CTI to develop a biological control product for dock control on the basis of the native clear-wing moth *Pyropteron chrysidiforme*. This project is being conducted in collaboration with ART, Andermatt Biocontrol AG and the University of Fribourg, Switzerland.

In spring 2012, we conducted field surveys in western Switzerland to find new sites where *P. chrysidiforme* occurred naturally. We found several sites, which allowed us to increase the size of our rearing colony of the Swiss population of *P. chrysidiforme* and to provide sufficient eggs and larvae for all tests carried out by our project partners and us. In addition, Ivo Toševski provided us with about 100 larvae of *Pyropteron triannuliforme* from Serbia. However, we did not succeed in improving mating success with this species and could therefore not continue working with it.

Mature larva of *Pyropteron chrysidiforme* (photo: P. Häfliger)

Kyle Landolt, an American student doing an internship at the University of Fribourg, came to CABI for the months of June and September to set up and analyse no-choice oviposition tests with *P. chrysidiforme* using 18 test plant species. Most *Rumex* species tested supported larval development to some degree. No feeding was observed on the economically important plants rhubarb and sugar beet. Although a few larvae were found on buckwheat, they did not seem to have an impact on seed production. Kyle also set up a multiple-choice open-field oviposition test at a site near Geneva where a high density of *P. chrysidiforme* had been detected. Again, no eggs or larvae were found on rhubarb and sugar beet.

In field impact experiments set up in 2012 by colleagues at ART and us, we tested different application methods to try and increase the establishment rate of *P. chrysidiforme*. First dissections of roots in autumn revealed variable attack rates. Importantly, for the first time we found attack rates on *Rumex* by *P. chrysidiforme* that are close to the targets required to make this biological control approach efficient. Revisiting the field sites in spring 2013 will provide additional information regarding larval survival and impact on the *Rumex* plants.

U. Schaffner (u.schaffner@cabi.org), **E. Esch, E. Kirby, N. Medeiros de Souza, K. Landolt** and **P. Häfliger**. Funded by: FOEN.

Evan Esch digging up a *Rumex* plant (photo: P. Häfliger)

novel method for controlling exotic knotweeds and restoring contaminated soil

Exotic knotweeds (*Fallopia* spp.) are among the most damaging 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 tests, up to 100% mortality of rhizome fragments was observed within a few months.

A series of tests was initiated in 2010 to assess the success of this method under different climatic conditions and to gather information on the recovery of native vegetation. A first knotweed infestation was treated in the Canton Jura in October 2010. In May 2011, several small sites beside the River Vidourle in southern France were treated.

In February 2012, additional sites in France beside the rivers Cèze and Gardon were also treated. Approximately 100 m^3 (Cèze) and 113 m^3 (Gardon) of soil infested with knotweed rhizomes was excavated and processed on-site in a screener-crusher. Sufficient homogeneity of the soil was achieved with only one treatment at the River Cèze site, where knotweed was growing in a largely stony soil substrate (see photo below). The knotweed site along the River Gardon is characterized by sandy soil, and the material needed to be processed three times to achieve the same goal. At the River Gardon site, crushed material was covered with opaque plastic foil, which will be removed in February 2013. A different protocol was applied at the River Cèze site: the crushed soil was put back in its original location and covered by a thick layer of biodegradable felt, which in turn was covered to a depth of 50 cm with stones. During a first assessment in autumn 2012, no knotweed regrowth was observed at this site.

Monitoring of the site in the Canton Jura revealed some regrowth of knotweed in the area treated in 2010. In contrast to other sites, where all knotweed rhizome fragments had decayed when stored for 12 months under a plastic foil cover, some have remained viable at this 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. A vegetation census carried out in the treated area indicates that crushed soil is quickly recolonized by native 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.

Regrowth on treated soil in the Swiss Jura (photo: E. Gerber)

Information panel set up during the work by the River Gardon, France (photo: E. Gerber)

Fallopia rhizome crushing beside the River Cèze in France (photo: E. Gerber)

MSc student Aline Junod determining the relationship between the biomass of an invasive plant and the species richness and biomass of surrounding native vegetation (photo: Sun Y.)

Centaurea stoebe (photo: M. Hahn, University of Fribourg)

environmental impact of invasive plants

Most hypotheses to explain exotic species success posit that exotics 'behave differently' in recipient communities compared to 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.

Centaurea stoebe is native to Europe and invasive in North America. In a greenhouse experiment, we tried to identify the relationship between invader biomass and impact in *C. stoebe* in its invasive range by conducting pairwise competition experiments with 15 European (old) and 15 North American (new) neighbouring species. Old neighbours grew larger and could use available soil moisture more efficiently for growth than new neighbours. Interestingly, biomass of *C. stoebe* explained a substantial amount of the variation in biomass of the coevolved neighbours, but not of the new 'naïve' neighbours. Thus, impact appears to be driven by competition for the same limiting resources in the home range, but by other factors in the introduced range, possibly by exploitation of resources that are not used by the new neighbours or by interference competition.

In a second greenhouse experiment, we compared the competitive interaction between *C. stoebe* and neighbour plants (European vs North American) using soil from both the native (European) and the introduced (North American) range. The experiment was set up in February 2012 and ran for five months. Analysis of the biomass produced by *C. stoebe* and by the neighbour plants revealed that neighbour origin explained a significant amount of variation in the impact of *C. stoebe*, but soil origin did not.

