




Abstract volume

Science Facing Aliens

Brussels, May 11th 2009



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The scientific conference "Science Facing Aliens" was organized on occasion of the International Day for Biological Diversity 2009, Theme: Invasive Alien Species, as designated by the Parties to the Convention on Biological Diversity

Organizing Committee

This conference is an initiative of the Belgian Biodiversity Platform's Forum on Invasive Alien Species

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Keynote lecture

Invasion pathways, species invasion success and habitat invasibility in Europe

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Biological invasions are not only regarded a problem throughout Europe by ecologists, but also policymakers recognized the importance of this topic. Consequently, the European Commission funded some large projects to analyse the problem. Two of them are the Integrated Project ALARM (Assessing LArge scale environmental Risks for biodiversity with tested Methods; www.alarmproject.net) and the Specific Targeted Research Project DAISIE (Delivering Alien Invasive Species Inventories for Europe, www.europe-aliens.org). I will briefly summarize the main findings of these projects, attempting to answer the following questions: How did alien species get into Europe? What makes species successful invaders? Which habitats are especially invaded in Europe?

Existing pathways of introduction of alien species were reviewed and a new classification system was elaborated which is also related to appropriate management responses and regulative bodies. The first distinction is whether alien species arrive with or as commodities, with specific vectors or by autonomous dispersal.

Analysing invasion success has quite some history and still no common conclusions can be drawn, except that species being invasive in one region are likely to become invasive in other regions. Nevertheless, recognizing multi-trait models and trait interactions can facilitate the quest for specific species characteristics.

Lastly, bases on the analyses of small-scale vegetation plots, we were able to provide an overview of the most invaded habitats through Europe and draw a map of the most invaded regions. Adding scenarios of possible future changes in land use, we were able to project species invasions into the future under these scenarios.

Session 1: Patterns, mechanisms and evolution of species invasiveness

Mediterranean container plants and their stowaways: a potential source of invasive plant species

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The ongoing discovery of new aliens underscores the high level of propagule pressure today. Since 2005, 162 taxa (including additions from the current study) have been added to the list of Belgian neophytes. The origin of introduced diaspores and the routes they follow changes over time. Since the early 21st century the importation of Mediterranean container plants has strongly increased. Together with palm trees, olive trees, etc., large numbers of 'stowaway' weeds are being introduced. In 2008 we studied the weeds in containers of Mediterranean origin in garden centres. 120 identified species could be used in our analysis. 30 species are indigenous to Belgium, and all but 3 of these are also indigenous to Spain and/or Italy. The remaining 90 species are naturalized in Belgium (25 species), casuals (45), or are recorded for the first time (20). 29 of these 90 species (32%) entered Belgium from a secondary distribution range in Spain and/or Italy, not from their natural range. Our species list suggests that the recent increase of records for certain aliens in urban areas, although originally not identified as 'container aliens', is probably linked with the increased importation of Mediterranean container plants. It further shows that the interpretation of 'lag time' between initial introduction and invasive expansion requires an awareness of the continually changing processes that drive biological invasions as evolving against the background of an ever-shifting, unpredictable historical context. Each introduction presents a unique combination of species traits and human history.

I. Hoste, R. van Moorsel & R. Barendse (2008). Een nieuwkomer in sierteeltbedrijven en tuinen: *Cardamine corymbosa* in Nederland en België. Dumortiera 93: 15-24.

F. Verloove (2006). Catalogue of neophytes in Belgium (1800-2005). Scripta Botanica Belgica 39. Meise, National Botanic Garden of Belgium.

On the occurrence of exotic mosquito species in Belgium: the tip of the iceberg?

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Ongoing eco-climatic changes and increasing worldwide transport create suitable conditions for the (re)emergence of mosquito-borne diseases in Europe. Recent events show the need for a better knowledge of the biodiversity of both endemic and invading mosquitoes. In this context a 4 year project (MODIRISK) was started in 2007. Mosquitoes were collected by use of Mosquito Magnet Liberty Plus traps in more than 900 randomly selected sites and 60 'mosquito-import risk areas'. These consisted out of harbours, airports, used tyre retailers and nature reserves. Potential breeding habitats (artificial containers and natural habitats) were checked for larvae. During MODIRISK the presence of the potential vector species *Ochlerotatus japonicus japonicus* at two tyre companies in Southern Belgium was confirmed. The species was probably introduced through the international trade in second-hand tyres. Based on the currently available data the species seems to be established in Belgium, but no clear indications exist that this exotic species actively spreads. *Aedes albopictus*, a known invasive species, has been observed in Belgium in 2000, new investigations made in the framework of the MODIRISK project did not confirm its presence, suggesting that is was not able to establish. However, seen its current European distribution and invasive status in surrounding countries it is likely that the species will re-appear in Belgium. Pointing to the importance of monitoring of exotic mosquito species the implications of the presence of these exotic species in Belgium will be discussed.

Schaffner et al. 2004. First record of *Aedes (Stegomyia) albopictus* in Belgium
Versteirt et al. Introduction and establishment of the exotic mosquito species *Aedes japonicus japonicus* (Diptera: Culicidae) in Belgium

Sources of phenotypic variation of life history traits in an invasive species, *Senecio inaequidens* DC. (Asteraceae)

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The importance of different sources of phenotypic variation, namely adaptation, phenotypic plasticity, environmental maternal effects, ploidy level and genetic drift, were estimated in several life history traits among populations of an invasive plant species within its invasion range. Several common garden experiments were set out, two of which in a reciprocal transplants experiment. The populations considered in this study were located in Belgium, in France and in the native range of the model species. *Senecio inaequidens* DC. (Asteraceae) is native to Africa. It was introduced in Europe via wool trade in the late 19th century. In the native range, the species occurs at two co-existing cytotypes: diploid and tetraploid. Only tetraploid individuals are reported in Europe. The particular and well-documented invasion history of *S. inaequidens* makes it an excellent plant model for evolutionary studies. Several life history traits were measured, related to germination, growth and sexual reproduction. The sources of phenotypic variation in those traits were analysed with respect to climatic variation along altitudinal gradients in the invaded areas. The influence of the ploidy level and the range (native vs introduced) on those traits was also analysed. Results showed that diploid and tetraploid populations differed, mainly in winter survival capacity. Along altitudinal gradients, clinal phenotypic differentiations with a genetic basis were observed among populations. However, environmental maternal effects were found to significantly influence phenotypic variation in areas with harsh climatic conditions.

Monty A., Mahy G. 2009. Clinal differentiation during invasion: Senecio inaequidens (Asteraceae) along altitudinal gradients in Europe. Oecologia 159:305–315.

Monty A., Lebeau J., Meerts P., Mahy G. 2009. An explicit test for the contribution of environmental maternal effects to rapid clinal differentiation in an invasive plant. Journal of Evolutionary Biology (Early view – doi: 10.1111/j.1420-9101.2009.01728.x)

Patterns of *Prunus serotina* invasion in two contrasting forests on sandy soils

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Prunus serotina, a North-American tree species, is considered an aggressive invasive species in Western Europe. Opposite to prior studies, which focused mostly on areas heavily invaded by *P. serotina*, we studied long-term (70 years) forest development in two forest reserves in areas with a low propagule pressure: the forest reserves Liedekerke (Belgium) and Ossenbos (the Netherlands). Based on cadastral maps and aerial photographs, tree ring analysis, forest inventories and regeneration data, we reconstructed the *P. serotina* invasion in both forests. Long-distance dispersal events and windows of opportunity triggered the invasion of *P. serotina,* while further colonization was directed by connectivity to seed sources and light availability. The presence of native shrub species, the quick canopy closure, and the recalcitrant herb layer seemed to hamper further *P. serotina* establishment. Conversely, high herbivore pressure was found to favour *P. serotina* above native species, which resulted in *P. serotina* dominance. The outcome of the *P. serotina* invasion process contrasted sharply between the two studied forests: *P. serotina* was omnipresent and very abundant in the Ossenbos while the species did not act as an aggressive invader in the Liedekerke forest reserve. Consequently, it appears to be important to study an invasive species and the recipient ecosystem jointly and to formulate differentiated management approaches conditional upon the characteristics of the recipient ecosystem.

Verheyen K, Vanhellemont M, Stock T, Hermy M (2007) Predicting patterns of invasion by black cherry (Prunus serotina Ehrh.) in Flanders (Belgium) and its impact on the forest understorey community. Diversity and Distributions 13:487–497.

Vanhellemont M, Verheyen K, De Keersmaeker L, Vandekerkhove K, Hermy M. Does Prunus serotina act as an aggressive invader in areas with a low propagule pressure? Biological Invasions. Published online first, September 23, 2008. DOI 10.1007/s10530-008-9353-8.

Vanhellemont M, Wauters L, Baeten L, Bijlsma R-J, De Frenne P, Hermy M, Verheyen K. Prunus serotina unleashed: invader dominance after 70 years of forest development under high herbivore pressure. Submitted to Ecological Applications.

Welcome to the world? Breeding alien bird species in Flanders

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Alien (exotic) species that breed originally in the Americas, Asia, Africa and Australia are becoming increasingly common in larger areas of Flanders (Belgium). During the most recent breeding bird atlas project (2000-2002) no less than 12 such species have been recorded as confirmed breeders. Population numbers of waterbirds as Canada Goose, Egyptian Goose and Barnacle Goose reach several hundreds to more than 1500 breeding pairs. The species are distributed over the whole of the region. Australian Black Swan, Magelanic Goose, Bar-headed Goose, Wood Duck and Mandarin Duck are still present in low numbers but populations are increasing slowly and their breeding area is extending. Ring-necked Parakeets have been mainly concentrated around Brussels but are now also extending their breeding range. Since 1994, population numbers of these species are assessed by a long-term monitoring scheme. Species trends are presented and problems of accuracy of the counts discussed, together with the possible impact on nature and results of management actions.

Session 2. Impacts of invasions on biodiversity, health and economy

Alien impact 1. A project to quantify and explain the biodiversity impacts of highly invasive plant species (HIPS) at different spatial scales and trophic levels

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Alien Impact (2007-2010) is a large-scale, integrated study on patterns and mechanisms of impact of alien invasive plant species in Belgium, funded by the Belgian Science Policy (Belspo) under the programme Science for a Sustainable Development. It considers both terrestrial and fresh water ecosystems. Five groups collaborate on a shared set of highly invasive alien plant species (HIPS). The goals are: (1) To quantify impact on the diversity of native plant communities. Which native species experience the greatest impact? Can low densities already induce high impact? Do critical invader densities exist above which impacts enhance disproportionately? (2) To assess whether changes in native communities trigger diversity loss or changes in community structure at higher trophic levels, notably in soil fauna. Are such changes mediated by modification of ecosystem properties? (3) To identify mechanisms of HIPS impact on native plants. Is impact mediated primarily by competition for soil resources, by competition for pollinator resources, or by other mechanisms such as secretion of allelochemicals? Does modification of ecosystem properties (soil) triggered by HIPS reinforce impact on native plant species? (4) To analyse factors that may modulate HIPS impacts in the future: eutrophication and climate-warming. We present results and preliminary conclusions from the first two experimental years.

