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Neobiota 2008 Programme

TUESDAY, SEPTEMBER 23

17:00 – 18:00 **Plenary:** Marcel Rejmánek
Biological invasions: what we know and what we want to know

18:30 – 20:00 Welcome party & Poster session I

WEDNESDAY, SEPTEMBER 24

8:10 – 8:30 Welcome
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Deputy Minister of the Environment of the Czech Republic

Jirí Drahoš
Vice-President of the Academy of Sciences of the Czech Republic

Svatopluk Matula
Vice-Dean of the Czech University of Life Sciences

Session 1: What is it out there? Invasion patterns, pathways and spread
(Chair: Ingo Kowarik)

8:30 – 9:10 **Keynote:** Tom Stohlgren
Invasion patterns: theory and scale

9:10 – 9:30 Philip E. Hulme
Relative roles of life-form, land use and climate in recent dynamics of alien plant distributions

9:30 – 9:50 David B. Roy, Philip E. Hulme & DAISIE partners
Delivering Alien Invasive Species Inventories for Europe: DAISIE as a tool for addressing biological invasions

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Across islands and continents, mammals are more successful invaders than birds

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Patterns of biological invasions in European aquatic environments: the analysis of the EU funded DAISIE and IMPASSE project results

10:30 – 10:50 J. Foucaud, J. Orivel, J. H. C. Delabie, B. Gerber, H. Jourdan, M. Vonshak, M. Tindo, J.-L. Mercier, J.-B. Mikissa, T. McGlynn, T. Thompson, S. Mikheyev, J. Oettler & A. Estoup
The non-paradoxical invasion of the World tropics by the little fire ant: introduction routes and evolutionary paths

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11:20 – 11:40 Elena Tricarico, Federica Cenni, Simone Cianfanelli, Elisabetta Lori, Annamaria Nocita & Francesca Gherardi
Ecological and socio-economic correlates of animal alien species establishment in Italian inland waters

11:40 – 12:00 Tomáš Herben
Patterns of invasibility in neutral communities

12:00 – 12:20 Yu.Yu. Dgebuadze & I.Yu. Feniova
Stochastic and deterministic mechanisms structuring aquatic communities invaded by non-indigenous species

12:20 – 12:40 Mark Torchin & Gregory Ruiz
Past, current and future role of the Panama Canal in regional and global coastal invasions

12:40 – 13:00 Mark Williamson, Jon Pitchford & Calvin Dytham
Spreading to a limit

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Session 2: How does it work? Mechanisms of species invasiveness

(Chair: Johannes Kollmann)

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Biological invasions on Southern Ocean islands: patterns and mechanisms

15:00 – 15:20 Stefanie Hilmer, David Algar, David Tonkin & Elke Schleucher
Ferals in paradise: feral cat research on Cocos (Keeling) Islands

15:20 – 15:40 Jaroslaw Kobak & Tomasz Kakareko
Behavioural responses of the invasive mussel Dreissena polymorpha to the presence of potential predators

15:40 – 16:00 Oliver Bossdorf, Emmanuel Cuenot & Stefan Klotz
An ecologically motivated index of plant invasiveness: comparing the abundances of invasive plants in their native versus introduced ranges

16:00 – 16:30 Coffee break

16:30 – 16:50 Andrew Kanarek & Colleen Webb
Predicting invasion success by modeling ecological and evolutionary dynamics

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Climatic niche shift hampers predictions of biological invasions? Both native and invaded ranges matter

17:50 – 18:10 Lorne M. Wolfe, Dexter R. Sowell, Maurine Neiman & Douglas R. Taylor
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Rapid evolution across independent invasions into novel environments

9:30 – 9:50 John Bailey
Opening Pandora's seed packet: unpredictable outcomes in indestructible plants?

9:50 – 10:10 Grégory Mahy, Sonia Vanderhoeven, Marie-Solange Tiébré, Christine Krebs, John Bailey & Urs Schaffner
Evolutionary potential of the invasive Fallopia spp. complex or why the evolution of invasive species must be considered in management strategies

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10:30 – 11:00 Coffee break

11:00 – 11:20 Ruth A. Hufbauer, Robin A. Marrs & René Sforza
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Intraspecific hybridization of native and introduced Phragmites australis in North America

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(Chair: Francesca Gherardi)

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14:20 – 14:40 Pälvi Salo, Erkki Korpimäki, Peter B. Banks, Mikael Nordström, Robert L. Thomson & Chris R. Dickman
Alien vs native predators and non-lethal effects of a top predator

14:40 – 15:00 Ronaldo Sousa, António J. A. Nogueira, Carlos Antunes & Lúcia Guilhermino
Extremely high production of the non-indigenous invasive species Corbicula fluminea: effects on ecosystem processes and functions

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Evaluating direct and indirect mediation of predation by a habitat modifying invasive species Caulerpa taxifolia in southeastern Australia

15:20 – 15:40 Heinke Jäger, Ingo Kowarik & Alan Tye
Long-term effects of ecosystem engineer on Galápagos plant communities and their underlying mechanisms

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How to respond to biological invasions? Key points of European policy

8:50 – 9:10 Marianne Kettunen & Clare Shine
Progress towards an EU Strategy on Invasive Alien Species

9:10 – 9:30 S. J. Novak & J. H. Rausch
Use of plant surveys, distributional data, and genetic analyses to monitor invasive populations: Taeniatherum caput-medusae (Poaceae) as an example of the approach

9:30 – 9:50 Rieks D. van Klinken
Predicting the future of weed invasions at the national to landscape scale

9:50 – 10:10 Franz Essl, M. G. Smolik, S. Dullinger, I. Kleinbauer, M. Leitner, J. Peterseil, L. M. Stadler & G. Vogl
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11:20 – 11:40 John D. Mumford, Richard H. A. Baker, Olaf Booy, Ray J. C. Cannon, Gordon H. Copp, Dominic Eyre & Mark Rees
Enhancing the UK non-native risk assessment scheme

11:40 – 12:00 Vadim Panov, Boris Alexandrov, Kestutis Arbaciauskas, Rosa Binimelis, Michal Grabowski, Frances Lucy, Rob Leuven, Stefan Nehring, Momir Paunovic, Vitaliy Semenchenko & Mikhail Son
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12:00 – 12:20 Paul O. Downey, S. A. King & Alana L. Burley
Monitoring the response of alien and native species to control measures: can we achieve a synthesis?