Taken together, the results of the two experiments suggest that the increased impact of *C. stoebe* in North America can be at least partly explained by the reduced competitive ability of North American plants. In contrast, potential differences in biotic or abiotic characters of soil from the native and introduced ranges appear to play a minor role, at least during the initial stage of the invasion by *C. stoebe*.

In a field study, we assessed whether the patterns found in our experiments can also be found under natural conditions. At sites in Europe with either invasive or dominant native species, the biomass of the target species as well as species richness and the biomass of the surrounding vegetation were determined. As found in the greenhouse experiment described above, the biomass of the native dominant species was always negatively correlated with the biomass of the surrounding vegetation. In contrast, the biomass of the invasive species was not correlated with the biomass of the native species in seven out of eight cases, indicating that the impact of invasive species is often due to special traits of the invasive species that directly interfere with resident competitors.

U. Schaffner (u.schaffner@cabi.org) and **Sun Y.**, in collaboration with **H. Müller-Schärer**, **A. Junod** and **R. Collins** (University of Fribourg) in Switzerland. Sun Yan is 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).

Set-up of a greenhouse experiment in which the effect of neighbour origin and soil origin on the impact of *Centaurea stoebe* was determined (photo: Sun Y.)

working towards sustainable management of *Ambrosia artemisiifolia* in Europe

Common ragweed, *Ambrosia artemisiifolia*, has uniquely raised the awareness of invasive alien species in Europe. 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. Furthermore, 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. Numerous research institutions in over 30 European countries are currently conducting research on ragweed, but control actions undertaken by extension services and other stakeholders in each affected European country are more or less uncoordinated. Although chemical and mechanical control methods have been developed and partially implemented, more sustainable control strategies such as biological control or habitat management, while successfully implemented in other parts of the world (China, Australia), are lacking in Europe.

In June 2012, a new Action on 'Sustainable Management of *Ambrosia artemisiifolia* in Europe' (SMARTER) was approved by the COST Domain Committee on Food and Agriculture. The proposal was developed largely by Prof. Heinz Müller-Schärer (University of Fribourg, Switzerland) and CABI in Switzerland. Within five months of approval of the Action, 28 COST countries had signed the memorandum of understanding. The Action brings together experts involved in the control of ragweed and biological control, health care professionals, aerobiologists, economists, atmospheric and agricultural modellers and numerous stakeholders. The goal of this Action is to develop habitat-specific 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.

In 2013, we will seek funding for assessing the prospects of classical biological control of ragweed in Europe, focusing on two leaf beetles and one moth that have recently been identified as promising biological control candidates for Europe.

U. Schaffner (u.schaffner@cabi.org) with many partners in the COST Action SMARTER.
Funded by: EU COST programme.

Young common ragweed plant in a crop field post-harvest (photo: C. Bohren, ACW)

Zygogramma disrupta, a leaf beetle native to North America that has been proposed for biological control of *Ambrosia artemisiifolia* in Europe (photo: Mike Quinn, TexasEnto.net)

Common ragweed, *Ambrosia artemisiifolia*, in a sunflower field (photo: C. Bohren, Agroscope Changins-Wädenswil – ACW)

integrated crop management

introduction

I am pleased to say that it has been another successful year for the ICM team. It was also one of growth as we welcomed on board three new members to help implement the increasing number of projects being managed by the group: Melanie Bateman, Erica Chernoh (both from the USA) and Frida Rodhe (from Sweden). Between them, Melanie, Erica and Frida bring a significant amount of knowledge and experience in the areas of sustainable agriculture and international development, and have therefore been able to jump straight into supporting ongoing projects including the maize IPM project in the Greater Mekong (see p. 73), the tobacco IPM programmes in Brazil and Turkey (see pp. 74 and 75) and Plantwise (see pp. 70-71).