Alien impact 2. Patterns of impact of highly invasive plant species (HIPS) on native vegetation in Belgium

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It is often suggested that diverse communities are less likely to be invaded, but both negative and positive relationships, between native flora richness and invasion, have been reported. Invaders may induce differential impacts on various native species, resulting in fundamental changes in community structure. Within the framework of the ALIEN IMPACT project we investigated the patterns of impact of seven highly invasive species (four terrestrial and three aquatic species) on native plant species richness, structure and composition in Belgium, with a particular focus on sites of high biological value. Our results showed similar patterns of impact following invasion, both for terrestrial and aquatic communities. The four terrestrial target species tended to invade diverse habitats or vegetation communities. Disturbances appeared to be the main cause of invaders establishment. The reduction in native plant richness/diversity was a common pattern to invasion. However, the magnitude of impacts were species specific. No endangered species or species of concern was found to be directly impacted by invasion. The three aquatic target species could invade ponds with a broad range of nutrient levels. Invaded ponds, regardless of the alien species, supported a lower native plant richness/diversity compared to adjacent non-invaded ponds. Submerged vegetation is the most threatened by the invasion because alien species tend to occupy a large amount of space. Indirect consequences on whole communities should be further studied and taken into account in order to produce an integrated ranking of HIPS impacts.

Alien impact 3. Impact of HIPS on ecosystem functioning: productivity, nutrient cycling and soil biota

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We studied the impacts of invasive plant species on soil chemical properties, productivity and nutrient uptake. We applied a comparative approach (invaded vs. adjacent uninvaded plots) in 36 sites invaded by one of the seven most invasive alien plants in Belgium (*Fallopia japonica, Heracleum mantegazzianum, Impatiens glandulifera, Prunus serotina, Rosa rugosa, Senecio inaequidens, Solidago gigantea*). Invasive plants systematically enhanced nutrient uptake and productivity. Their impact on soil properties strongly varied depending on site but in a predictable way (increased nutrient availability in sites with low initial nutrient availability and the opposite pattern in initially rich soils). This suggests that exotic plant invasion could lead to the homogenization of soil properties across invaded landscapes. More recently, with the project ALIEN IMPACT, we focused on the impact of *Fallopia* on nitrogen cycle and on implicated soil biota. *Fallopia* tends to conserve nitrogen in the ecosystem. The decomposition of its litter is slow and immobilizes a large amount of inorganic N, reducing its availability in soil. The internal cycling of N in *Fallopia* was found exceptionally efficient (80 % of the N present in aboveground biomass in summer is translocated to the rhizomes before leaves abscission). This process makes the plant relatively independent from soil N mineralization and contributes to the high productivity of the species. *Fallopia* is also able to decrease N losses from the ecosystem by decreasing nitrification and denitrification intensity in sites with high nitrification potential. Finally, *Fallopia* also impacts soil fauna (lower invertebrate density and altered composition of the community). These changes are mainly explained by a reduction of food diversity and a change in soil microclimate. –

Dassonville N., Vanderhoeven S., Domken S., Meerts P., Chapuis-Lardy L., 2009. Impacts of Alien Invasive Plants on Soil and Ecosystem Processes in Belgium: Lessons from a Multispecies Approach. In Wilcox C.P. and Turpin R.D. (eds). Invasive Species: Detection, Impact and Control. Nova publishers. Under press. –

Dassonville N., Vanderhoeven S., Vanparys V., Hayez M., Gruber W., Meerts P., 2008. Impacts of alien invasive plants on soil nutrients are correlated with initial site conditions in NW Europe. Oecologia 157:131-140.

Dassonville N.*, Vanderhoeven S.*, Gruber W., Meerts P., 2007. Invasion by Fallopia japonica increases topsoil mineral nutrient concentrations. Ecoscience 14: 230-240.

Vanderhoeven S., Pieret N., Tiebre M.S., Dassonville N., Meerts P., Rossi E., Nijs I., Pairon M., Jaquemart A.L., Vanhecke L., Hoste I., Verloove F. & Mahy G., 2006. INPLANBEL: Invasive Plants in Belgium : patterns, processes and monitoring. Final report. Contrat BELSPO (EV/11/27C)

Alien impact 4. Plant-pollinator interactions: methodological approaches from the field to an experimental design

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Indirect interactions between plant species may be mediated by shared pollinators and modification of their services. The presence of an invasive species can have either a negative impact on pollination and subsequent seed set of native species by competing for pollinators (decreasing visitation rate and/or transferring heterospecific pollen), or a positive effect by facilitating pollinator visitation. Within the framework of the ALIEN IMPACT project, plants-pollinators interactions are being studied for 4 HIPS (highly invasive plant species) in Belgium. For two HIPS (*Fallopia* spp. and *Solidago gigantea*), given the lack of information on pollinator guilds and their sharing with native species, a food web approach was applied as a first step to study plants-pollinators interactions in the field. Our results show not only an integration of HIPS into the plant-pollinator networks, but a dominance of the HIPS in terms of frequency of visits. A bioassay with relevant native competitors will be performed as a second step. In parallel, for the HIPS with known pollinator guilds (*Senecio inaequidens* and *Impatiens glandulifera*), an approach in outdoor controlled competition experiments with potted plants was chosen in order to provide a detailed analysis of the processes that lead to the reproductive success of native species. Experiments were carried out with pairs of invasive-native species and aimed at testing the effects of density (different numbers of alien individuals) and distance (different distances between alien and native). Pollinator-mediated impacts were specific to each pair of native-invasive, increased with alien density and were more marked at short distances.

Alien impact 5. Taking the heat: will climate warming fuel alien plant invasions and enhance impact on the native flora?

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Future alien plant species will not experience the climate of today. Global surface temperatures are projected to increase by 1.1 to 6.4 °C over the next 100 years, in response to the rising atmospheric concentrations of greenhouse gases. There are several reasons to believe that alien invasive plant species will react differently to such changes than their native counterparts, but experimental data are scarce. We show results from a range of studies on terrestrial species in climate-controlled greenhouses, most of which were done in the ALIEN IMPACT project. These studies illustrate effects of climate warming on: (i) congeneric alien and native species grown as single plants under optimal rainfall conditions; (ii) highly invasive alien species competing with native counterparts under optimal rainfall conditions, and (iii) highly invasive alien species competing with native counterparts, allowing for drought associated with warming. In the congeneric pairs, the native species generally became less productive in the warmer climate. Their alien counterparts, on the other hand, on average showed no productivity response, but some aliens were favoured by warming and others were set back. The alien species that responded highly positively are currently non-invasive but all of them originate from regions with a warmer climate. Still, other alien species that also originate from warmer regions became less or remained equally productive. In competition experiments, simulated climate warming modified current competitive interactions between native and invasive terrestrial plants. However, the way in which the balance between invasive and native species was altered depended on the studied species pair. Most of the changes could be ascribed to warming influences on nutrient uptake. From the species pairs examined, it appears that the sensitivity of the native-invasive interaction to climate warming does not necessarily mirror the intrinsic sensitivities of the species. This poses a challenge for identifying the winners and losers in a future, warmer world.

Alien macro-crustaceans in freshwater ecosystems in Flanders

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During the last decades, the spread of aquatic alien species has increased enormously. Range extensions of exotic species have been facilitated by the interconnection of river basins and increased shipping. Invasive species are considered as an important component in the decline of diversity of communities and the abundance of other species in freshwater ecosystems. Besides their ecological impact, alien species are considered to cause worldwide economical damage. Currently, eighteen alien macro-crustaceans have been found in freshwater ecosystems in Flanders. One of these invasive species is the Ponto-Caspian invader *Dikerogammarus villosus*, which has invaded most of Europe since the beginning of the 1990s, mainly as result of the opening of the Main-Danube canal. This species was recorded for the first time in the east of Flanders in 1997. In order to assess the potential effect of this species on other macroinvertebrates, laboratory experiments as well as field observations were conducted. All types of prey that were used in predator-prey experiments were consumed by *D. villosus*, especially species that were less mobile such as Chironomidae. Substrate preference experiments indicated that *D. villosus* preferred a stony substrate. Using decisions trees to model field observations, it could be concluded that *D. villosus* could mainly be found in habitats with an artificial bank structure, a high oxygen concentration and a low conductivity, which corresponds with the canals where it has been observed mostly in Flanders.

Boets P, Lock K, Goethals PLM, submitted. Combining datadriven methods and lab studies to analyse the ecology of *Dikerogammarus villosus*. Special issue Ecological informatics.

Impact of *Harmonia axyridis* on native ladybird species in Belgium: 1. Niche overlap and population trends.

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The Harlequin ladybird *Harmonia axyridis*, an introduced biocontrol agent, has rapidly invaded Belgian ecosystems and occurs now in a wide range of habitats, including habitats of conservation value. The first feral H. axyridis population in Belgium was recorded in 2001 and the species has expanded its range since and colonised the whole country. Recorded occupancy in Belgium showed an average rate of increase of 189% between 2002 and 2006. In less than five years it has become the predominant species in ladybird assemblages, posing a threat on native tree dwelling aphidophagous species. Since 1999, the Belgian Ladybird Working Group is mapping all Belgian Coccinellidae and recording data on substratum plants and habitat. Based on data of this field survey we assessed potential impact of the species on native guilds. A niche overlap analysis based on plant use data showed that the potential to affect native species is higher for generalist, deciduous and coniferous tree species than for heathland and wetland specialist ladybirds. Also, habitat and land cover analysis showed that *H. axyridis* is, at present, more frequently found in urbanised landscapes than in semi-natural areas, suggesting that natural ecosystems show some resilience to invasion by *H. axyridis*. Preliminary trend analysis of native ladybird species shows the tree dwelling species *Adalia bipunctata* and *Adalia decempunctata* to be struck hardest which is consistent with studies on intraguild predation by *H. axyridis* in the field. Phenology data showed that *H. axyridis* is able to reproduce longer in the year than native species and thus has a competitive advantage over indigenous species. The potential pest status of *H. axyridis* is evaluated using reports on nuisance. Moreover, we address the usefulness of large-scale field survey for impact monitoring and discuss possible control options for this invasive alien.

Adriaens, T, Branquart, E. & Maes, D. (2003). The Multicoloured Asian Ladybird *Harmonia axyridis* Pallas (Coleoptera : Coccinellidae), a threat for native aphid predators in Belgium? Belg. J. Zool., 133 (2) : 201-87

Adriaens T, San Martin y Gomez G, Maes D (2008). Invasion History, habitat preferences and phenology of the invasive ladybird *Harmonia axyridis* in Belgium. BioControl 53: 69-88

Impact of *Harmonia axyridis* on native ladybird species in Belgium: 2. Intraguild predation revealed by exogenous alkaloid sequestration.