12:20 – 12:40 Uwe Starfinger
Concerted action against further spread of Ambrosia artemisiifolia in Germany

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Session 5: What can we do? Prediction, risk assessment, management & policy

Biological invasions: what we know and what we want to know

Marcel Rejmánek

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Over millions of years of the earth history, there have always been spreading and migrating species and subspecific taxa. Colonization of deglaciated areas has been very well illustrated by many examples and we know that floras and faunas of many islands would not be here without occasional long-distance dispersal events. Now, however, the rate of human-assisted migrations (invasions) of plants and animals is several orders of magnitude higher. Biological invasions are a widespread and significant component of human-caused global environmental change. There are three reoccurring major questions of invasion biology: (i) Are there any inherent differences in invasiveness among biological taxa? (ii) Are some ecosystems more or less resistant to invasions? (iii) What are consequences of biological invasions? An emerging theory of plant invasiveness based on biological attributes has resulted in several rather robust predictions, namely for woody seed plants. However, in spite of the exponentially growing number of publications, there are still serious gaps in our understanding of invasion causes and consequences. Operational criteria for impact assessment of alien taxa are one of them. Invasive species are often blamed for extinction of rare species. Invasive predators, pathogens, and herbivores provide several conclusive examples. As for plants, however, we have yet to reach a more balanced view of what is the situation. Biological invasions are very often just symptoms of human-created changes in our environment rather than their causes.

Invasion patterns: theory and scale

Thomas J. Stohlgren

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Theories about plant invasions have been dominated by observations on islands and experiments in small (1 m^2) vegetation plots. The resulting paradigm suggested that areas high in native species richness were less prone to invasion by non-native species. My colleagues and I sought to better understand the effects of spatial scale on patterns of invasion at local, regional, and national scales in the United States. Our results were surprising. Across a wide range of spatial scales, "the rich got richer" – areas of high native species richness were more heavily invaded than species-poor areas. But scale matters! Invasion patterns are inconclusive at small scales. However, at modest spatial scales (>100 m^2), there was little sign of saturation (i.e., invasion by non-native species was likely to occur despite apparent competition from native species). In addition, there is little sign of saturation for state, regional or national floras in the USA where colonization (i.e. invasion by non-native species) exceeds extirpation by roughly a 24 to 1 margin. We also report an alarming temporal trend in plant invasions in the Pacific Northwest over the past 100 years. Counties highest in native species richness appear increasingly invaded over time. Despite the possibility of some increased awareness and reporting of native and non-native plant species in recent decades, historical records show a significant, consistent long-term increase in non-native species (number and frequency) at county, state and regional scales in the Pacific Northwest, USA. Here, as in other regions of the USA, colonization rates by non-native species are high and extirpation rates are negligible. The rates of species accumulation in space in multi-scale vegetation plots may provide some clues to the mechanisms of the invasion process from local to national scales. There are many challenges related to invasion ecology, theory, and management: (i) harmful non-native plants, animals, and pathogens continue to spread globally; (ii) hot spots of native diversity are often hot spots of invasion; (iii) there is little sign of species saturation at regional scales; and (iv) it is increasingly important to prevent, document, map, and predict harmful invading species to preserve native species and plant assemblages.

Biological invasions on Southern Ocean islands: patterns and mechanisms

Steven L. Chown

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Despite their considerable isolation, the islands of the Southern Ocean are home to a wide variety of alien and invasive plants and animals. The patterns of terrestrial invasion are relatively well understood, with factors such as propagule pressure and energy availability playing important primary roles influencing richness variation across the region. Humans continue to be significant vectors and the extent of propagule transport on personal clothing, equipment and cargo is substantial. Several management methods to limit propagule supply are not as easily applied as might at first have been thought possible, whilst others require little more than sustained application. Marine invasions are much more poorly known, though clearly ships form important vectors. Ongoing climate change across the region suggests that invasive alien species will benefit more from warming and drying than will indigenous ones. However, the mechanisms underlying this differential success are not simply those associated with a 'general purpose genotype' or enhanced phenotypic flexibility. Rather, depending on the organisms and traits involved, the form of plasticity or simply the mean trait values, may differ between the two groups of species. Current understanding suggests that the levels of invasion seen on Southern Ocean islands are likely to increase, and might well also become a feature of the rapidly warming Antarctic Peninsula, in the absence of more stringent management action.

Invasions and extinctions in island avifaunas

Tim Blackburn

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The arrival of humans on islands around the world has typically been followed by the extinction of significant components of the resident fauna, most notably the birds. The exact mechanism of extinction has been debated, with direct human hunting, habitat loss or the introduction of exotic species all mooted as possible causes. In this talk, I discuss the evidence for the importance of different drivers of recent extinctions in island bird faunas.

How to respond to biological invasions? Key points of European policy

Piero Genovesi

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The ongoing explosive growth of biological invasions imposes to develop more stringent policies aimed at preventing and mitigating the impacts posed by invasive alien species to the biological diversity of Europe, as well as to our economies and well being. The key components of a European policy have already been defined at the global and regional scale: prevention as the priority, rapid response when prevention fails, permanent control as the last option. But implementing these simple principles is a complex challenge in the European system for different reasons, partly ecological, partly political.

First of all Europe is a extensive continuous region, and regulating movements of species – both internally and from other regions – is particularly challenging. Furthermore, the free market policy of the region is perceived as an obstacle to preventing the import of unwanted alien species. Least but not last many past cases show the limited ability to respond promptly to new incursions by the competent national or local authorities. However, it must be recognised that Europe has great opportunities for implementing a more efficient policy on biological invasions. It is in fact a rich region, with a very solid basis of information available, and there are powerful institutions – such as the European Union – perfectly placed to ensure both the legal and political authority to develop more stringent measures, but also the needed coordination among member states.

In recent years the European institutions have shown a growing interest and commitment to work toward a regional policy on biological invasions. To be successful, this effort requires the support of many sectors of the society including the academic world. I will discuss some priorities for future action by the different bodies, both at the national and regional level.