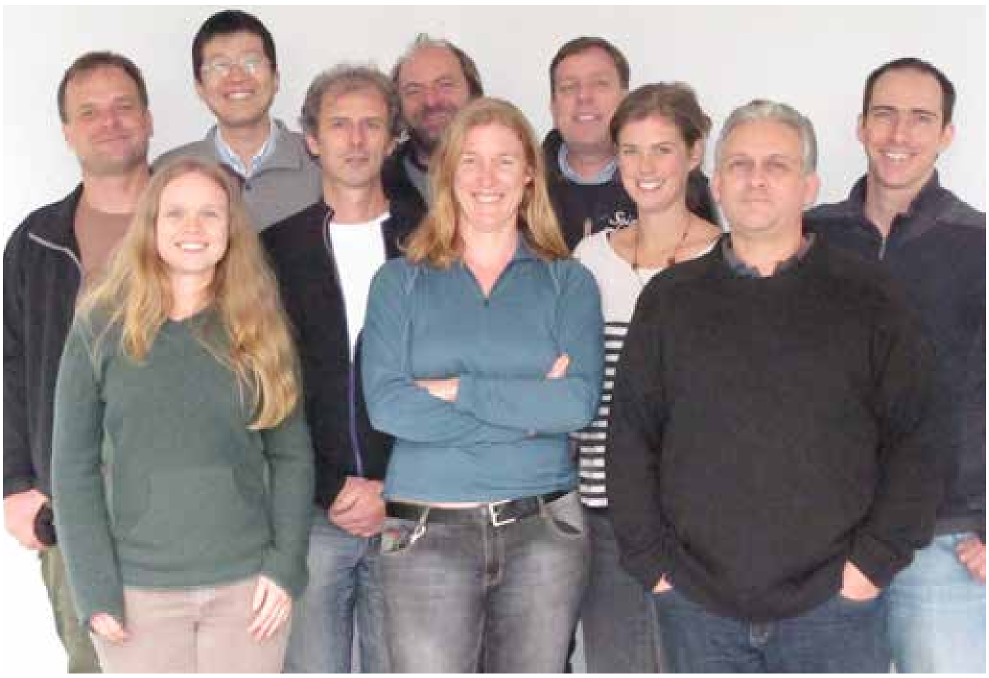
In 2012, the ICM team started a new project in Brazil with Philip Morris Brazil and in collaboration with the University of Santa Cruz do Sul. During a mission to Brazil in May to meet local partners, we jointly developed an IPM project that will support tobacco farmers in improving their pest management practices. Project activities began during the second half of the year, including a training course for field technicians to enhance the pest management advice they provide to farmers.

Our SNSF/SCOPES (Scientific Co-operation between Eastern Europe and Switzerland) Institutional Partnership project in Albania has been very productive and has demonstrated clear benefits in terms of strengthening IPM capacity and knowledge transfer at various institutional levels, including education, extension and government. It is hoped that an additional funding source will be identified in 2013 in order to continue this good work.

As testament to the fruitful work we have been carrying out in DPR Korea over the last 12 years, as well as to the strong and productive relationships that CABI has formed with various partner institutions in the country, the DPR Korea MoA decided to establish a Department of Plant Protection (MoA-DoPP) in 2012. This directly acknowledges the enhanced profile that plant protection now has within DPR Korea, which itself has resulted largely from our previous project activities. In order to support the overall structure, management and operation of this newly-formed department, CABI, together with partners in DPR Korea and China, submitted a proposal for a DG DEVCO EuropeAid Partnership Project entitled 'Building plant protection capacity for improved food security in DPR Korea'. We heard at the end of the year that we had been successful in obtaining this project and will commence activities in spring 2013.

Finally, the ICM team has also been significantly involved in the implementation of CABI's Plantwise programme this year, which was officially launched in 2011. Our group's involvement has predominantly been to develop a training workshop on how to establish a Green and Yellow List, an important pest management decision-making tool for understanding and applying IPM principles (see p. 9).

Dr Ulli Kuhlmann, Head of Integrated Crop Management (u.kuhlmann@cabi.org)



Integrated Crop Management team. From left to right: Stefan Toepfer, Melanie Bateman, Zhang Feng, Dirk Babendreier, Manfred Grossrieder, Erica Chernoh, Ulli Kuhlmann, Frida Rodhe, Keith Holmes and Wade Jenner; not pictured: Emma Jenner and Urs Wittenwiler (photo: KCS Convention Services, Delémont)

SCOPES Institutional Partnership project in Albania

Funded by SNSF and SDC through SCOPES, this project aims to strengthening 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.

In 2012, the ICM lectures developed in previous years (approximately 850 Microsoft PowerPoint slides) were delivered to Master's students at the University of Korçë for the second year while adapted ICM lectures were given at ABS for the first time. A major achievement was the finalization and printing of hand-outs for the ICM lectures which contain all the key information in both English and Albanian for students at both institutions. It is anticipated that the new ICM lectures will better prepare students at the University of Korçë and ABS for employment in the agriculture sector and will help to anchor the principles of sustainable agriculture among the future agricultural leaders of Albania.

A farmers' training curriculum was developed to serve as a framework for the 'training package' that is offered to new members of the Apple IP [Integrated Production] Producer Club. Additional training course material was developed and the local partner Agrinet is now able to offer training on all aspects of IP in apple, including the newly occurring problem of fire blight. A survey on the farmer training given in 2010–12 showed that there is high motivation for following the training course and IP farmers even tend to repeat the training sessions, if possible. In addition, a grading concept was developed aiming to further increase the quality of IP apples and to establish a more trustful relationship between apple producers in the Korçë region and traders.

Several key stakeholders from Korçë region, including the partner institutions, were taken on a study tour to Switzerland to improve their knowledge of ICM, the extension system in Switzerland, and the Swiss vocational education system.

Numerous meetings with governmental stakeholders in Tirana aimed to anchor ICM at the national level. A major breakthrough was the agreement of the Ministry of Education to give ICM lectures, as developed for ABS Korçë, in the other five agrobusiness schools in the country. It is anticipated that the enhancement of stakeholders' capacity will motivate the promotion of ICM in Korca region and beyond as well as wider scale implementation of IP in apple and other crops.

D. Babendreier (d.babendreier@cabi.org), **F. Rodhe** and **U. Kuhlmann**, in collaboration with Agrinet, CATT, the Agriculture Faculty of the University of Korçë, and ABS, Korçë in Albania.
Funded by: SNSF and SDC.