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The Multicoloured Asian Ladybird, *Harmonia axyridis*, has invaded the whole of Belgium in less than five years. In parallel, decline of some native ladybird species such as *Adalia bipunctata* and *A. decempunctata*, was observed in tree habitats. Laboratory studies have reported that *H. axyridis* acts as an intraguild predator, resulting in high risks for the survival of native species. In order to assess the real impact of *H. axyridis* on aphidophagous guilds, it is important to determine the frequency of intraguild predation (IGP) in natural conditions, in the presence of extraguild prey (e.g; aphids). Therefore, a method for detecting IGP by *H. axyridis* on native coccinellids was developed based on detection of exogenous alkaloids from native ladybirds in *H. axyridis* larvae using Gas Chromatography - Mass Spectrometry. The analysis of *H. axyridis* larvae collected in several habitats revealed trace of exogenous alkaloids produced by other coccinellid species: adaline (*Adalia* spp.), calvine (*Calvia* spp.), precoccinelline (*Coccinella* spp.) and propyleine (*Propylea quatuordecimpunctata*). The presence of these alkaloids in *H. axyridis* larvae confirms the existence of intraguild predation in the field towards native coccinellid species. To date, on 599 larvae *H. axyridis* collected from lime trees and analyzed, 122 larvae contained exogenous alkaloids and 90% of these alkaloids were adaline. These results support the hypothesis that IGP on *Adalia* spp. could explain the observed decline of these species in trees.

Hautier L, Grégoire JC, De Schauwers J, San Martin G, Callier P, Jansen JP, de Biseau JC. 2008. Intraguild predation by Harmonia axyridis on coccinellids revealed by exogenous alkaloid sequestration. Chemoecology, 18: 191-196

Jansen JP, Hautier L. 2008. Ladybirds population dynamics in potato: comparison of native species with an invasive species Harmonia axyridis. BioControl 53: 223-23.

San Martin G, Adriaens T, Hautier L, Ottart N. 2005. La coccinelle asiatique Harmonia axyridis. Insectes, 136 : 7-11

Session 3. Early detection, risk assessment and management

ISEIA, a Belgian non-native species assessment protocol

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Harmonia, the information system on invasive species in Belgium, has been recently developed at the initiative of scientists gathered within the Belgian Forum on Invasive Species (http://ias.biodiversity.be). Harmonia is based on a standardised assessment protocol (ISEIA) which allows to assess, categorise and list non-native species according to their invasion stage in Belgium and to their impact on native species and ecosystem functions, as described in the scientific literature. The ISEIA protocol is designed to minimise the use of subjective opinions and to make the process of assessing and listing invasive species transparent and repeatable. It offers a scientific background to identify non-native species of most concern for preventive or mitigation actions and to develop national and regional regulation frameworks.

So far, 57 neophytes and 32 vertebrates from terrestrial and freshwater environments were selected and assessed by Belgian experts* using the ISEIA protocol. Eighty-one percent of these are already naturalised in Belgium whereas the remaining 19 % are likely to be established in the coming years if no preventive action is undertaken. Fifty-four percent of the examined species were assessed as organisms with a strong detrimental impact on native biodiversity (black list species), for which preventive and mitigation actions are strongly recommended. Most of the remaining species were recorded on the watch list, which means either that their impact on native biodiversity is moderate or is still unclear due to a shortage of scientific studies.

Compared to neophytes, a higher proportion of the naturalised exotic vertebrate species has been shown to be detrimental to native species and ecosystem functions. Invasive neophytes typically affect biodiversity in making very dense populations in semi-natural habitats, which outcompete native species and often modify vegetation structure and alter nutrient cycling, whereas vertebrates adversely impact biodiversity though a wide range of interspecific interactions (competition, predation, disease transmission and hybridisation) that may act separately or synergistically.

The ISEIA protocol (see http://ias.biodiversity.be/ias/documents/ISEIA_protocol.pdf) will be used in the future to assess and categorise additional non-native species, including organisms from other taxonomic groups and from the marine environment.

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* Members of the ISEIA expert group (listed by taxonomic group and in alphabetical order): Iris Stiers, Ludwig Triest, Sonia Vanderhoeven, Wouter Van Landuyt, Fabienne Van Rossum, Filip Verloove (vascular plants); Tim Adriaens, Patrick De Clercq, Wouter Dekoninck, Jean-Claude Grégoire, Wim van Bortel (insects); Dieter Anseeuw, François Lieffrig, Jean-Claude Micha, Denis Parkinson, Hugo Verreycken (fishes) ; Arnaud Laudelout, Gérald Louette, Youri Martin, Joachim Mergeay, Chistiane Percsy (amphibians), Anny Anselin, Diederik Strubbe, Anne Weiserbs (birds) ; Margo D'aes, Alain Licoppe, Grégory Motte, Vinciane Schockert, Jan Stuyck (mammals) ; Etienne Branquart (coordination).

Non-indigenous freshwater fishes in Flanders: status, trends and risk assessment

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** Corresponding author Tel. 02 658 04 26 E-mail: hugo.verreycken<at>inbo.be*

At least eighteen non-indigenous freshwater fish species were reported to occur in the wild within the territory of Flanders. Nine are considered naturalized while the others are acclimatized and do not form self sustaining populations. Nine of the introductions occurred prior to 1950, with the other nine species introduced since then. This contribution reviews the available information on these introductions, and evaluates a decade of data from fisheries surveys to assess the recent development of these non-indigenous populations. Gibel carp *Carassius gibelio* and topmouth gudgeon *Pseudorasbora parva* are the most widespread of the non-indigenous species in Flemish waters, and both continue to expand their ranges. A reduction in range has been observed in brown bullhead *Ameiurus nebulosus* only. Only four species occur in all eleven river basins while eight species are restricted to one or two basins and often only one specimen was found during fish stock assessments. We also discuss non-indigenous fish species that are likely to colonize Flanders inland waters in the near future. For all non-indigenous freshwater fish species present and expected to appear soon, different risk analysis tools (FISK and ISEIA) were used to screen these species for their possible invasiveness. Although scores from FISK and ISEIA differ for some species, gibel carp and topmouth gudgeon were in both assessments classified as 'highest risk' species in relation to their potential invasiveness.

Verreycken, H., Anseeuw, D., Van Thuyne, G., Quataert, P. and Belpaire, C., 2007: The non-indigenous freshwater fishes of Flanders (Belgium): review, status and trends over the last decade. – J. Fish Biol. 71 (Supplement D), 160–172.

Verreycken, H., Vandenbergh, K., Vilizzi, L. and Copp, G.H., (in prep): Initial application of the Fish Invasiveness Screening Kit (FISK) to freshwater fishes in Flanders

Brussels Psittacidae: impacts, risks assessment and actions range

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Invasive species raise many questions regarding their environmental impacts. A study carried out in 2008 by Aves, in collaboration with Brussels Capital-Region environment institute (IBGE) reviewed Psittacidae populations current status in the Brussels area and analysed their present and potential impacts in order to inform policy-makers about the best management practices able to limit these impacts. Three Psittacidae breed in Brussels: the Alexandrine Parakeet (*Psittacula eupatria*), the Ring-necked Parakeet (*Psittacula krameri*) and the Monk Parakeet (*Myiopsitta monachus*). The case of the Monk Parakeet will not be further developed here, the population being easier to manage. The impact assessment includes the following points: invasive potential, damage for crops and vegetation, competition with indigenous species, pathology transmission risks, massive feeding by man and roosts impacts. The risk assessment is based on two schemes. Both of these schemes lead to the conclusion of a weak to moderate impact of the Alexandrine Parakeet and the Ring-necked Parakeet. The actions range reviews the possible management measures, from the weakest to the strongest. The conclusions highlight the necessity to adapt measures to the impacts. Preventing the massive feeding of these species by the inhabitants is an important lever, but stronger measures, like chemical sterilization, could be considered for the two species.

Management strategy of invasive plants: study cases with three species in the Walloon region: *Impatiens glandulifera, Fallopia* spp. and *Acer rufinerve*

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At present, around 36 terrestrial plant taxas are included in the list of invasive species in Belgium, composed of a black list with high impact species and a watch list of species with a moderate or unknown impact. The invasion level varies from plants present in isolated populations to others with widespread distribution. The management strategy must be adapted to the invasion extent. It is generally admitted that eradication is only possible for species in the beginning of the invasion process, while containment or attenuation measures will be selected to control the spread of widely distributed species. Similar techniques are commonly proposed in the literature: manual, mechanical or chemical methods, used separately or combined. But these methods often lack scientific assessment and follow up. Since 2006, the Laboratory of Ecology lead applied research projects in the walloon Region, aiming at identifying most appropriate techniques concerning 6 invasive plants (*Impatiens glandulifera, Heracleum mantegazzianum, Fallopia* spp., *Acer rufinerve, Cotoneaster horizontalis* and *Spiraea* spp.), representative of contrasted invasion situations in different types of ecosystems. Experimental designs are conducted in situ to test efficient techniques adapted to local situations. The choice of a method strongly depends on the plant physiology, the reproduction mode and the habitat type invaded. The approach will be presented through three cases study: two black list plants (*Impatiens glandulifera*, annual herbaceous species and *Fallopia* spp., rhizomateous species) and one watch list plant (*Acer rufinerve*, ligneous species). The overall objective aims at providing scientific and technical guidelines for managers.

BIOLOGICAL INVASIONS: A BELGIAN PERSPECTIVE

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Introduction

Three years after the SOS invasion milestone, the Science facing Aliens conference is a new opportunity to make the point on the Belgian research dedicated to biological invasions. As a preparatory work to the conference, the Belgian Biodiversity Platform analysed the Belgian research linked to the conference theme.

Methodology

Research projects dealing with biological invasions were surveyed through the BioBel database (Belgian Biodiversity Platform, http://biobel.biodiversity.be, accessed April 30, 2009). Projects extracted from the database were sorted in two different categories. The first one includes projects that typically focus on biological invasions and involve at least 1 full time scientist. The second one includes projects that incidentally deal with invasion ecology.

Several attributes were assigned to the projects. This includes starting and ending date of the project, taxonomic affiliation, habitat type, research topic, and funding source. Five main research topics were considered based on the session themes of the last Neobiota conference (Prague, September 2008). These topics are supposed to encompass the full spectrum of research activities linked to biological invasions (see table 1).

For all the analyses presented hereafter, individual projects were weighted based on the number of research teams involved with a least 1 full time scientist. This implies that more importance was given to large networks than to individual PhD theses.

Although we made a great effort to include all invasion-related research projects in BioBel, some may have escaped our attention. The following results will have to be interpreted having this limitation in mind.

Bibliometric analyses were also performed to compare Belgian and international research dedicated to invasion ecology. We used “invasive species” or “biological invasion*” for a search of the Web of Science ® (WoS, accessed 29 April 2009), in combination with the keywords corresponding to the 5 main research avenues cited in table 1. This yielded 5220 papers, among which 56 were produced by Belgian authors alone or in collaboration with international authors.

Table 1 – *Invasion ecology research topics and key-words used for bibliometric analyses.*

Research topic	**Key-words**
1. Invasion and dispersion patterns	Pattern* OR distribution OR dispers* OR range OR pathway OR spread
2. Mechanisms and evolution of invasions	Evolution* OR mechanism* OR process* OR invasiveness OR life-history
3. Impacts of invasions	Impact*
4. Prediction and risk assessment	Predict* OR risk assessment OR impact assessment
5. Management (best practices)	Management OR control

The Belgian research on biological invasions

We identified 56 research projects dedicated to biological invasions being conducted by Belgian scientists from 1990 to 2009. As shown in figure 1, a rising interest in invasion ecology is manifest in the exponential growth of research projects related to invasive species since 1999.