Relative roles of life-form, land use and climate in recent dynamics of alien plant distributions

Philip E. Hulme

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A widespread expectation of climate change is that it will increase the number, distribution and impact of alien plant species. At least three situations may lead to this expectation where alien plant floras are represented proportionally more by species that (i) are pre-adapted to future climates; (ii) comprise life-forms that are known to benefit from future climates and/or (iii) possess life-history traits that facilitate the rapid tracking of climate change across a region. Sequential atlases of plant species distributions of the British Isles provide an opportunity to assess changes in native and alien plant species distributions over the latter half of the 20th century, a period coincident with marked warming in the United Kingdom. It appears that while the climate profiles and life forms of alien species in the UK indicate considerable potential to respond to a warmer drier climate, changes in species distributions since the 1960s do not appear to reflect climate. The strong association of aliens with anthropogenic habitats and the tendency for spread to be within rather beyond existing range boundaries results in land-use change being a stronger correlate of temporal patterns in alien distributions. The overall importance of land-use change over those driven by climate are expected to continue even in the face of future climate change in the UK. While it is likely that certain species will respond more to future climates than others, the flora as a whole will probably reflect other drivers, e.g. land-use change, and globalisation of trade. Spread within existing ranges may pose as many if not more problems than expansion at range boundaries. Therefore rather than making general statements about alien plant invasions increasing under future climates, research should aim to identify the specific species and particular circumstances likely to be responsible for changes in invasive plant species.

Delivering Alien Invasive Species Inventories for Europe: DAISIE as a tool for addressing biological invasions

David B. Roy[1], Philip E. Hulme[2] & DAISIE partners[3]

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The 2002 European Strategy on Invasive Alien Species encouraged the development of a pan-European inventory of invasive alien species. In response, the European Commission supported the 3-year DAISIE (Delivering Alien Invasive Species Inventories in Europe) project. The DAISIE internet gateway (www.europe-aliens.org), published in 2008, brings together Europe's information on alien species and their impacts, and for the first time has developed an overview and assessment of biological invasions in the Pan-European region (Nentwig et al. 2008).

The key results from DAISIE are presented. Over 10,600 alien species within Europe have been identified, the majority (60%) of which are vascular plants, followed by terrestrial invertebrates (25%) and aquatic marine species (10%). The arrival rate of new alien species to Europe is increasing for many species groups; at the current rate, one new alien mammal species is introduced to the continent each year for example. Vertebrates tend to be deliberately released, invertebrates generally arrive as contaminants of plant material and most plants escape from gardens. Overall, around one in six European alien species are known to have an ecological or economic impact.

The DAISIE inventory, accounts, and distribution maps today provide the first qualified reference system on invasive alien species for the European region. The information presents an outstanding resource to synthesise current knowledge and trends in biological invasions in Europe. DAISIE helps identify the scale and spatial pattern of invasive alien species in Europe, understand the environmental, social, economic and other factors involved in invasions. The potential for DAISIE to form a key component of the emerging European Strategy on Invasive Alien Species is discussed.

References

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Across islands and continents, mammals are more successful invaders than birds

Jonathan M. Jeschke

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How many species will become invasive in a certain region? The best-known answer to this question is the tens rule, which predicts that about 10% of the species introduced to an exotic region will establish there (establishment success) and about 10% of the established species will spread, i.e. become invasive (spread success) (Williamson 1996). According to Jeschke & Strayer (2005), animals have a higher establishment and spread success than predicted by the tens rule, but the data are highly variable. Here, I am asking if this variation can be explained by differences among taxonomic groups and the regions to which the species were introduced. As data on mammal and bird introductions are most reliable, I am analyzing a dataset of such introductions to the earth's islands and continents. I calculated establishment success and spread success for each region (an island, or a country in a continent), separately for mammals and birds.

Establishment success for mammals (79±1.7%, mean±SE, N=65) was higher than for birds (50±2.6%, N=53) ($P<0.001$, t-test). Both values lay significantly above the 10% value suggested by the tens rule ($P<0.001$, t-tests). Spread success was also higher for mammals (63 ± 5.8%, N = 4) than for birds (34±17.5%, N=3), but sample sizes were low here. I performed a second analysis with a dataset restricted to those regions where information for both mammals and birds was available. In all of these 21 regions, mammals again had a higher establishment success than birds ($P<0.001$, paired t-test).

I characterized each island and continent by its size and tested the hypothesis that small landmasses (islands) are more susceptible to invaders than large landmasses (continents) (Elton 1958, Simberloff 1995). The data did not support this "island susceptibility hypothesis", as no significant relationship between establishment success and landmass area was observed, for neither mammals ($r= -0.08$, $P=0.51$, N=65) nor birds ($r= -0.17$, $P=0.23$, N=53).

Thus, while observed differences in establishment and spread success seem to be partly based on taxonomic differences, my analysis does not indicate an influence of landmass area. My results suggest that mammals are more successful invaders than birds and that the tens rule is not applicable to either taxonomic group.

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Patterns of biological invasions in European aquatic environments: analysis of the EU funded DAISIE and IMPASSE project results

S. Olenin[1], V. Didžiulis[1], B. Galil[2], S. Gollasch[3], D. Minchin[4], V. Panov[5], I. Cowx[6], A. D. Nunn[6], F. Gherardi[7], E. Tricarico[7], L. Miossec[8], A. O. Ambrogi[9], D. Savini[9] & G. Jeney[10]