CABI's Dirk Babendreier and a university professor assessing students' exams (photo: D. Babendreier)

Presentation of ICM lecture hand-outs to the staff of Korçë University (photo: F. Rodhe)

CABI and Agrinet conducting a farmers' survey (photo: F. Rodhe)

Mr Ri In Chan, Ongjin County Plant Protection Station Manager, Ms Jong Ok Dong, Chairman of Up Co-Farm, and Mr Kim Jong Hyon, Up Co-Farm Chief Engineer outside the Up Co-Farm nematode production facility (photo: Ri H.C.)

Pak Il Chol of PPI trains county and co-farm staff during the in-vivo nematode production workshop (photo: K. Holmes)

Looking for overwintering soil insect pests in compost heaps in the field at AAS (photo: K. Holmes)

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

Over recent years, food crops in DPR Korea have come under increasing threat from soil-borne insects, with yield losses of up to 30% not unusual. Currently farmers lack feasible and sustainable methods for controlling these pests. Funding has been provided by DG DEVCO EuropeAid (for 2011–14) to improve pest management practices targeting soil-borne insects, by making low-cost biological control agents, i.e. beneficial entomopathogenic nematodes, locally available. This involves mass rearing the beneficial nematodes and their application in the field as part of ICM. As the proposed technology is new to DPR Korea, national and provincial agricultural centres will gain experience through the project in operating their own nematode production facilities. National, provincial and county-level facilities will all play a key role in the widespread dissemination of the technology.

In 2012 project associates from China and Switzerland continued to provide hands-on training to project partners PPI-AAS and CPPS-MoA, in particular supporting local adaptation of methods. Following the development of two DPR Korean provisional nematode production methods, an advanced in-vitro and basic in-vivo method, a prototype production facility was developed at CPPS-MoA in Pyongyang to further adapt and assess them. The facility was completed at the end of 2012 and should be able to mass produce nematodes in 2013.

To enable the further dissemination of the new technology and its use at the co-farm level, a number of production facilities were established at the county and co-farm level. They were installed at three County Plant Protection Stations (in Anak, Ongjin and Sinwon counties) in South Hwanghae Province. These are referred to as County Competence Centres (CCCs), and now house facilities for advanced and basic nematode mass production. In addition, the CCCs were equipped with training rooms to allow them to train and disseminate the technology to other counties and to co-farms. Three pilot co-farm facilities for basic nematode production (at Ryongsong, Anak County, Up, Ongjin County and Woldang, Sinwon County) were also established, each linked to one of the CCCs.

To facilitate the establishment of these county, co-farm and the CPPS-MoA prototype facilities, a shipment of over 7.5 tonnes of equipment was delivered by rail from China to Pyongyang and then distributed with the logistical support from CPPS-MoA to all the facilities (see Highlights, p. 8).

In order to support the effective establishment of these new facilities, a training workshop, focused on the basic in-vivo production method, was held in August at the PPI-AAS Training Facility and the PPI-AAS Experimental Nematode Production Facility. This was attended by 18 staff from the three CCCs, the three co-farm facilities and also from three Provincial Plant Protection Stations; training successfully provided by staff of PPI-AAS and CPPS-MoA.

To support the eventual field application of the beneficial nematodes, laboratory and field screening of nematodes against key target pests was carried out by PPI-AAS in 2012, and will be continued in 2013. It will be linked to validation of application methods appropriate for conditions in DPR Korea at the co-farm level as well as further development of decision tools for application.

Specialists in nematode production will continue to support the development of a locally-adapted production system that works effectively under the conditions in DPR Korea. In 2013 CABI will, in collaboration with PPI-AAS and CPPS-MoA, facilitate the transfer of production and application knowledge, skills and equipment to provincial, county and co-farm level. It is envisaged that this project will eventually contribute to a reduction in the volatility in the nation's food production and will consequently address impending food insecurity.

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

In-vivo nematode production training workshop participants and trainers outside the PPI Experimental Nematode Production Facility, AAS (photo: Ri H.C.)

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

If DPR Korea is to be able to address plant protection and food security issues independently, it needs a strong, applied research community. Currently, a significant proportion of the DPR Korean research community lacks the necessary resources for experimentation and communication with stakeholders to allow them to realise their full potential in conducting problem-oriented scientific studies.

This DG DEVCO EuropeAid-funded Partnership Project aims to strengthen the knowledge and in-house applied research capacity of AAS for solving agricultural problems.

A major achievement of the project so far has been to enable the scientific staff of AAS to access the internet and online resources (including CABI's) to support the development and implementation of their research. To support the use of the internet, material used during a training workshop in 2011 has been adapted by AAS and Kim Il Sung University – Pyongyang Agricultural University (PAU) and is now a part of the Agricultural Information Department's course. AAS also used this material to deliver two, two-day workshops to its researchers in 2012. Special training was also given at The Grand People's Study House in Pyongyang in December 2012 to 60 officials, technical staff and lecturers from the agricultural/academic sectors in Pyongyang and the outlying provinces.