In addition to those projects, 22 more projects involve invasive species in a more incidental way. They are related either to biodiversity monitoring activities or to pest control studies. Such projects will not be considered in further analyses.

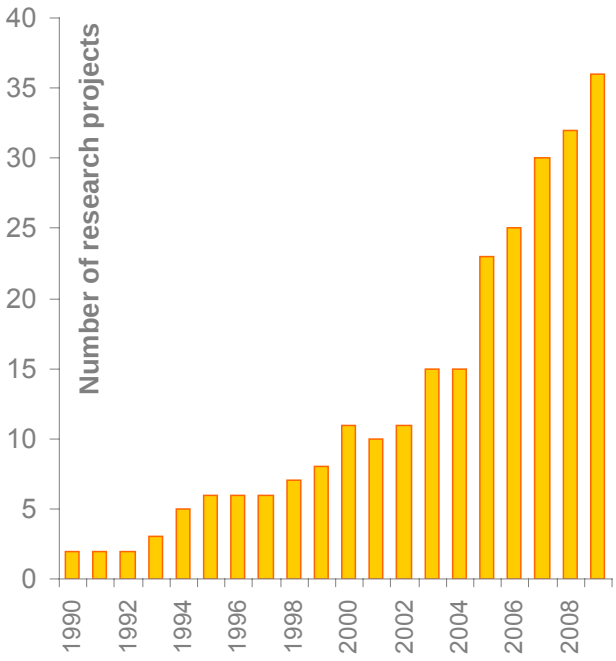

Figure 1 - *Number of Belgian research projects dedicated to biological invasions since 1990.*

A majority of research projects (62 %) focused on invasive plants; vertebrates were considered in 23 % of the projects and invertebrates in only 15 % (see figure 2). There is no project in our BioBel database that deals explicitly with invasive micro-organisms, fungi or algae.

Research dedicated to biological invasions was mainly conducted on terrestrial ecosystems (67 %). Twenty-nine percent of projects targeted freshwater systems whereas only 4 % dealt with marine areas. These proportions are not related to ecosystem invasiveness as many non-native species typically thrive in freshwater and marine environments in Belgium as in other parts of the world.

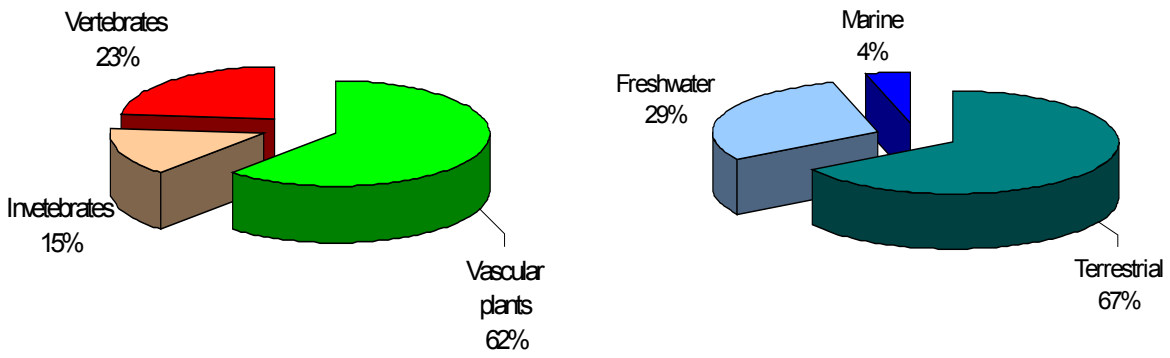

Figure 2 – *Share of Belgian research projects dedicated to biological invasions between main taxonomic groups (left) and major ecosystems (right)*

Two out of the five main research avenues (invasion patterns and management) are investigated since the early nineties and make the baseline of Belgian invasion ecology research. The three other research topics came progressively on top them. Prediction and risk assessment studies are the most recent and less developed subjects (see figure 3).

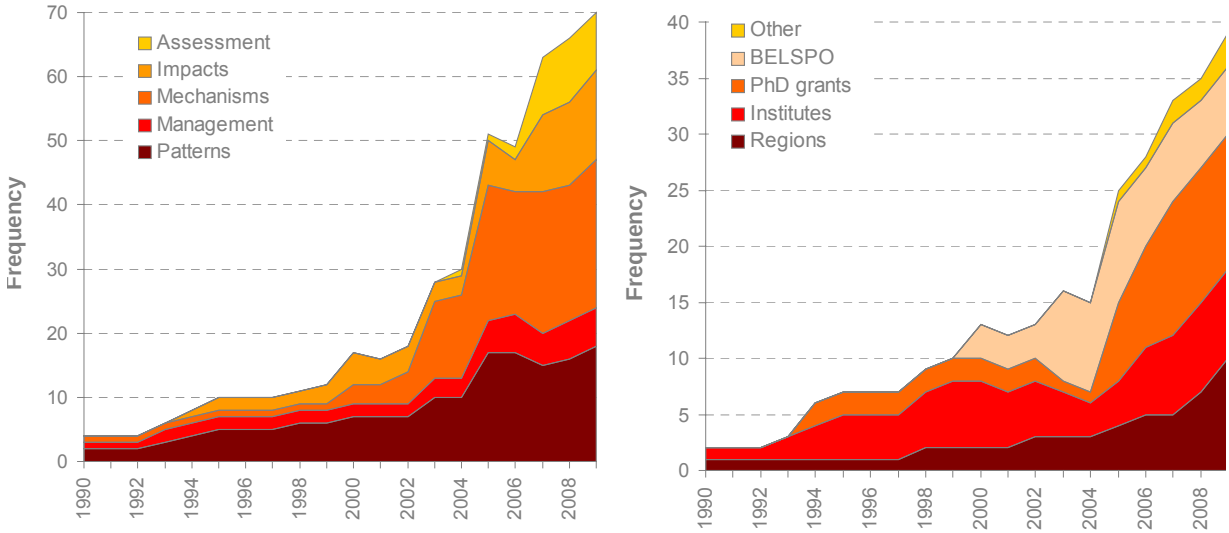

Figure 3 – *Evolution of project frequency from 1990 to 2009, shared between research topics (left) and research funding sources (right).*

Research funding

Different funding sources supported the Belgian research effort on biological invasions (1990-2009) to the following extent: 25% from BelSPO, 25% from PhD grants, 23% from regional administrations and 18 % from institutes budgets and 9% from various other sources (see figure 3). International funding of the Belgian invasion ecology research during that time was nearly absent.

A core funding was available from regional administrations in charge of environment management and from biological research institutes (e.g. National Botanic Garden of Belgium, Research Institute for Nature and Forests, Royal Belgian Institute for Natural Sciences), allowing the development of long-term monitoring and research programmes. On top of that, more focused initiatives were developed from 1999 onwards based on the work of research teams involved in BelSPO projects and of PhD students. Those studies often focused on invasion mechanisms and impact of biological invasions; they often produced innovative results to be published in international journals (see further). The implementation of the BelSPO "Science for a Sustainable Development" programme which included invasion ecology as a priority topic allowed to significantly increase the research effort from 1999 to 2005 and acted as a strong catalyst for the development of invasion ecology in Belgium.

It has to be noted that Belgian research on biological invasions was limited by the availability of funding sources. During the last decade, several innovative and challenging projects involving a strong partnership between different research teams in Belgium proved abortive due to the lack of funding opportunities.

Belgian vs international research

Fifty years ago, the publication of Charles Elton's book *The Ecology of invasions by animals and plants* (1958) launched the systematic study of biological invasions. However, biological invasion- related scientific papers only started to be readily produced some 30 years later, mostly as a result of the launch of the SCOPE programme on biological invasions. This programme raised awareness on the importance of the phenomenon at a world-wide scale[1].

Although international publications dealing explicitly with invasion ecology are being produced at an exponential rate since the early nineties, publications by Belgian scientists started to appear with a time lag of approximately 10 years (figure 4A). With a total of 56 international publications, Belgium comes 7th amongst European countries after correcting number of publication by population size (figure 4 B). We expect that this number will continue to rise in the future as a consequence of the increasing number of research projects dedicated to biological invasions in Belgium.

Twenty percent of Belgian papers published in WoS-indexed journals result from BelSPO funded projects. This concerns mainly research teams that are member of the INPLANBEL-PERINBEL-ALIEN IMPACT suite of projects. The following laboratories also contributed significantly to the production of Belgian publications related to invasion ecology: Animal Ecology (UA), Behavioural and Evolutionary

[1] David M. Richardson & Petr Pysek (2008). Fifty years of invasion ecology : the legacy of Charles Elton. *Diversity and Distribution* **14** : 161-168.

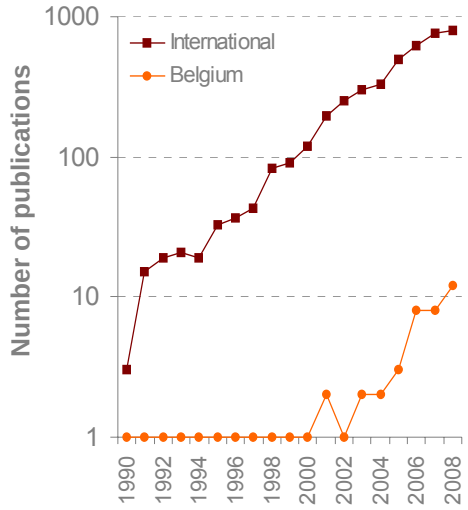

Figure 4A - *Growth in the number of publications registered on Web of Science, by Belgian and international scientists.*

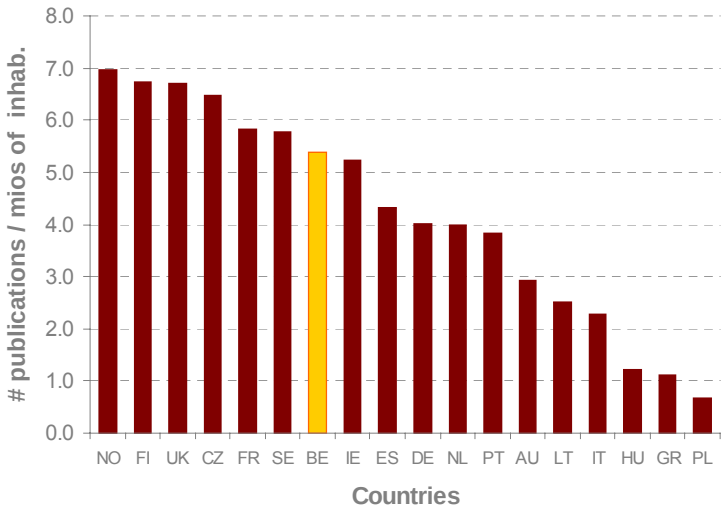

Figure 4B- *Number of publications produced since 1990 and registered on Web of Science divided by the number of country inhabitants (in millions).*

Ecology (ULB), Biological Control and Spatial Ecology (ULB), Forestry (UGent) and Forest, Nature and Landscape (KUL).