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We analyse regional differences in the patterns of alien species introductions to various parts of Europe. Both intentional and unintentional introductions of alien species into European coastal and inland waters have resulted in the establishment of self-sustaining populations of species originating from the Americas, South-East Asia, the Indian Ocean and other world regions (Leppäkoski et al. 2002, Gherardi et al. 2008). In order to understand and reveal the extent of biological invasions within European aquatic ecosystems two extensive data mining analyses were undertaken under the 6th EU framework projects involving the recently completed DAISIE and the ongoing IMPASSE. Presently, these databases contain a compilation of 1071 alien marine and almost 481 freshwater species introduced to Europe from elsewhere or from one European region to another (e.g., from the Caspian Sea to the Baltic, or from Atlantic coast to the Black Sea). The databases contain documented introduction records of these species in 71 inland and coastal countries/regions of Europe including neighboring non-European countries of the Mediterranean Sea. The main pathways responsible for these introductions include ships' ballast water and hull fouling (30% of all introduction events in aquatic environments of Europe), via marine and inland canals (24%), aquaculture and stocking practices (20%). Other pathways (e.g., ornamental, leisure activities, research, biocontrol) and introduction events, where pathways remain unknown, constitute more than 25% of introduction events. Primary and secondary anthropogenic pathways may overlap, and together with natural factors greatly facilitate the spread of non-native aquatic biota (Minchin 2007, Galil et al. 2008, Gherardi et al. 2008). The importance of these pathways varies within different European regions. For example, aquaculture and stocking practices are considered to be responsible for ~25% of all introductions to the Atlantic coast of Europe, ~20% to the Baltic Sea and ~10% in the Mediterranean (Occhipinti-Ambrogi et al. 2008, Cowx et al. 2008). Almost 700 alien species have been introduced to European marine and freshwater ecosystems as a result of aquaculture and stocking activities, of which some 325 were intentionally introduced and with these nearly 300 non-target species were transported. The role of the ornamental and leisure activities have expanded in recent decades. Attitudes to species can vary between countries where the same species may be considered beneficial in one country and an unwanted pest in another. The examination of native ranges of taxa alien to the Mediterranean shows that most of them are thermophilic species from tropical Indo-Pacific regions, whilse aliens recorded from the Atlantic, North Sea and Baltic coasts of Europe are of more diverse origin, yet have arrived from similar latitudes.

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The non-paradoxical invasion of the World tropics by the little fire ant: introduction routes and evolutionary paths

J. Foucaud[1], J. Orivel[2], J. H. C. Delabie[3], B. Gerber[1], H. Jourdan[1], M. Vonshak[4], M. Tindo[5], J.-L. Mercier[6], J.-B. Mikissa[6], T. McGlynn[7], T. Thompson, S. Mikheyev[8], J. Oettler[9] & A. Estoup[1]

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Biological invasions are a major component of current global change. The role of human activity is thought to be of primary importance in the current displacement of species at the global scale. Moreover, when displaced, species are introduced in new environments where they probably lack specific adaptations, and probably undergo bottleneck events. Invasive species, which thrive in their introduced environment, thus overcome this lack of adaptation, despite a probable low genetic variability of the introduced propagule. Some authors therefore argue that biological invasions are paradoxical events. However, recent studies refute this 'paradoxical' vision of bioinvasions, mostly through the demonstration of a high propagule pressure and maintained, or even increased, genetic variability in introduced populations. In the present work, we studied introduced populations of the little fire ant worldwide. Using microsatellite markers, we aimed at reconstructing the introduction routes and evolutionary path that led to the widespread occurrence of the little fire ant around the globe. We found three main routes of introduction of the little fire ant, all of them being uniquely explained by human trade. Together with the results of a similar study of native populations, our results help to build a parsimonious scenario where the worldwide invasion of the little fire ant is a two-step, paradox-free process. The generality of our conclusions for other invasive organisms will be discussed.

Ecological and socio-economic correlates of animal alien species establishment in Italian inland waters

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Biological invasions are a worldwide phenomenon with recognized negative effects on biodiversity. However, information on how ecological characteristics of the recipient region and human activities in the area influence the establishment of alien species and their potential invasion is still scanty (but see Vilà & Pujadas 2001). Here, we analyzed the main 20 drainage basins and the 20 regions in Italy to identify the variables correlated with the occurrence of animal alien species (AAS). For each basin, we recorded the density of AAS (data from Gherardi et al. 2008) and considered some ecological-climatic variables [latitude; mean yearly flow; mean yearly precipitation; temperature range percentage of class 1+2 of the Extended Biotic Index (EBI); density of indigenous fish species; percentage of forest areas] and some socio-economic variables [human population density; road density (percentage of areas covered by roads); percentage of agricultural areas; percentage of anthropogeneous areas; density of aquaculture facilities; density of fishing shops; density of the main industries; density of cities with >200.000 inhabitants]. The number of AAS per region was compared to the gross domestic product per inhabitant, the number of tourists (all tourists and foreign tourists), and the mean annual merchandise imports. Stepwise regression analyses showed that the density of AAS is significantly correlated with EBI and density of indigenous fish species ($F=336.87$, $df=17$, $P<0.0001$) among the ecological-climatic variables, and with aquaculture facilities ($F=56.15$, $df=18$, $P<0.0001$) among the socio-economic variables. At the regional level, a significant correlation was found between the number of AAS and all the economic variables analyzed ($r = 0.64–0.74$, $n=20$, P between <0.0001 and <0.02). In synthesis, both the ecological status of the recipient basin and the socio-economic variables in the area seem to be important for the establishment of AAS, being thus prerequisites of their possible invasion of Italian inland waters.

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Patterns of invasibility in neutral communities

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Comparative data in invasion ecology show that (i) disturbance enhances community invasibility, (ii) there is a positive relationship between residence time of an invader and its success, and (iii) there are broadly constant proportions of newly arrived species to those that become established and dominant (tens rule), (iv) invasive species have higher growth rates in comparison with non-invasive species. I use a simple neutral model to test whether these patterns occur in communities with all species identical and no species-specific interactions. In the model, local communities are grouped into continents with immigration rates smaller between than within the continents. Species coming from the other continent are considered to be alien and their fates are recorded. In the model, disturbance predictably increases species numbers and numbers of individuals of aliens. However, the model makes different predictions on effects of disturbance on three processes involved in alien species spreading: establishment (positive effect of disturbance), naturalization (negative effect) and dominance (positive effect). The predictions do not change if variation of growth rates is incorporated into the model. The model predicts positive relationship between residence time and abundance. The broad agreement of the predictions of the neutral model with the patterns from the field suggests that some these general patterns of community invasibility are to some degree fully independent of any specific biological assumptions and by themselves may not provide many insights on underlying biological processes. Aggregate data should therefore be used with great caution and statistical patterns must be removed by means of generating null model predictions.