In 2012, to build on the improved access within AAS to international and national resources and to further improve the ability of AAS staff to communicate among themselves and with other stakeholders, the AAS's communication infrastructure was enhanced. Instead of 10–40 researchers being able to access information at the Bulgil intranet office, every AAS research institute, 400–500 staff, now have regular access. In particular, access was provided to some of the institutes at a distance from the main AAS compound, such as the Crop Cultivation Institute (CCI) some 6 km from the main AAS compound.

Materials and methods used in a 2011 workshop that introduced AAS staff to experimental design and statistical analysis and its application to their research has been developed by PAU, with CABI's support, into a new course and course manual, which PAU used to train 300 students in 2012. This course was also used by AAS to train 120 research staff from various institutes as a 'training of trainers', with these individuals returning to train their own institute's staff. To further support this activity, 1000 manuals were printed and delivered to PAU and AAS.

A key activity in this project was the coordination of an international symposium focusing on current pest monitoring and forecasting and future needs, as a means to identify problems for future research (see Highlights, p. 20). This First AAS-CABI Joint Scientific Symposium was successfully held at AAS in Pyongyang, and was a useful forum for developing ideas for future implementation.

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Staff of the Crop Cultivation Institute, AAS, laying fibre-optic cable (photo: Chae C.S., AAS)

Mr Kim Sang Hyok, Director of the AAS's Crop Cultivation Institute demonstrates newly acquired computers and link to the DPR Korean internet and AAS Bulgil intranet (photo: K.Holmes)

Participants of the AAS-CABI symposium on pest monitoring and forecasting (photo: K. Holmes)

Plant doctor trainee in northern Sri Lanka practicing diagnoses with plant samples as part of Module 1 (photo: W. Jenner)

Plant doctor trainees in Sierra Leone doing a written exercise in Module 2 (photo: W. Jenner)

global roll-out of CABI's flagship programme: Plantwise

On average, up to 40% of the food currently grown worldwide is lost to crop pests, including pathogens, weeds, vertebrates and invertebrates, before it can be consumed. Although there is considerable global knowledge on the management of crop pests, this vital information is often not reaching the farmers who need it most. This is because extension services are typically weak and poorly resourced. Providing better advisory services that are regular and reliable requires innovative solutions that recognise the entrenched weaknesses in agricultural support systems.

Plantwise was launched in 2010 in response to a unanimous mandate from CABI's Member Countries to support them in meeting the challenges of food security and improved rural livelihoods. Since then, it has grown into a structured programme, involving staff from all CABI centres and offices worldwide. The programme is now guided by strategies and policies on topics ranging from gender to pesticide use to data management. Plantwise has been shaped by earlier international development activities as well as market research into users' needs in areas such as extension, rural farming, research, plant protection and inspection, and policy-making. Its goal is to enable the development of national and regional plant health systems by strengthening the links between relevant stakeholders, particularly farmers, extensionists, researchers, agro-input dealers and regulatory bodies.

Many of the potential components of plant health systems already exist in most of the Plantwise target countries, but the individual elements often operate in disparate ways. Plantwise focuses on building the capacity of existing rural advisory services to more effectively deliver knowledge to farmers by introducing complementary concepts and methods. The spearhead of the initiative is a network of plant clinics, operated by plant doctors who provide advice to farmers on a local basis and as required for any problem and any crop. The long-term acceptance and sustainability of plant clinics requires them to be an integral part of broader national systems of plant health and extension. Plant clinics can act as a catalyst to stimulate the interaction and integration of these parts into a stronger and more effective system.

Plantwise is underpinned by an open-access web-based knowledge bank, developed and hosted by CABI. It is a searchable database containing factsheets, management advice and other information on problems of plant health affecting the most commonly grown crops worldwide. The Plantwise Knowledge Bank will also gather and collate plant health information and extension materials generated by the plant clinics in each country and make them more broadly available both within the country of collection and in other countries where similar problems exist.

The 2012 year began with a planning workshop in Wallingford, UK for all Plantwise coordination and implementation staff. This major kick-off event provided an opportunity for the programme strategy and procedures to be explained clearly. It also enabled the Regional Teams to exchange previous implementation experiences and work on harmonised annual plans for all of the target countries. Following this planning meeting, the Regional Teams, supported directly by European Resource Staff and indirectly by the Plantwise Programme Board, began implementing their 2012 activities in 24 countries across Africa, Asia and Latin America and the Caribbean (see map).

The 24 Plantwise target countries, grouped by Regional Teams, in 2012.

A key task for the Regional Teams in 2012 was to begin obtaining partnership statements/agreements (MoUs) and data sharing agreements signed by programme partners, particularly the Ministry of Agriculture in each target country. Despite sometimes lengthy delays in obtaining partner signatures on these documents, signed agreements were obtained from partners in 14 countries in 2012 with a number of others under consideration.

There has been a tremendous swelling of interest from national partners in the plant clinic concept as an advisory and surveillance tool. This led to a focus in 2012 on meeting the demand for training and support in establishing plant clinic networks. An important highlight for Plantwise in 2012 was the establishment of more than 200 new plant clinics, bringing the total to approximately 413 clinics in 24 countries. This expansion involved the training of over 400 local personnel, primarily government extension workers and related plant protection staff, to become plant doctors. Plantwise staff conducted short (normally 3-day) training sessions, which introduce participants to the plant clinic concept and get them thinking about the steps to sound field diagnosis of plant health problems and also about the way they give advice to farmers. In addition to training plant doctors, Plantwise supported the development of simple reference materials, such as the more than 250 factsheets and 100 pest management decision guides that were drafted by in-country partners. Furthermore, in a number of countries, data management processes were established and tested to build up national systems that effectively exchange, analyse and report on the information gathered at plant clinics.