Publications produced by Belgian and international scientists relate to very similar topics. Belgian scientists, however, seem to focus slightly more on mechanisms and evolution of invasions and, relatively less on invasion patterns and management issues (figure 5).

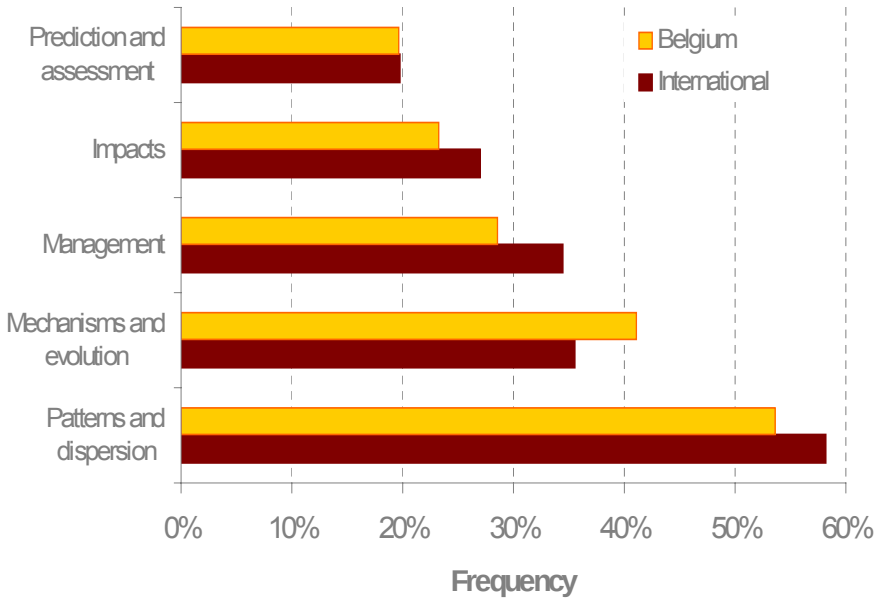

Figure 5 - Frequency of publications related to the 5 main research topics.

On top of international publications, Belgian scientists produce significant amounts of worthwhile "grey" literature,. Notwithstanding the sometimes unjustified poor standing of such publications, they are particularly useful for risk assessment and management purposes. An example is the "Catalogue of the Neophytes in Belgium" (1800-2005)[2] or the various reports produced by scientists of the Research Institute for Nature and Forest. Most of those publications are referred to in the *Harmonia* information system of the Belgian Forum on Invasive Species and in the data centre of the Flanders Marine Institute.

Integration within international networks

Despite the high level of the scientific research dedicated to invasion ecology in Belgium, only few research teams have been able to take advantage of European funding sources. The only institutions involved in EU RTD projects are VLIZ (MarBEF), INBO (ALTER-Net) and ULB (FORTHREATS). No Belgian partner was involved in the large EU projects that typically focused on biological invasions (ALARM, DAISIE, IMPASSE, etc.). The contribution of Belgian scientists to the European alien species inventory has been provided without any remuneration. This poor integration of Belgian scientists in EU research network is probably due to the publication time lag.

Table 2 – *Presentation of the different European RTD projects related to biological invasions and partnership with Belgian research teams.*

Program	Acronym	Title of the project	Starting year	Belgian partners
FP5	GIANT ALIEN	Giant Hogweed (*Heracleum mantegazzianum*) a pernicious invasive weed: Developing a sustainable strategy for alien invasive plant management in Europe	2002	(NBGB)
FP6	ALARM	Assessing LArge-scale environmental Risks with tested Methods	2004	(KUL, UCL)
FP6	MarBEF	Marine Biodiversity and Ecosystem Functioning	2005	VLIZ
FP6	DAISIE	Delivering Alien Invasive Species Inventories for Europe	2005	-
FP6	IMPASSE	Environmental impacts of alien species in aquaculture	2006	-
FP6	REBECA	Registration of Biological Control Agents	2006	-
FP6	ALTER-Net	A Long-Term Biodiversity, Ecosystem and Awareness Research Network	2006	INBO
FP6	FORTHREATS	European Network on emerging diseases and threats through invasive alien species in forest ecosystems	2007	ULB
FP7	PRATIQUE	Enhancements of Pest Risk Analysis Techniques	2008	-

[2] Filip Verloove (2006). Catalogue of the Neophytes in Belgium (1800-2005). *Scripta Botanica Belgica* **39**, 89 pp.

On the other hand, many Belgian scientists are today involved in EU policy-oriented networks, linked to, amongst others, the Bern Convention, the European Environmental Agency (EEA), the European Food Safety Agency (EFSA), the European Plant Protection Organisation (EPPO) and the European Platform for Biodiversity Research Strategy (EPBRS). The Harmonia information system and the ISEIA assessment protocol elaborated by the Belgian Forum on Invasive Species were welcomed by those initiatives.

Conclusions and perspectives

Today, Belgian research dedicated to biological invasions enters a phase of maturity and is conducted according to high quality standards. Some research topics are well developed by Belgian teams and can be considered as very competitive within the international arena, like studies dedicated to the evolutionary and ecological mechanisms of plant invasions or to those focusing on the spatial dynamics of invasions. Research effort should capitalise on that basis and try to integrate as much as possible within international networks. Scientists should also try to address some gaps and consider invasion issues in less studied ecosystems like freshwater and marine environments.
If we aim at limiting the impact of biological invasions then an important challenge to tackle in the coming year is setting up an early detection and rapid response (EDRR) system in Belgium. This implies developing adequate monitoring activities, correctly identifying new invasive species, performing rapid risk analyses and implementing adequate management responses. Scientific research activities in support of EDRR should be promoted within emergent disciplines like bio-informatics, DNA barcoding and risk analysis. Best practices for the management of invasive species should be also identified.

It is important to document the invasion history of new invasive alien species as much as possible, especially for non-native species that have so far not or hardly been recognised as posing a threat in other countries. We further need to quantify the Impact of such species on biodiversity and ecosystem functioning, using both observational and experimental studies. To be effective, the results of these studies should be dissipated to field managers and experts from Belgian and other countries. We therefore invite scientists involved in research on invasive species to participate to the risk assessment activities co-ordinated by the Belgian Forum on Invasive Species, and to attend meetings organised by EEA, EFSA, EPPO and other international initiatives.

Finally, we advocate that invasion ecologists liaise with colleagues from disciplines to reinforce interdisciplinary and integrative studies. Key areas where improved links with invasion ecology are needed are global change biology, restoration ecology, weed science as well as plant, animal and human health science, as exemplified by BelSPO MODIRISK and EPI-STIS projects.

Acknowledgements

The authors would like to acknowledge all the Belgian scientists that were so kind as to provide information about their research projects in the BioBel database, without which this analysis would have not been possible.

Poster Presentations

ABSTRACTS POSTER PRESENTATIONS

Session 1: Patterns, mechanisms and evolution of species invasiveness

Soil-dependent growth strategy of invasive plants: experimental evidences and model predictions using Carpobrotus edulis as target species

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Several invasive species modify the biotic and abiotic composition of the soil, which results in a contrasting mosaic of soil environments within the invaded landscape. However, up to date, it has not been addressed how the mosaic created by the residual effects of these species on soil influence their own establishment. This is particularly important for invasive species that are able to disperse by means of seeds or vegetative growth. Using a combination of lab experiments and a evidence-based Monte-Carlo simulation model we assessed on one hand whether the residual effects on soil caused by *Carpobrotus edulis* (a highly invasive species in Mediterranean Europe and also in the British Isles) would affect the vegetative and reproductive traits of the species; and on the other hand, the consequences for the dynamics of establishment under different scenarios. The outcome of the experiments and the simulation model indicated that slight initial differences attributed to the residual effect on soil of *C. edulis* have determinant consequences in the rate and the dynamics of colonization and re-colonization of landscapes in invaded areas. Our results highlight the plasticity of the species as a function of the soil environment and put forward a model that can be useful to understand the dynamics of invasion not only of *C. edulis* but of other exotic species.

de la Peña, E., Rodríguez-Echeverría, S., Roiloa, S., Freitas, H., Bonte, D. Soil-dependent growth strategy of invasive plants: experimental evidences and model predictions using *Carpobrotus edulis* as target species. Oecologia, in review

Roiloa, S., Rodríguez-Echeverría, S., de la Peña, E. Freitas, H. Understanding the role of clonality in plant invasions: a field experiment with *Capobrotus edulis*. Annals of Botany, in review

Distribution Patterns of Introduced Plants Differ From Native Plants in Lowland England

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The hypothesis that introduced plants show different patterns of distribution to native plants was tested on the flora of southern England. Spatial patterns were investigated using semi-variograms of presence and pseudo-absence data from floristic surveys of 2 km2 grid squares with data collected between 1987 and 2008. Semi-variograms are a convenient technique to visually represent the patchiness (auto-correlation) of species distributions. Various patterns of spatial distribution were seen in the flora, including species that are highly patchy, through to species whose distribution is apparently random at this scale. Almost all native plants showed patchiness in their distribution at distances of less than 10km, whereas introduced plants either showed no patchiness or over less distance than native plants. The best predictors of patchiness were the environmental preferences and nativeness of the species. The difference between native and introduced plants is likely due to the difference in the mechanism of spread for native and introduced plants. This patchiness of distributions has important consequences for how vegetation change is currently assessed using large (≤10 km2) grid squares as this significantly biases results towards introduced species. Also, the difference in patchiness of introduced species has consequences for understanding the migration of plants in a modern landscape and the breakdown of geographic barriers to gene flow.

Comparing *Fallopia japonica, F. sachalinensis* and their hybrid *F. x bohemica* in Belgium: population ecology, functional traits and invasiveness.

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Université Libre de Bruxelles, Belgium Faculté Agronomique de Gembloux, Belgium

In the course of the nineteenth century two *Fallopia* species were introduced to Europe from Asia. *F.japonica* has become one of the most invasive plant in Europe (Beerling et al, 1994). *F.sachalinensis* is much less invasive and still rare in Western Europe. *F. ' bohemica,* the hybrid between the two species, is said to spread even more rapidly than its parents (Mandak et al, 2004). Our objective is to test if the three taxa have contrasting values of key functional traits that might explain their contrasting invasiveness. We also examine if the hybrid is intermediate between its parents or, alternatively, if it shows transgressive variation in some traits. In sites where two or three taxa coexist in sympatry, the following traits are being monitored: shoot height, number of leaves and ramifications, number and length of internodes, concentrations of nitrogen in shoots and leaves, specific leaf area. The first results reveal interesting differences among the three taxa. Thus, *F.japonica* has higher N resorption efficiency (up to 70% N is resorbed from senescing leaves, vs. 40% in *F.sachalinensis*) . *F. ´bohemica* is intermediate between the parents (though often closer to *F. japonica*). It shows transgressive variation for leaf and ramification numbers. Growth speed is the same for the three species, but *F.japonica*'s growth stops earlier. Field observations will be complemented by a "controlled conditions" experiment to test if the three taxa show contrasting phenotypic plasticity of functional traits in response to different soil fertility conditions.