Stochastic and deterministic mechanisms structuring aquatic communities invaded by non-indigenous species

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Predicting the patterns of transformations of aquatic community is the key challenge of aquatic ecology. The important components to the risk assessment of invasion are assessing the vulnerability of recipient communities and invasiveness of non-indigenous species (NIS). Currently, there are two different hypotheses explaining community changes: neutral and niche theories. In the neutral model, local community assembly is a random process driven by stochastic walks of regional propagules of competitively identical species (Hubbell 2001). Niche theory provides an explanation of the community structure by competitive interactions between species (Shea & Chesson 2002). We assume that both stochastic and deterministic processes influence the probability of establishment of NIS. The objective of these studies was to assess the relative role of stochastic and deterministic processes in structural changes of communities driven by invasions, using a model system of five cladoceran species.

First we simulated invasions where the differences between competing resident and NIS species were negligible (neutral hypothesis). In this case the most successful species was the first occupant (priority effect). When the competing species had significantly different population parameters, the species with a high competitive ability, measured by the lowest threshold food concentration (Tilman 2004), appeared the most successful. Then we simulated invasion processes under two levels of food supply, including or excluding a fish predator. The model indicated that the success of NIS depends on their competitive ability (threshold food concentrations) only under a strong competition. *Simocephalus vetulus* was a dominant species in this case. When competition was weak, our simulations resulted in more alternative patterns of species composition, pointing to the importance of stochastic processes. Field studies of the community structure in the upper Volga reservoirs showed similar patterns of community modifications resulting from invasion of planktivorous fish.

Laboratory experiments were performed to test the results of these simulations. The outcomes of experiments were analyzed in relation to the superior competitor, *Ceriodaphnia reticulata*, used as a model NIS. The results indicate that the priority effect was important only if the resident species were highly competitive. When they were inferior competitors, they were displaced by the most competitive *C. reticulata*, showing that biological traits of the NIS are more important in this scenario than the priority effect. Thus, if competition between resident and NIS species is strong, species composition is driven by deterministic processes as follows from the niche theory, but when competition is weak, stochastic mechanisms become most important.

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Past, current and future role of the Panama Canal in regional and global coastal invasions

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Biological invasions cause billions of dollars of economic damage each year and are a serious threat to native biodiversity. Once established, introduced species can become numerically or functionally dominant in invaded communities, altering ecosystem processes, impacting economies, and affecting human health. In marine and coastal environments, ships are a major transfer mechanism of introduced species. However, what controls or limits the extent of invasions in any region remains poorly understood. Dramatic variation exists in the establishment and demographic success of non-native species in different regions. Several hypotheses aim to explain this geographic variation, including differences in (a) the supply of organisms (propagule pressure) delivered to a region, (b) the environmental compatibility of arriving organisms, (c) frequency and magnitude of disturbance in the new region and (c) biotic interactions such as predation, parasitism and competition which may limit invasions.

Panama is an important focal point for the study of ship-mediated marine and coastal invasions and provides the opportunity to evaluate hypotheses about invasion dynamics. The Panama Canal serves as an aquatic corridor between the Atlantic and Pacific oceans. Since its opening in 1914, approximately 800,000 ocean-going commercial vessels have passed through the Canal. Recently, the annual number of commercial ship transits exceeded twice the number of ship arrivals in the largest U.S. ports. This suggests that the potential supply of organisms associated with ships may be relatively high, yet reports of marine invasions are limited in this tropical region. Current plans for expanding the capacity of the Panama Canal and Panama's ports will increase shipping and the potential for invasions. We are evaluating how shipping and biotic processes interact to facilitate invasions in the Panama Canal and how this can elucidate processes driving marine and coastal invasions in general.

Spreading to a limit

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The expanding range of a species invading a finite area must eventually reach a limit. Despite much recent theoretical interest in spread models (Hastings et al. 2005), this simple fact has scarcely been considered by modellers. Of 50 well recorded species of alien plants in the Czech Republic with well defined patterns of spread, 31 showed clear signs of deceleration in spread rate (Williamson et al. 2005); a 'bend'. We have constructed a variety of mathematical and simulation models to describe invasive spread across finite landscapes (an example is shown in fig. 1). Some stop suddenly at the limit, others show an asymptote. Some spread initially at a constant radial spread, others exponentially, as in the Czech data. Tukey folded transformations of the model output are usually a useful tool (see Williamson & Gaston 1999) but require a knowledge of the position of the limit, so we have also devised methods to estimate the limit in real data. Comparing the model results with the Czech data provides some interesting and possibly surprising results.

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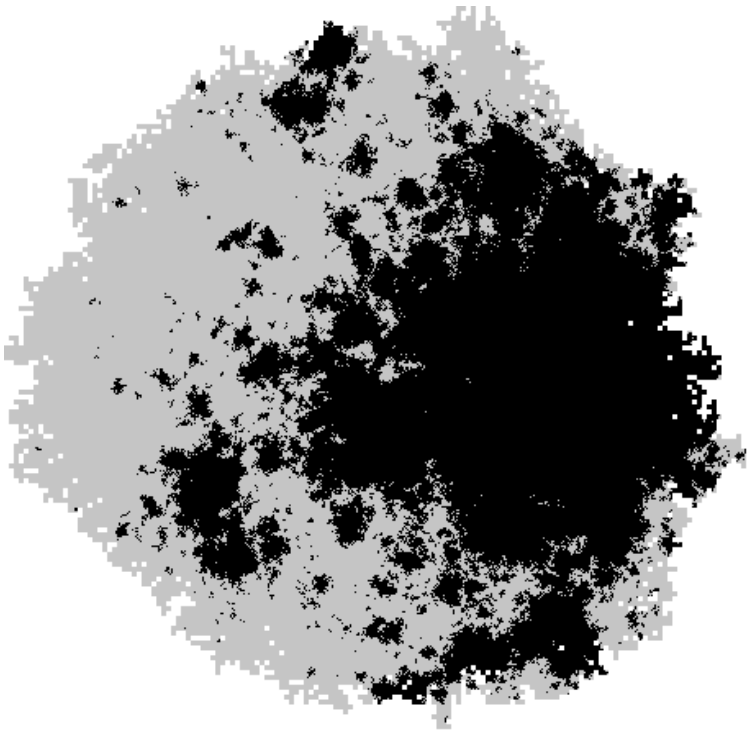

Figure 1. Snapshot of a distribution during a simulated invasion into a finite space. The invasion was initiated at a single focal point and dispersal was modelled using a Cauchy distribution (a very long tailed distribution) which gives rise to many satellite colonies that coalesce.