Another significant 2012 highlight was the official launch of the Plantwise Knowledge Bank for use by plant health stakeholders worldwide. Tailored webpages were developed for each of the 24 Plantwise countries, providing country-specific news and information, which makes searching for information more streamlined. The Knowledge Bank was populated with over 2,000 factsheets and simple pest identification tools and enhanced maps showing pest distribution were created to provide a broader service.

At the end of 2012, all of the Plantwise implementation staff were brought together for a review and planning workshop in Delémont, Switzerland. This event gave the staff an opportunity to share experiences and lessons learned with colleagues from other Regional Teams, and to begin setting targets and planning activities for 2013.

Plantwise will continue to scale up (more clinics, more knowledge) and scale out (more countries) its programme to reach its target to support five million farmers in 40 countries by 2016. However, there must be a clear focus on the sustainability of the programme and its components. Going forward with a significant focus on programme outcomes and impact in 2013, monitoring and evaluation will become a more prominent feature of the Plantwise work, facilitating professional development, reflection and analysis of results within CABI and with our partners.

Participants of a training workshop in Bolivia for the production of pest management decision guides (photo: E. Chernoh)

Plant doctors in Sichuan, China discussing symptoms on a citrus sample (photo: W. Jenner)

Participants of the year-end Plantwise review and planning workshop in Delémont, Switzerland. The workshop was attended by CABI Country Coordinators, European Resource Staff and the Plantwise Programme Board members (photo: CABI)

The field experiment implementation team during preparatory discussions (photo: D. Babendreier)

Meeting with farmers in Manglong village, Yunnan Province, China, to discuss implementation of IPM activities (photo: D. Babendreier)

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

Rice is a major staple food and increased productivity in rice is crucial for both achieving food security and meeting the targets laid out in the Millennium Development Goals by the United Nations. Moreover, a vast amount of pesticides is being used in rice fields, so there is an urgent need to develop sustainable practices with reduced input of toxic agrochemicals. This project aims specifically to sustainably increase rice production in south-western China, Lao PDR and Myanmar through intra-regional research, capacity building and the implementation of biologically based pest management suited to current and predicted climatic conditions.

Final field surveys were conducted in Lao PDR and south-western China in 2012, and a *Trichogramma* species found was identified as *T. japonicum*. During this second year of the project, there was a focus on laboratory and field experiments to determine the most promising *Trichogramma* species for rearing and release. Results indicated that a specific *T. chilonis* strain performed best in host acceptance tests conducted on major target pests, and showed highest survival and parasitism rates in the field. In addition, it was found that a medium release rate was nearly as successful as a higher one, with positive implications on the costs of the final product.

Work on participatory rural appraisals (PRAs) and an assessment of monitoring and decision making practices were also completed in 2012. The summary reports subsequently written provide a comprehensive overview of rice pests and their management and an understanding of local crop problems and specific crop protection practices in rice, based on knowledge and information from a wide range of stakeholders. Knowledge obtained through the PRA's and from the experimental work was then synthesized into a draft IPM strategy. As a core part of this, a *Trichogramma* release strategy describes release densities, times, etc., tailored for all cropping systems that exist in the target region.

In both Guangxi Province and Yunnan Province, locations and buildings for pilot *Trichogramma* production facilities were agreed upon, and these are being renovated. The facilities will be equipped when all preparatory work on design and detailed production methods are finalized. A quality control strategy for *Trichogramma* mass production was also jointly developed in 2012.

During the year, three successful multi-stakeholder meetings were held in the target region to plan and review project implementation as well as to jointly work out technical documents including the IPM strategy.

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Well-located rice fields in the south of Lao PDR show wide structural diversity which supports a high abundance of natural enemies (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 an overall low productivity and profitability. This intra-regional project, funded by DG DEVCO EuropeAid, aims to improve agricultural productivity of smallholder farmers through the effective transfer of a validated and sustainable plant protection technology.

The project is promoting the establishment of *Trichogramma* mass production facilities in 21 villages, capacity building of extension and production personnel, empowering of grassroots organizations and improved market linkages. This will give smallholder farmers access to an affordable and practical control method against the Asian corn borer (*Ostrinia furnacalis*; ACB), a particularly destructive pest in the region. The tiny *Trichogramma* wasp parasitizes the ACB's eggs and kills the pest before it has the chance to cause damage to the crop. Technology transfer within this project is using knowledge supplied by the project associate, Tianyi Biological Control Company Ltd (TBCC), China, as well as experts from CABI and IPP-CAAS, the project applicant. An overall IPM approach is being taken to promote sustainable practices in general in maize production to minimize harm to human health and the environment from the use of pesticides.