Beerling DJ, Bailey JP, Conolly AP (1994) *Fallopia japonica* (Houtt.) Ronse Decraene. J Ecol 82:959–979.

Mandák B, Pyšek P, Bímová K (2004) History of the invasion and distribution of *Reynoutria* taxa in the Czech Republic: a hybrid spreading faster than its parents. Preslia 76:15-64.

Habitat preference of a new invasive species in Wallonia: the bullfrog (*Lithobates catesbeianus*)

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2. Belgian Biodiversity Platform
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Lithobates catesbeianus has been observed in Wallonia since 1992 (de Wavrin, 2007). So far, no study was designed to characterise its distribution and habitat use. This is, however, important since *L. catesbeianus* is considered by the IUCN as one of the hundred worst invasive species in the world (Lowe et al., 2000). Bullfrog distribution and habitat preferences were studied in Wallonia during the summer 2008, with a focus on the surroundings of the two population cores reported in Wallonia, at Ransart (Charleroi) and in the Dyle valley (Brabant Wallon). 22 sites were carefully monitored to search for adults and tadpoles. Multivariate analyses were computed to identify which variable combination best explains their presence. Our results show that *L. catesbeianus* is present in a very limited number of water bodies close to introduction sites and that reproduction only occurs in 3 ponds, which suggest that invasion is still at a very early stage. *L. catesbeianus* seems to prefer eutrophic and turbid waters colonised by fish, usually with the presence of helophytes. Due to its strong negative impact on biodiversity and its very limited distribution range in Wallonia, early eradication of bullfrog is strongly recommended.

Martin,Y. (2009) *Lithobates catesbeianus*, une nouvelle espèce invasive en Wallonie: distribution, habitat et régime alimentaire. Mémoire de l'Université Catholique de Louvain, pp. 81.

Branquart, E., Laudelout, A., Louette G., Martin Y. & Percsy C. (2009). Harmonia database: *Rana catebeiana*. Harmonia version 1.2, Belgian Forum on Invasive Species.

Acer rufinerve Siebold & Zucc., a new invasive tree in Belgium ?

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The red veined maple, *Acer rufinerve*, is a tree native to Japan described as an early successional species of temperate forests. It is characterised by a very short generation time, high survival and growth rates and a strong ability of resprouting after cutting. Although it has been introduced as an ornamental in gardens and public green areas of many countries, invasion histories were never reported so far in the scientific literature. *A. rufinerve* has been recently reported to invade the understorey of a forest of 300 ha near the city of Mons, where a few individuals were planted in 1950-1970. We conducted a systematic inventory of this forest based on a 50 m x 50 m sampling grid to map plant distribution at local scale and document the invasion. Results show that this species thrives on podzolic soils (pH 4) and prefers moist stands dominated by oaks. It is often found together with *Prunus serotina*, another invasive tree species. Both of them avoid dense canopies dominated by beech trees. Today, the population is made of a few large trees surrounded by a large number of seedlings and young stems. Seeds may be dispersed over distances of 500 meters. Forest colonisation is rather efficient as more than 50 ha were colonised during the last 10 years. Young stems form very dense thickets wherein few herbaceous plant species are able to grow except bramble, *Rubus fruticosus*. Red veined maple development is therefore likely to reduce plant diversity. A rapid eradication of *A. rufinerve* is strongly recommended. Control techniques are currently tested to determine best practices to reach that goal.

Baus E., Branquart E., Vanderhoeven S., Van Landuyt W., Van Rossum F., & Verloove F. (2009). Harmonia database: *Acer rufinerve*. Harmonia version 1.2, Belgian Forum on Invasive Species.

Halford, M. (2009). Fiche descriptive d'*Acer rufinerve* Siebold & Zucc. Cellule d'appui à la gestion des plantes invasives, FUSAGx.

Rafalowicz, T. (2009). *Acer runfinerve* Siebold & Zucc. Mémoire de fin d'études ISA La Reid.

Growth performance of invasive alien *Landoltia punctata* and invasive alien *Lemna minuta* in monocultures and mixtures under different nutrient conditions

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A controlled indoor experiment was conducted to compare the performance of two alien Lemnaceae species both in monocultures and mixtures along a nutrient gradient. *Lemna minuta* is an invasive aquatic macrophyte native to America but has spread in Europe and has invaded ponds and ditches in Belgium. *Landoltia punctata* on the other hand is a native to Australia and Southeast Asia that has been reported in The Netherlands. Lemnaceae can be transported over short distances by waterbirds and therefore, *L. punctata* will potentially invade ponds in Belgium. Relative growth rate (RGR) of the two species and relative growth rate difference (RGRD) between the species was modelled to (1) reveal which of the two alien species is a superior competitor (2) determine what is the role of species identity, species initial biomass and nutrient enrichment in determining the composition change of these two species in mixture. Preliminary results indicated stronger intraspecific relative to interspecific effects on the RGR of either species. As a result, species effects greatly influenced the difference in growth rate of both species. High nutrient level favoured *L. punctata* relative to *L. minuta* and even at low nutrient level *L. punctata* had a relative advantage over *L. minuta*. Increasing the initial biomass of *L. minuta* enhanced RGRD while increasing the initial biomass of *L. punctata* had the opposite effect. These preliminary results indicate that species influence was the main determinant

Alien macrobenthic species in the Sea Scheldt and its tidal tributaries (Belgium)

Piesschaert Frederic, Soors Jan, De Regge Nico, Speybroeck Jeroen & Van den Bergh Erika

Research Institute for Nature and Forest (Belgium)

The Sea Scheldt comprises the brackish (Belgian-Dutch border to Burcht) and fresh water part (Burcht to Ghent) of the macrotidal Scheldt estuary. The port of Antwerp is situated in the brackish part of the river. Brackish harbour regions are considered particularly susceptible to introductions, because the diversity of native species is usually low and the import rate of new species by ballast water is high. Canals, inland navigation and active introduction are other possible ways for colonisation. Although we have no specific research program for exotic species in the Sea Scheldt and its tidal tributaries, they are regularly encountered, e.g. during the monitoring campaigns for benthic infauna, as by-catch in the monitoring campaigns for migratory fish, on artificial substrates used for monitoring glass eel migration or on buoys. We present a non exhaustive list of 27 alien macrobenthic species (belonging to Oligochaeta, Polychaeta, Gastropoda, Crustacea and Diptera) that we encountered in the intertidal or subtidal zone since 1993. The tanaid *Sinelobus stanfordi* was found for the first time in Europe (Van Haaren & Soors, in prep.) The isopod *Synidotea laevidorsalis* is new for northwest Europe (Soors et al., submitted). Our list confirms the susceptibility of the brackish zone to alien species (19 out of 27 species), but the fresh water part also counted 13 aliens. Five species occur in both brackish and fresh water. Specific research, especially on epifauna and hard substrates, undoubtedly will reveal more alien taxa and further extend the range of the currently known taxa.

Soors, J., Faasse, M., Stevens, M., Verbessem, I., De Regge, N. & E. Van den Bergh (submitted). New crustacean invaders in the Schelde estuary (Belgium). Belgian Journal of Zoology.

Ysebaert, T., Meire, P., De Block, M., De Regge, N. and J. Soors. (1997). A first record of *Marenzelleria viridis* (Verril, 1873) (Polychaeta, Spionidae) in the Schelde estuary (Belgium). Biologisch Jaarboek Dodonaea 64: 176-181

Trends in the distribution of the Chinese mitten crab in the Scheldt estuary

Stevens Maarten, Van den Neucker Tom, Buysse David and Coeck Johan

Research Institute for nature and Forest

Since its arrival in Germany in the beginning of the 20th century, the Chinese mitten crab has rapidly invaded coastal and inland waters throughout Europe. The species was first observed in Belgium in 1933 in the Zeeschelde near Antwerp and is found nowadays in the main rivers and canals of the Scheldt basin. Macrocrustaceans were caught as bycatch during fish surveys with fyke nets in the Zeeschelde in 1995, 1998 and 2008. During the surveys in the nineties, only a few mitten crabs were found. Ten years later however, *E. sinensis* spread throughout the estuary and more than 50 crabs can be caught per fyke net per day. The expansion of the distribution and the increase of the population size of the Chinese mitten crab coincided with the improvement of the water quality in the estuary during the last decade. The abundance of mitten crabs in the estuary shows two distinct seasonal peeks. The first peek in spring coincides with the upstream migration of juveniles towards the freshwater reaches of rivers, where they burrow in the banks. The second peek in autumn coincides with the seaward spawning migration of adults. The highest densities are observed in the oligohaline and freshwater zone of the estuary. Increasing numbers of this crab may have a significant adverse impact on the natural balance of the Scheldt ecosystem. Because of the crab's flexible, omnivorous feeding habits, it may have a competitive edge over other bottom dwelling species. Their burrowing nature may also accelerate bank erosion and instability.

Measuring invasive speed of alien plant species using data from a general mapping program in the north of Belgium

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The start and spread of alien plant species in most countries is not well documented. Often alien plant species are not detected in the early start of their introduction. Once the presence of a certain alien plant species is detected they get a lot of attention resulting in numerous new records, which rather reflect the recording effort rather than a real expansion of the species. To cope with this problem we used a dataset which was set up for mapping the flora of Flanders with a time scope from 1972 until 2008. Each year on average 200 grid cells of 1 km² are prospected and the field surveyors record all plant species they find in the grid cell without having special attention for certain species. By calculation the proportion of the prospected grid cell where a certain alien species was present for each year we could calculate the spread of alien species in a more objective way so we could compare the expansion of alien species with each other. This method is useful for species, which are easy to recognize and are not limited to rare habitats. It also requires a wide spread of the prospected grid cells over the country or region.

Invasion history and control of *Callosciurus erythraeus* in Dadizele, Belgium

Stuyck Jan, Baert Kristof, Breyne Peter & Adriaens Tim.

Research Institute for Nature and Forest (INBO)

The escape of exotic animals bred in zoos or kept as pets has been identified an important pathway of introduction of alien invasive terrestrial vertebrates in Europe. We provide data on invasion history and eradication attempts of an invasive squirrel population possibly resulting from a zoo or pet shop escape in Dadizele, Belgium. In August 2005, bark stripping and cable gnawing was observed in a 5 hectare suburban park in Dadizele, Belgium. The damage was immediately linked to the occurrence of greyish squirrels that were agilely jumping around in the crowns of the trees and were running around crossing open stretches in the wood. Initially the animals were suspected Chinese rock squirrels *Sciurotamias davidianus,* but further behavioural observations and literature data on Chinese rock squirrels offered growing doubts on this. Largely based on the morphology of the male reproductive system we could identify the squirrel as Pallas's Squirrel *Callosciurus erythraeus*, a species of Asian origin. To validate this determination, sequence analysis of two nuclear genes (c-myc and RAG1) was performed. Homology searches against other known sequences showed an almost perfect match with *C. erythraeus.* The exact invasion history of this population is unclear. However, densities were growing rapidly and further damage was to be expected if the species would further expand its range to other urban areas or forest ecosystems. Studies have shown Pallas squirrels to disperse easily and achieve relatively high population densities (5-10 individuals/hectare). In this case also, regular sightings in nearby gardens and the vicinity of a nearby amusement park suggested initial range expansion. The species is a food competitor of the native red squirrel *Sciurus vulgaris* and may outcompete it. Pallas's squirrel has also been observed feeding on bird eggs. Furthermore it damages trees by bark stripping and may be the cause of substantial economic loss in tree plantations. Local authorities agreed on quick action, systematic eradication and monitoring of the whole Dadizele population. Eradication efforts started October 2005. At least 45 squirrels were removed from the site during the first three months. Despite maintained efforts in 2006 sighting of squirrels in the park, surrounding gardens and the nearby abandoned fun-fair Dadipark were still numerous. Trappings from february-april 2008 yielded another 76 animals. Recent sightings have not been reported since. The relatively high number of animals caught illustrates a high reproductive capacity for this invasive alien. Meanwhile, the species has been classified A1 on the BFIS list and received the highest ISEIA score of 11.