Ferals in paradise: feral cat research on Cocos (Keeling) Islands

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Colonisation of new habitats by feral cats is a worldwide problem, particularly on oceanic islands where it has lead to the decline and extinctions of endemic island fauna. Cats appear to be highly adaptive to a wide range of environments but despite their abundance and threat to biodiversity, little data is available regarding their ecophysiology. This study seeks to provide a physiological background and understanding of the ecology of the feral cat by investigating potential differences in the energy requirements of cat populations in relation to different climates and seasonal conditions. The Cocos (Keeling) Islands, a remote Australian External Territory located in the Indian Ocean, was one of five study sites used to compare the energy consumption of feral cats from arid, temperate and tropical zones from mainland and island habitats. A seven-year periodic cat control program was previously commenced on these islands as cats are a potential health risk, carrying diseases such as toxoplasmosis and hookworm, and provided the opportunity to use the islands as a study site. Results show a tendency for cats from the tropical zone to exhibit the highest basal metabolic rates (BMR) (9.35 ± 2.11 $J.g^{-1}h^{-1}$), followed by cats from the arid zone (8.58 ± 1.69 $J.g^{-1}h^{-1}$). Cats from the temperate zone exhibited the lowest BMR (6.92 ± 1.25 $J.g^{-1}h^{-1}$, $p=0.0104$). These preliminary results indicate a physiological flexibility in the cats, which may be a key to their success in colonizing new habitats.

Our results will add to the broader understanding of the cat's ability to adapt to different environments. Potential differences in the cat's seasonal energy requirements may prove useful in refining and optimizing control management strategies such as the most appropriate time to conduct baiting programs. Furthermore, the identification of factors characterising successful invaders may be of assistance in assessing biosecurity risks of other potential introductions.

Behavioural responses of the invasive mussel *Dreissena polymorpha* to the presence of potential predators

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The zebra mussel *Dreissena polymorpha* is a Ponto-Caspian bivalve which, since the 18th century, has invaded European and North American water bodies. In some regions of the world, its spread is still ongoing. It has become an influential part of invaded ecosystems, providing substratum for complex communities, competing with other organisms for food and space, and being an important part of food webs. It is consumed by waterfowl, fish and crayfish. Thus, one could expect that it is able to respond to the presence of other organisms, including potential predators.

We studied behaviour of zebra mussels in the presence of four predator species differing in their feeding habits: (1) roach *Rutilus rutilus*, the specialized molluscivore, (2) racer goby *Neogobius gymnotrachelus* (another Ponto-Caspian species) (3) crayfish *Orconectes limosus*, both opportunistic mulluscivores and (4) perch *Perca fluviatilis*, not feeding on molluscs. Three groups of mussels: small (<10 mm), medium (10– 17 mm) and large (>17 mm), were tested in 100-l tanks, in which predators of a given species were present, or in a control empty tank. The mussels were separated from predators by 1-mm mesh. We tested their attachment strength, aggregation behaviour as well as horizontal and vertical movement.

The attachment strength (measured with a digital dynamometer) of small and medium mussels exposed for six days on PVC substrata was higher in the presence of roach than in the other treatments. Percentage of mussels forming aggregations (i.e., touching each other) on these substrata was higher in the presence of roach than in the control treatment. Large mussels did not respond to the presence of any of the tested predator species. Horizontal distances moved by mussels were measured by putting a single individual into a circular dish with a 2–3 mm layer of sand on the bottom. A dish was then placed in an experimental tank. A moving mussel left a trail in the sand, which was photographed and analysed. Mussels did not change their movement intensity after 24 h of exposure in the presence of any predators. To check if the tendency to move upwards, exhibited by small mussels, changes in the presence of predators, we put a single individual into a test tube and measured the vertical distance moved by it after 24 h of exposure in a tank with predators. Mussels significantly reduced their vertical movement in the presence of roach.

Mussels modified their behaviour only in response to roach, which is the most efficient molluscivore used in our study. The observed changes may help mussels to occupy safer sites: away from places exposed to the open water column, in the vicinity of conspecifics and in the lower layers of the colony. Furthermore, stronger attachment also may increase their chances of survival, as predators usually select prey that is easier to handle.

An ecologically motivated index of plant invasiveness: comparing the abundances of invasive plants in their native versus introduced ranges

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Estimates of plant invasiveness are crucial to many research areas in plant invasion biology. However, in most if not all cases such estimates are based on rather crude presence-absence data that do not contain information about the local abundance and therefore the true ecological impact of these species. Moreover, many current hypotheses about the ecological and evolutionary mechanisms underlying plant invasions are based on the notion that invasive plants are more successful and locally dominant in their novel range. However, the evidence for this pattern is largely anecdotal.

Here, we attempt to address these issues in a cross-continental study of vegetation plot databases. In our pilot study, we used the Dutch Vegetation database and VegBank (US) to compile comparative abundance (% cover) data for European plants that are invasive in the US. A preliminary analysis of our data indicates that in fact only few invasive plant species occur at higher local abundances in their invasive US range than in their native European range, whereas many invasive plants are less or equally abundant in invasive populations (Figure 1).

One could argue that, from an ecological-evolutionary point of view, only those species with an abundance ratio significantly greater than 1 require special explanation. Only a fundamental change in ecological interactions or an evolutionary shift will allow species to play such different roles abroad than at home. In contrast, species with an abundance ratio close to 1 may simply do the same abroad and at home, so there may be no need to invoke special explanations such as enemy release, novel weapons, or microevolution.

We think that data about local plant abundances are an important aspect of describing plant invasiveness. Moreover, the ratio of local abundances in the introduced versus native range can serve as an ecological index of plant invasiveness that should be very useful to guide ecological research. In general, vegetation plot databases are a valuable and rich source of ecological data that can also be exploited for invasion biology.