The first project year started with a fact-finding mission to the three partner countries i.e. south-western China, Lao PDR and Myanmar. The mission provided fundamental information on maize growing, local pest problems, environmental conditions and rural livelihoods, which was and will continue to be used throughout the project's implementation as a basis for adapting the activities to country-specific conditions. An inception workshop was held (see Highlights, p. 7) at which planning documents were developed and agreed, followed by an awareness creation tour to state-of-the-art rearing facilities in Hengshui in China and in DPR Korea to give participants deeper understanding of the rearing procedures (see Highlights, p. 10). In the project countries, the main focus has been on the establishment of a pilot facility in each country and the development of adapted local rearing designs. Local expertise has been used to find long-term sustainable solutions that meet the project requirements and budget as well as local needs and knowledge. To ensure ownership from the start, local implementation groups, have been appointed in the pilot villages to manage project activities at the village level.

Partner institutions have been trained in participatory rural appraisal (PRA) methodology and PRAs have been carried out in the three pilot villages, and are planned for an additional 18 villages. The PRAs provide essential information to embed the project in the communities and encourage each village to analyse its own situation, which will enable further adaptions of project activities to local needs. Knowledge transfer concepts have been defined to assure that *Trichogramma* production and application staff acquire the necessary skills for rearing and using the parasitic wasp. The first training event will take place in January 2013, with delegations from the three countries participating in a week-long training workshop at TBCC in Hengshui for hands-on *Trichogramma* rearing and management training. The next phase of the project will focus on establishing more production facilities as well as further supporting farming communities with knowledge transfer and improved access to markets.

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A community meeting in Pinphyit village, Myanmar, to explain and exchange about the IPM project objectives and activities (photo: M. Grossrieder)

A smallholder farmer in Lao PDR waiting for the rain next to his field, which has been prepared for sowing maize (photo: M. Grossrieder)

Assessing the damage by Asian corn borer in a maize field close to Ruili City, Dehong, China (photo: M. Grossrieder)

Using PRA tools in a village community in order to find out about the workload for smallholder farmers over the year (photo: M. Grossrieder)

Leaf inspectors are trained in seedbed stage inspection methods and standards (photo: E. Jenner)

implementation of best agricultural practices in tobacco in Turkey

In 2012 CABI continued its collaboration with Philip Morris International (PMI) and six Oriental tobacco leaf supplier companies in Turkey on an agronomy programme aimed at improving yields and maintaining quality of Oriental tobacco. However, the overall objective of the programme shifted in 2012 from IPM to identifying new technologies that increase yield and the implementation of best agricultural practices.

The core activities in 2012 included: agronomic research trials, the founding of model farms, a cost of production study, training leaf experts in best agricultural practices, and carrying out inspections to determine the impact of farmer training from previous years. The agronomic research trials are being used to identify new techniques to boost yields while maintaining the high premium quality of Oriental tobacco. Model farms have been established to demonstrate the implementation of best agricultural practices. Yield, quality, and cost of production data were collected from both model farms and farms that represented typical farmer behaviour in order to compare the results. The trials, establishment of model farms, and cost of production study were carried out by all six leaf suppliers in three different regions of the country. CABI provided technical support in programme planning, monitoring and implementation, as well as experimental design and statistical analysis.

Seedbed stage of research trials at Borlu (photo: C. Anton, Alliance One, Turkey)

CABI also continued to support the development and implementation of an internal farm inspection programme in order to monitor the impact of the IPM programme that was initiated in 2009. The inspection results were used to determine farmers' adoption of IPM practices at the seedbed stage. The results demonstrated that the training has had a positive effect on pesticide use and safety; however, further training is required to improve farmer adoption of IPM practices and record keeping.

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A group of women string tobacco leaves from a fertilizer research trial (photo: E. Chernoh)

improving pest management strategies in tobacco production in southern Brazil

After several years of collaboration with PMI, developing and implementing sustainable agricultural practices for tobacco production in Turkey and Argentina, CABI was requested by them to facilitate the implementation of IPM practices in Rio Grande do Sul in southern Brazil. In 2012 CABI has, together with the PMI affiliate, Philip Morris Brazil (PMB), developed an agronomy programme with the aim of improving IPM practices in tobacco production, while reducing labour requirements and production costs and enhancing crop integrity.

The active involvement and strong motivation of PMB field technicians has been crucial to the programme as they are the direct link between the company and the contracted tobacco producers. CABI has worked closely with selected field technicians, building capacity in IPM and developing visual and comprehensive IPM guidance tools, such as Green and Yellow lists, which use a step-by-step approach for planning and implementing IPM in tobacco production. By using a 'traffic light' system, producers are guided through the most appropriate methods for preventing or controlling common and problematic pests. These practical documents will facilitate the work of the field technicians when introducing and motivating producers to implement IPM as general practice to promote more sustainable tobacco production in southern Brazil.

Another key activity in 2012 has been testing the feasibility and practicality of using sticky traps to monitor selected pests in the tobacco field. The monitoring system aims to facilitate early detection of pest problems. Field technicians have been given training in management of the traps and have thereafter been handling the traps in the field, removing and analysing their contents weekly. The pilot study has focused on flea beetles and thrips, two of the major pests in the area, and is being undertaken in close collaboration with ongoing research by the University of Santa Cruz do Sul (UNISC). An alert system has been developed in conjunction with the traps with the purpose of alerting neighbouring farmers when the number of insects in the main traps reaches a certain threshold. As the traps will allow field technicians and producers to detect a pest problem early in the season, they will facilitate early treatment and pest prevention, and therefore avoid unnecessary pesticide applications, and reducing late spraying as well as and the risk of residues in the final product.