Exotic carnivores in Flanders: area expansion or repeated new input ?

Van Den Berge Koen

Research Institute for Nature and Forest (INBO)

Since 1998, a volunteer network was installed to collect victims of traffic among native Mustelids Mustelidae all over Flanders. Place and date of dead specimen finds deliver basic elements for population distribution, but autopsy of the dead bodies generates additional information about their population ecology. In particular, the difference between erratic or settled animals is quite essential.
Collecting dead animals also allows a correct determination of the species – even when the body is very massacred or decomposed. E.g., the correct distinction between badgers *Meles meles* and other black-and-white rough-coated animals such as raccoon *Procyon lotor* and raccoon dog *Nyctereutes procyonoides* is not always evident, while American mink *Mustela vison* and polecat *Mustela putorius* can easily be confused. These exotic carnivore species are believed to be on the point of colonizing Flanders for some decades yet. So, collecting dead mustelids was extended to all carnivores from the beginning of the research project. Actually, raccoon, raccoon dog and American mink were indeed found as traffic casualties, beside some unexpected species such as striped skunk *Mephitis mephitis*, south American coati *Nasua nasua* and crab-eating raccoon *Procyon cancrivorus*. For none of those animals however, autopsy revealed indications for reproduction in the wild. All of the specimen were most probably escaped animals in the first generation, mostly at very low numbers. However, raccoon and – surprisingly – also striped skunk can be expected to establish wild populations from repeated escapes.

Van Den Berge, K. (2008). Carnivore exoten in Vlaanderen. Zoogdier 19 (2): 6-9

Distribution of the Chinese pond mussel *Sinanodonta woodiana* (Lea, 1834) in Flanders (Belgium)

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Sinanodonta woodiana originates from East Asia. Since the first records in Romania in 1979 the species has expanded its range to 16 European countries, including Belgium. Currently, observations seem to be limited to the eastern part of Flanders. The first Belgian specimens were found in 1999 in a recreational pond in Diest. Additional specimens were collected in ponds in Zonhoven (2001), Oud-Heverlee (2001) and most recently in Genk (2009). These ponds are all connected to rivers belonging to the Schelde catchment, which may facilitate further colonization of Belgian waters. The populations seem to be persistent, as several age classes were found. Introductions of fish for angling purposes or to remove aquatic vegetation are likely to be the main cause of its dispersal to isolated ponds and river basins. The larvae (glochidia) are parasites of fish gills and the species is therefore introduced together with fish restocking. Considering its rapid range expansion, *S. woodiana* is regarded as an invasive species. The presence of the species could have adverse effects on indigenous unionids. It occurs in the same habitats and may compete for resources such as food and space. There are indications that *S. woodiana* is more tolerant to low oxygen concentrations and has higher recruitment than indigenous mussels. These characteristics offer competitive advantages over native unionids and may explain its success in European waters. In some European locations *S. woodiana* has become more abundant than native unionid species.

Richerzhagen, C. & Van den Neucker, T. (2009). Chinese vijvermossel duikt op in De Maten. *Natuur.focus* 8(1):36.

Sablon, R. (2002). Exotic mussel species invasions in Belgian freshwater systems (Mollusca: Bivalvia). *Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen* 72(Suppl.):65-66.

Occurrence and first breeding of Ruddy Duck *Oxyura jamaicensis* in Flanders (Belgium)

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Research Institute for Nature and Forest (INBO)

The first sighting of the exotic Ruddy Duck in Flanders dates from 1979. Sightings became regular since. The records presumably involved both local escapes as well as migrants from the feral population in the United Kingdom. In 2008 a first breeding attempt of this species was confirmed in Flanders. At least two pairs bred successfully, raising 3 and 4 chicks, in the Antwerp harbour area on the Leftbank of the river Schelde (Beveren). A third pair was seen with 5 newly fledged chicks but they apparently did not survive afterwards. These breeding records seem to be the origin of a feral population in Flanders. In an international context Belgium agreed to prevent the Ruddy Duck from reaching a feral population. This agreement was reached between 15 European countries in order to protect the Iberian population of the White-headed Duck *Oxyura leucocephala*. This species has severely suffered from competition and hybridisation with feral Ruddy Ducks reaching the Iberian peninsula. The prosecution of feral species is a matter of the Community Governments in Belgium. The Flemish Agency for Nature and Forest, advised by INBO, is now investigating which steps should be taken in order to cull these Ruddy Ducks.

Raccoon progression in the Walloon Region (Belgium)

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Native from North America, the raccoon (*Procyon lotor*) has been observed in Europe since the '30ies. Feral populations have established in the wild from escaped individuals out of breeding farms (fur) in Eastern and Northern countries (Germany, Ouzbekistan, Azerbaïdjan, Bielorussia, Northern Caucasus, Denmark…). Today, despite hunting control, raccoon populations are still increasing in those countries, from which individuals may emigrate towards neighbouring areas.

Up to recent years, the raccoon was rarely observed in Wallonia. However, the number of dead specimen found along roads and the quantity of tracks reported from the field (alluvial forests) by naturalists and scientists are steeply increasing since 2006. Today, observations are especially numerous near the German and the Luxembourg borders.

Although potential impacts of the raccoon on native biodiversity are poorly documented, it is often included in black lists of invasive species in Europe. Its predation activity may affect aquatic molluscs, amphibians and ground nesting birds. Species expansion in Belgium should be limited and population density should be reduced as much as possible in areas where populations of rare and threatened species occur (pearl mussel, hazel grouse, etc.).

Comparative Study of *Impatiens* Species (Balsaminaceae). A Native Species Faces Invasive Alien Brothers From Asia.

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The research project is devoted to a comparison among related Impatiens, two invasive exotics (*Impatiens parviflora* and *I. glandulifera*) and one native, *I. noli-tangere*. Different hypotheses are tested to address the invasiveness of species and the invasibility of habitats. To explain invasiveness, one common hypothesis posits a better reproductive success for invasive species than for their relative natives. Do the Impatiens species present the same mating system, with similar reproductive success and dispersal? We demonstrated that both invasive species present high reproductive success through different mechanisms: *I. parviflora* by means of spontaneous selfing, *I. glandulifera* by attracting huge numbers of pollinators. On the other hand, the native species requires pollinators but is poorly visited. A second hypothesis posits that invasive species show an increase competitive ability with re-allocation of resources to growth and reproduction (EICA). We tested first if the species can share similar habitat niches, allowing competition among them. Belgian sites, representing all potential habitats, were analysed with vegetation surveys and soil analyses. We concluded that *I. parviflora* and *I. noli-tangere* grow in very similar habitats, the invasive even showing a larger spectrum than the native. These species should be in competition with a possible exclusion of the native. Finally, their competitive abilities were compared using three experimental steps: (1) growth and reproduction in pure and mixed stands in forest, (2) experimental design with pure and mixed stands at different densities and (3) physiological capacities under controlled conditions (photosynthesis, mineral uptake).

Session 2 Impacts of invasions on biodiversity, health and economy

Impact of aquatic invasive species on native plant and benthic macro-invertebrate assemblages in Belgian ponds.

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Exotic invasive species such as *Ludwigia grandiflora*, *Hydrocotyle ranunculoides* and *Myriophyllum aquaticum* may alter the available structure in an aquatic habitat by creating monotypic floating mats. However, little is known about the impact of aquatic invasive species both on native vegetation and their associated food webs at pond level. We investigated the hypothesis that both native plant species richness and macro-invertebrate community structure is affected by invasive species by comparing invaded and adjacent non-invaded sites. Up to 32 ponds in Belgium were selected for this study with a cover gradient of the alien species (ranging 0-100%), most of them located in sites of high biological value. Our findings indicate that invaded ponds, regardless of the alien species, supported lower native plant species richness/diversity compared to non-invaded ponds and that submerged vegetation is most threatened. Native plant species richness is positively correlated with total macro-invertebrate abundance, suggesting a link between the replacement of native species by an invasive species and the reduction in overall macro-invertebrate abundance. A density effect of the alien cover was revealed for both native plant species and macro-invertebrates: with increased alien cover, native plant cover, macro-invertebrate abundance and taxon richness decreased. No difference in trophic groups (detritivore, herbivore, predator) could be detected between invaded and non-invaded ponds. The data suggest that a shift from a rather diverse vegetated habitat to a highly homogenous habitat of an alien species can present a threat to native plant species and macro-invertebrate abundance, but macro-invertebrate assemblage appears not to be affected.

Soil arthropods associated to the invasive *Senecio inaequidens* and the native *S. jacobaea*

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Soil arthropods play an important role in soil processes (litter fragmentation) and are often influenced by the composition of plant community. In the context of invasions by exotic plants, they might respond differently to native and exotic species. Our general hypothesis was that the invasive *Senecio inaequidens* (Asteraceae) and the native congener *S. jacobaea* are not associated with the same community of soil animals, in terms of abundance and taxonomic assemblage. This hypothesis was tested in a semi-natural grassland in Antwerp where the two species coexist for at least 3 years, by comparing arthropods extracted from soil samples collected under both plant species. Taxonomic assemblages were similar between the two *Senecio* and no difference in community structure was revealed by the PCA. However, the size of the community was reduced under *S. inaequidens* compared to *S. jacobaea* with a total of 930 and 2243 respectively collected. This reduction is essentially due to Collembolans Arthropleona, which were six fold less abundant under *S. inaequidens*. On the other hand, the Shannon diversity index was higher for communities associated to *S. inaequidens* (H'= 2.00) than *S. jacobaea* (H'= 1.54). These results call for further investigations in other sites, as they suggest that soil arthropods might be affected by the presence of *S. inaequidens*.