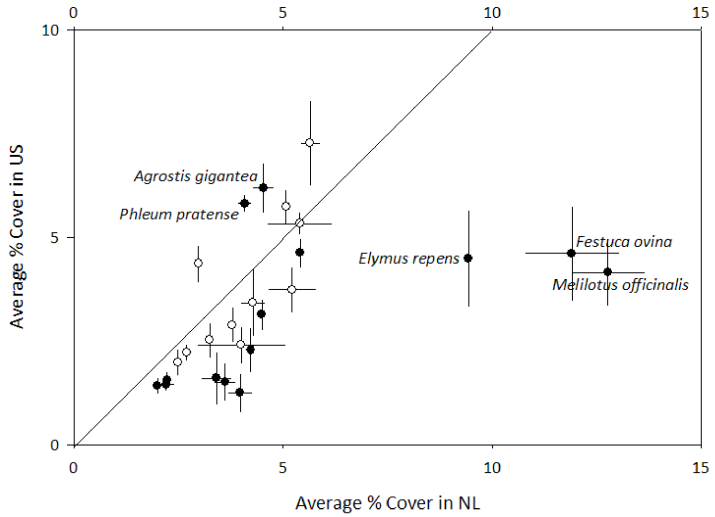

Figure 1. Average abundances (± 1 SE) of 25 European plant species in vegetation plots in the Netherlands (native range) versus the US (introduced range). Each symbol is one species. The diagonal line is where the abundance ratio equals 1. Species above this line are locally more abundant in the US; species below this line are more abundant in the Netherlands. Bold symbols indicate species where abundances are signficantly different (t-test, $P<0.05$).

Predicting invasion success by modeling ecological and evolutionary dynamics

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The mechanisms that facilitate success of an invasive species include both ecological and evolutionary processes. Investigating these factors can provide insight on management strategies for controlling further establishment of foreign populations in areas they would not naturally inhabit. We expand on previous work for controlling introductions of non-indigenous freshwater and marine species through ballast water discharge. This system can be modeled by a population growth function with Allee effects which incorporates spatial dispersal by a diffusion process. This approach can provide good estimates for acceptable volumes of discharge for various organisms (with differing reproductive rates) for a range of invasion risk tolerances. Additionally, repeated immigration events may lead to persistence by rescuing populations at below threshold densities or minimum volumes. In order to make our analysis more robust, we include an evolutionary subsystem to explore the effects of selection and genetic variance on traits that may increase a population's likelihood of survival. Specifically, we allow the Allee threshold to become a dynamic parameter which is considered the result of evolutionary adaptations enabling organisms to cope with low densities and overcome Allee effects. Our results reveal the possibility that an introduced population that would fail to persist in the ecological context of this model has the potential to succeed through evolutionary means.

Release from fungal pathogens cannot explain the spread of invasive plants

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Alien species invading other continents cause enormous economic and ecological problems. The enemy-release hypothesis has stimulated invasion research, is now widely accepted as the main explanation of the success of alien species, and is the justification for biological control programs. However, we show, using a global fungus-plant host-distribution database, that the release of North American plant species naturalized in Europe from their foliar and floral fungal pathogens is much smaller (10.3%) than suggested previously. Moreover, these plants are mainly released from their rare pathogens, which have only minor impacts. Most importantly, and directly opposing the enemy-release hypothesis, the spread of the alien plants is negatively instead of positively related to release from fungal pathogens. We conclude that understanding and counteracting plant invasions very urgently requires the test of currently neglected alternative hypotheses.

Possible shift of *Cacyreus marshalli* on native *Geranium* plants

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Cacyreus marshalli Butler (Lepidoptera: Lycaenidae), commonly known as geranium bronze, is a species indigenous to South Africa and was recently introduced into Europe. It was found in Italy in Rome at the end of the 1990s and quickly spread to many other regions of the country. Ornamental *Pelargonium* species are the main host plants on which it performs many overlapping generations causing damage to flowers, stems, and leaves. Seriously affected plants may die as a result of the infestation. As a consequence of the fast spread and danger imposed by this pest, pelargoniums were included among the species requiring quarantine and *C. marshalli* was listed as an A2 quarantine pest by the European and Mediterranean Plant Protection Organization.

The potential of the pest to spread to native *Geranium* species was investigated and the conservation risks that such a shift would pose for both native geraniums and cohabitant butterflies was evaluated. Host plant preferences were investigated on native *Geranium* species, which commonly occur in many mountainous and hilly habitats of the northwestern Italy, by conducting both no-choice and multi-choice oviposition tests in controlled conditions. The tested plants were presented to *C. marshalli* adults and the number of eggs laid was then counted. The adults emerged from the eggs laid on each plant species were transferred to cages containing *Pelargonium zonale* potted plants, to test if they were able to mate and oviposit.

The tests showed that oviposition can occur easily on many Italian native *Geranium* species. Both in no-choice and in multi-choice trials, females clearly preferred *G. pratense*, *G. sanguineum* and *G. sylvaticum* plants, while *G. nodosum* and *G. phaeum* were the least desirable. The potential competition between the geranium bronze and other native geranium-consuming lycaenids, such as *Eumedonia eumedon* Esper and *Aricia nicias* Meigen, is also discussed.

Climatic niche shift hamper predictions of biological invasions? Both native and invaded ranges matter

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Niche-based models calibrated in the native range by relating species observations to climatic variables are commonly used to predict the potential spatial extent of species' invasion. This climate matching approach relies on the assumption that invasive species conserve their climatic niche in the invaded ranges. We tested this assumption by analyzing the climatic niche spaces of spotted knapweed (*Centaurea maculosa*) in western North America and Europe and showed with robust cross-continental data that a shift of the observed climatic niche occurred between native and non-native ranges, providing the first empirical evidence that an invasive species can occupy climatically distinct niche spaces following its introduction into a new area. We further showed that the shift was not related to a shift of ploidy level between the two ranges. The models fail to predict the current invaded distribution, but correctly predict areas of introduction. Climate matching is thus a useful approach to identify areas at risk of introduction and establishment of newly or not-yet-introduced neophytes, but may not predict the full extent of invasions. As an alternative, we propose an approach that involves fitting models with pooled data from both ranges. We show that this pooled approach improves prediction of the extent of invasion of spotted knapweed in North America on models based solely on the European native range. Furthermore, it performs equally well as models based on the invaded range, while ensuring the inclusion of area with similar climate to the European niche, where the species is likely to further spread. We then compare projections from these models for 2080 under a severe climate warming scenario. Projections from the pooled models show fewer areas of intermediate climatic suitability than projections from the native or invaded range models, suggesting a better consensus among modelling techniques and reduced uncertainty.