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PMB field technicians develop pest management decision guides for tobacco production (photo: F. Rodhe)

Field technician shows a farmer how to manage sticky traps in the field (photo: F. Rodhe)

PMB field technician with a sticky trap (photo: Y. Colmenarez)

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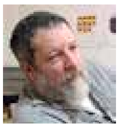
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what does CABI do?

CAB International (CABI – www.cabi.org), originally established in 1910, is a not-for-profit science-based development organisation, operating under an international treaty agreement amongst its, currently 48, member countries, registered with the UN. It has a Headquarters Agreement with the Government of the United Kingdom 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:

publishing

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 these 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, science 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 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 and weeds. Many of the most damaging pests and weeds 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 so-called 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 (Food and Agriculture Organization of the United Nations), OECD (Organisation for Economic Co-operation and Development), EPPO (European and Mediterranean Plant Protection Organization), IOBC (International Organisation for Biological Control) and national authorities such as FOAG (Federal Office for Agriculture) and FOEN (Federal Office for the Environment), to provide inputs to protocols and guidance documents required for regulation, as well as 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 due 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 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 their 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 of farmers around the world to adopt good agricultural practices (GAP) and elevate standards of food production due to market globalization and growing consumer concerns about food safety and environmental health. Our centre's Integrated Crop Management 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 integrated pest management (IPM) in order to reduce unnecessary use of pesticides.

CABI staff based in Switzerland annually host international student placements whereby 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
AAS	Academy of Agricultural Sciences (DPR Korea)
ABS	Agrobusiness School Korçë (Albania)
ACB	Asian corn borer (*Ostrinia furnacalis*)
ACW	Agroscope Changins-Wädenswil (Switzerland)
AGES	Austrian Agency for Health and Food Safety
APHIS	USDA Animal and Plant Health Inspection Service
ARS	USDA Agricultural Research Service
ART	Agroscope Reckenholz-Tänikon, Zurich (Switzerland)
BACCARA	Biodiversity and Climate Change, A Risk Analysis (EC RTD FP7 project)
BBCA	Biotechnology and Biological Control Agency, Rome (Italy)
BLM	USDI Bureau of Land Management
Bt	*Bacillus thuringiensis*
CCI	Crop Cultivation Institute (AAS, DPR Korea)
CAAS	Chinese Academy of Agricultural Sciences (part of MoA)
CATT	Centre for Agricultural Technology Transfer (Albania)
CCC	County Competence Centres (DPR Korea)
CEH	Centre for Ecology and Hydrology (UK)
COST	EU Cooperation in Science and Technology programme
CPHST	USDA-APHIS Center for Plant Health Science and Technology
CPPS	Central Plant Protection Station, MoA (DPR Korea)
CTI	Swiss Commission for Technology and Innovation
DPR Korea	Democratic People's Republic of Korea
DG DEVCO	Directorate-General for Development and Cooperation
DoPP	Department of Plant Protection, MoA (DPR Korea)
EBCL	European Biological Control Laboratory (USDA-ARS)
EC	European Commission
ECTS	European Credit Transfer and Accumulation System
EPPO	European and Mediterranean Plant Protection Organization
ERA-ARD	European Research Area – Agricultural Research for Development (EC RTD 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 (EC)

FP7	RTD Seventh Framework Programme (EC)
GAP	good agricultural practices
ICM	integrated crop management
INIFAP	Instituto Nacional de Investigaciones Forestales y Agropecuarias (Mexico)
IOBC	International Organisation for Biological Control
IP	integrated production
IPM	integrated pest management
IPP	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 (EC RTD FP7 project)
JATROPHABILITY	Investigating impacts of *Jatropha curcas* production
Lao PDR	Lao People's Democratic Republic
LfL	Bayerische Landesanstalt für Landwirtschaft (Germany)
LTZ	Landwirtschaftliches Technologiezentrum (Germany)
MAS	Master of Advanced Studies
MoA	Ministry of Agriculture (China or DPR Korea depending on context)
MoA-DoPP	Department of Plant Protection, Ministry of Agriculture (DPR Korea)
MoU	memorandum of understanding
NCCR	National Centres of Competence in Research (Switzerland)
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
PAU	Kim Il Sung University – Pyongyang Agricultural University (DPR Korea)
PBL	problem-based learning
PERMIT	Pathway Evaluation and pest Risk Management In Transport (EU COST Action)
PMB	Philip Morris Brazil
PMI	Philip Morris International
PPI	Plant Protection Institute, AAS, (DPR Korea)
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 (EC RTD FP7 project)
RTD	EC Research, Technological development and Demonstration framework programmes
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 (EU COST Action)
SME	small and medium-sized enterprise
SNSF	Swiss National Science Foundation
TAG	USDA-APHIS Technical Advisory Group
TBCC	Tianyi Biological Control Company Ltd (China)
UNISC	University of Santa Cruz do Sul (Brazil)
USDA	United States Department of Agriculture
USDI	United States Department of the Interior

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