Assessing the potential impact of invasive species on native biota: a case study on the invasion of ring-necked parakeets in Belgium

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Predicting the impact of species invasions on native biota is one of the biggest challenges facing invasion ecologists. In Europe, ring-necked parakeets (*Psittacula krameri*) have been widely introduced, and their growing populations are raising concerns for the loss of native biodiversity, as they are known to compete with native cavity-nesters such as nuthatches (*Sitta europaea*). Given this threat, we applied species distribution modelling to predict the potential impact of parakeets on other species. In Belgium, ring-necked parakeets currently occur only around Brussels, and we applied a regression model on a regional dataset of parakeet and nuthatch abundances to obtain a competition coefficient, quantifying the parakeets' impact on nuthatches. Spatially explicit predictions of parakeet and nuthatch abundance across Flanders were obtained using Boosted Regression Trees (BRT). Based on environmental variables that influence parakeet abundance in its current range, we predicted parakeet abundance across Flanders while Bird Atlas data were used to obtain predictions of nuthatch abundance. Parakeet impact was then quantified by superimposing these abundance maps and applying the competition coefficient, resulting in an estimate of the number of nuthatches that will be lost when parakeets have occupied all suitable sites. Results show that there is ample suitable habitat for the parakeets to spread into, and that they could become one of Flanders most numerous cavity-nesters. However, the expected impact on nuthatches is only moderate, with a maximum loss of ±25 % of nuthatch pairs, probably because parakeets reach their highest densities in urban areas while nuthatches prefer larger, more natural forests.

Strubbe, D; Matthysen, E (2009) Predicting the potential distribution of invasive ring-necked parakeets *Psittacula krameri* in northern Belgium using an ecological niche modelling approach. BIOLOGICAL INVASIONS 11 (3): 497-513.

Strubbe, D; Matthysen, E (2007) Invasive ring-necked parakeets *Psittacula krameri* in Belgium: habitat selection and impact on native birds. ECOGRAPHY 30 : 578-588.

Strubbe, D; Matthysen, E (in press). Experimental evidence for nest-site competition between invasive ring-necked parakeets (*Psittacula krameri*) and native nuthatches (*Sitta europaea*). BIOLOGICAL CONSERVATION.

Waterfrogs in Wallonia : genetic identification of the introduced taxa (*Pelophylax* ssp.) and impact on indigenous waterfrogs (*Pelophylax lessonae* and *P. kl. esculentus*).

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Waterfrogs, from different origins, have been introduced in Wallonia during the last two decades, mainly as a consequence of aquatic horticulture: aquatic plants are imported from central Europe ... with eggs, tadpoles or adults of waterfrogs; the frog reproduces successfully and spread in (semi-)natural habitats. As a consequence, P. ridibundus has become the most frequent green frog in Brabant wallon (Percsy & Percsy, 2002a and 2002b). It is also abundant in the neighbourhood of large cities (Brussels, Liège, Namur, Verviers), (Percsy & Percsy, 2007). Actually, it is not easy to recognize the different taxa of Waterfrogs present in Wallonia. To insure their identification, we collect samples on 47 frogs from 8 different populations and submit these for enzymatic and genetic analyzis. The « Laboratoire d'Ecologie des Hydrosystème fluviaux » (Prof. Joly) at the University of Lyon made protein electrophoresis and the « Museum fûr Naturkunde » (Prof. Plötner) in Berlin investigated mitochondrial DNA. The results of these analyses allow to obtain : 1.a validation of the identification method of the taxa on the field and, thus, a reliable follow of the evolution of the populations; 2.the determination of the geographic origin of the introduced frogs; 3.the evidence of hybridization and/or introgression between *Pelophylax ridibundus* and the indigenous frogs *P. lessonae* and *P.kl.esculentus*; this result corroborates recent similar observations made in other European countries.

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Percsy C. & Percsy N. (2002b) : Evolution des populations indigènes et introduites de grenouilles « vertes » en Brabant wallon. Pages 213 – 218 in Peeters M. & J.L. Van Goethem (éds) (2002) : Belgian fauna and alien species. Actes du symposium : Faune belge : statut et tendances observées avec une attention particulière pour les espèces exotiques. Bulletin de l'I.R.S.N.B., Biologie 72, supplément, 297 pages.

Percsy C. & Percsy N. (2007). Quatre chapitres sur les grenouilles vertes in Jacob J.P. et al., Amphibiens et reptiles de Wallonie. Aves-Raînne et CRNFB, série « Faune-Flore-Habitats » n°2. Namur, 384 pages.

Percsy C. & Percsy N. (2009). Identification des grenouilles « vertes » (*Pelophylax*) en Wallonie : résultats de la confrontation de critères morphologiques et acoustiques avec des analyses enzymatiques et d'ADN (à paraître).

Comparative performance between invasive alien *Eichhornia crassipes* and native *Ludwigia stolonifera* under nutrient non-limiting conditions: Lake Naivasha, Kenya

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The ability of *Ludwigia stolonifera* to thrive in the presence of *Eichhornia crassipes* was investigated in Lake Naivasha, Kenya. *L. stolonifera* (indigenous) and *E. crassipes* (invasive) were grown in outdoor experimental boxes in monocultures and mixtures under nutrient non-limiting conditions. An additive series experiment with eight combinations of planting densities and four replicates was used. Competitive interactions between the two species were determined by assessing the final total biomass and the above-below ground biomass allocation after 98 days of growth. Biomass accumulation and allocation were significantly affected by competition in relation to species identity, with *L. stolonifera* accumulating more biomass than *E. crassipes*. ANOVA results indicate that there was no significant difference in Relative Growth Rate (RGR) and root/shoot ratio between monocultures and mixtures of *E. crassipes*. However, significant differences in RGR's were observed between monocultures and mixtures of *L. stolonifera*. Moreover, doubling the initial biomass of *E. crassipes* resulted to a significant increase in *L. stolonifera* roots relative to shoots allocation. Multiple regressions on species RGR's revealed that, increasing initial biomass of a conspecific neighbour resulted to a greater reduction in species RGR relative to increasing initial biomass of a heterospecific neighbour. This indicates a stronger intraspecific than interspecific competition which, coupled with the significantly higher RGR of *L. stolonifera* relative to that of *E. crassipes*, enabled *L. stolonifera* to outperform *E. crassipes*. This emphasizes the relative importance of species identity in determining the outcome of competition.

Impact of exotic invasive plants on soil fauna

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As part of the project ALIEN IMPACT we wanted to test if exotic invasive plants species modify soil fauna communities in terms of density and diversity. We investigated the impact of two troublesome species, *Fallopia japonica* and *Solidago gigantea*. For each species, three locations were selected with contrasting native vegetation (grassland, clearing, woodland). Pitfall traps and soil cores were used to assess the meso and macrofauna in invaded area compared to the indigenous vegetation with two sampling dates, spring and autumn. Earthworm extractions were also made. All individuals were identified at the family level and also at the species level for some taxonomic groups such as isopods, millipedes or earthworms. Data analysis is still underway but interesting trends have already emerged concerning *Fallopia japonica*. We noticed a significant decrease in the total number of individuals (from 50 to 60 %) found under the canopy of *F.japonica* compared to the uninvaded plots. In the site with grassland as native vegetation, groups like millipeds or isopods were more abundant under *Fallopia*, wich have affinity for shaded and humid environment. Multivariate analysis revealed a faunistic assemblage more homogeneus under *Fallopia* mainly due to the monospecific vegetation as opposed to the multispecific resident vegetation. Earthworms species found in invaded plots were associated with moist environment while grassland species were only present in the native vegetation. Our hypothesis is that differences of soil fauna assemblage observed between *Fallopia* plots and the resident vegetation might be due to microclimatic modifications after invasion.

Detection of intraguild predation by *Harmonia axyridis* on native cocccinellids by alkaloids

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Many laboratory studies have showed that the invasive ladybird *Harmonia axyridis* is an intraguild predator of other ladybird species. However its real impact is poorly known in natural conditions where multiple prey species occur and where preys have the opportunity to escape. To monitoring intraguild predation (IGP) of coccinellids in natural conditions, we propose here a new method based on alkaloid detection by Gas Chromatography - Mass Spectrometry. As many ladybird species are chemically defended by alkaloids, these compounds can be used as predation tracers. In laboratory experiments, alkaloids from native species : adaline, calvine, precoccinelline, propyleine, were unambiguously detected in fourth instar larvae of *H. axyridis* which had ingested respectively one first instar larva of *Adalia bipunctata, Adalia decempunctata*, *Calvia quatuordecimguttata*, *Coccinella septempunctata* or *Propylea quatuordecimpunctata*. Prey alkaloids in the predator decreased in time, however traces were still detected when the fourth instar *H. axyridis* larvae had become pupae and adults. Alkaloid traces were found in the exuviae as well. The GC-MS analysis of alkaloid content in *H. axyridis* larvae from samplings in semi-natural and agricultural habitats confirms intraguild predation in natural conditions, allowing to follow interactions between this invasive species and native ladybird species.

Hautier L, Grégoire JC, De Schauwers J, San Martin G, Callier P, Jansen JP, de Biseau JC. 2008. Intraguild predation by *Harmonia axyridis* on coccinellids revealed by exogenous alkaloid sequestration. *Chemoecology*, 18: 191-196

Patterns of impacts of four highly invasive plants species on native vegetation in Belgium

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There is a need to improve our ability to predict species responses to human-induced global change, such as the consequences of plant invasions, given their ecological, economical, and societal deleterious effects.

It is often suggested that diverse communities are less likely to be invaded, but both negative and positive relationships, between native flora richness and invasion, have been reported. Invaders may induce differential impacts on different species, resulting in fundamental changes in community structure.

Within the framework of the ALIEN IMPACT project, we investigated the patterns of impacts of four highly invasive species (HIPS) on native plant species richness, structure and composition in Belgium, with a particular focus on sites of high biological value (Natura 2000, SGIB, nature reserves).

Our results showed that the four target species tended to invade diverse habitats or vegetation communities. Disturbances appeared to be the main cause of invaders establishment. The reduction in native plant richness/diversity was a common pattern to invasion. However, the magnitudes of impacts were species specific and were found to be related to the invasive plant density. Although sites of high biological value were targeted, no endangered species or species of concern was found to be directly impacted by invasion.

Indirect consequences on whole communities should be further studied and taken into account in order to produce an integrated ranking of HIPS impacts.

Session 3 Early detection, risk assessment and management

Non-indigenous species of the Belgian part of the North Sea and adjacent estuaries

VLIZ Alien Species Consortium (listed in alphabetical order):
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Flanders Marine Institute and its consortium of experts on non-indigenous species conduct an ongoing effort to collect and maintain a list of alien species with documented established populations in the Belgian part of the North Sea and its adjacent estuaries. The list strives to include all currently known non-indigenous and cryptogenic species registered in salt and brackish environments in the Belgian part of the North Sea, the Belgian coastal zone and adjacent estuaries (Yser, Scheldt, Ostend Sluicedock). The discovery of America (1492) marked by a strong increase in trans-Atlantic shipping is set as the historical baseline of this assessment. This effort scrutinizes intentional and unintentional introductions by man or other vectors. Alien species for which there is no evidence of resident populations are not included in the list, nor are species that are limited to the fresh water environment. Newly registered species as a consequence of (expected) naturally induced migrations are also excluded. This initiative aims at providing a freely available online source of information on non-indigenous species and its associated network of experts for this study area. This includes definitions, information sheets and background literature, by species, and further links to European and international initiatives. Each information sheet describes the life cycle and ecology of the species, the introduction pathways and distribution, the possible effects or impacts of the species on its environment and potential mitigation measures. Pictures and a fully documented reference list - all available at the VLIZ library - represent an important added-value.

http://www.vliz.be/NL/Cijfers_Beleid/Niet_inheemse (Dutch).

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