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The role of historical and contemporary forces in biological invasions

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One of the major goals in the study of biological invasions is to determine why species behave in what appears to be a fundamentally different manner in the introduced and native parts of their range. In other words, why does a species that is a relatively benign component in its native ecosystem become problematic following introduction? Perhaps the most traditional explanation for invasiveness is that natural selection resulting from enemy escape favors a shift in investment from defense to traits enhancing growth and reproduction. The plant *Silene latifolia* was introduced from Europe to North America approximately 200 years ago. Our previous work has revealed large differences in the species' biology between the two continents: (i) Silene has escaped a number of specialist enemies during colonization and the resulting damage levels are higher in Europe; (ii) North American plants display a 'weedier' and more reproductively prolific phenotype, and; (iii) North American plants invest less in defense and have lower resistance to fungal infection and fruit predation. These results are consistent with (but do not demonstrate) the hypothesis that the invasive North American phenotype has evolved at the expense of defensive abilities due to altered enemy interactions.

We are currently adopting a trans-continental experimental approach to understand the forces contributing to *Silene*'s successful invasion of North America. By using a series of replicated common gardens in Europe (England, Switzerland) and North America (Canada, USA) we will be able to determine the role of enemy-mediated natural selection to the observed life history evolution in North American populations. Our preliminary results suggest the following. First, there exists negative genetic covariance between generalist enemy damage, plant size, and time to reproduction. Second, based on a selection gradient analysis, enemies exert stronger selection in Europe where slower-growing and longer-lived phenotypes are favored. Taken together, the evidence from *Silene* provides insight into how historical (e.g., aspects of the genetics of colonization) and contemporary forces play crucial roles in the fate of introduced species.

Rapid evolution across independent invasions into novel environments

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A fundamental unresolved problem in ecology and evolution regards the limits to species distributions. Invasive species provide powerful models for studying limits to species distributions and factors that allow those distributions to shift. Of the large number of species that are introduced into novel habitats, few become successful as invaders. What allows some species to invade, when most cannot? In this talk I summarize the multifaceted approaches used in my laboratory to explore this question. We hypothesized that invasions into novel environments might involve the rapid and parallel evolution of genetically labile traits. Within the past century, the copepod *Eurytemora* affinis has invaded freshwater habitats multiple times independently from saline sources. To dissect evolutionary responses during these independent habitat invasions, we integrated analyses of physiological function (ion efflux and uptake) with comparative functional genomics (using custom cDNA microarrays and genomic scans for selective sweeps). We analyzed evolutionary shifts during invasions for pairs of ancestral saline source and derived freshwater populations across four independent invasions from two genetically distinct clades. We found evolutionary shifts in the expression of genes spanning many functional categories, including osmoregulation, energy production, and stress response. A diverse array of genes showed parallel shifts in gene expression across multiple independent invasions, but in many cases only within clades. The integration of functional (physiological) and gene expression analyses has allowed us to prioritize plausible candidate genes that might serve as the targets of selection. Several of the candidate genes appear to show significant signatures of selection. The evolutionary parallelism observed here might have relevance for taxonomically different but ecologically similar species that invade across similar habitat clines.

Opening Pandora's seed packet: unpredictable outcomes in indestructible plants?

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With the introduction and establishment of alien plants, invasion and occupation of new territory is only one possible outcome of such introductions – since such radical translocations produce unprecedented opportunities for hybridisation with both indigenous and other adventive taxa. This may have different outcomes depending on how closely related the two taxa making up the hybrid are, and can be exacerbated by the occurrence of self incompatibility or dioeciousness. If they are closely related this can give rise to hybrid swarms, if less related, to sterile F1s and amphiploid speciation. This is nicely illustrated by the case of *Spartina alterniflora*, on both sides of the Atlantic.

In this talk I shall briefly explore the role of alien introduced plants in the production of amphiploid species around the world before concentrating on how a Victorian garden plant has had such a major impact in two continents and is now up to no good in a third! *Fallopia japonica* was introduced to the west in the middle of the 19th century by Philipp von Siebold via his 'Garden of Acclimatisation' in Leiden, as an expensive and desirable garden plant. Due to its phenomenal powers of vegetative propagation, a single clone has been able to invade large areas of Europe and the USA. Fortuitously this clone was the male sterile form of a gynodioecious taxon, this in turn led to a giant inadvertent breeding experiment. Thousands of hectares of small white flowers spread over three continents, devoid of any pollen of its own species. In such circumstances anything that could conceivably pollinate these flowers has done so!

In a long-term examination of seed produced by Japanese knotweed s.l. from around the world I have found hybrids with three different taxa, two non-sympatric diploids and one sympatric tetraploid. The 4x *F. sachalinensis* has hybridised with *F. japonica* to form 4x, 6x and 8x hybrids, which are not only more invasive and difficult to control than either parent, but are also able to backcross and increase the genetic diversity of the parental taxa. Hybridisation with the less related diploid woody climbing vine *F. baldschuanica* has given rise to a sterile F1. Whilst the combination of the vigour of *F. japonica* and *F. baldschuanica* with a hint of heterosis does not bear thinking about, fortunately (although perfectly viable), this hybrid is not very successful due to the opposing over-wintering strategies of its two parents. The male parent of the latest putative hybrid that I am investigating is far more compatible in this respect. If this new hybrid becomes established, it could present a much worse threat than the original Japanese knotweed. The occurrence of amphiploidy would spell out even more problems, although any such amphiploid would be 2n=108, there are perfectly normal *F. japonica* plants with 110 chromosomes and one need look no further than *Spartina anglica* to see that high chromosome number is no bar to a successful amphiploid.

Evolutionary potential of the invasive *Fallopia* species complex or why the evolution of invasive species must be considered in management strategies

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So far, evolution has not been well integrated into our understanding of the ecological dynamics of invasive populations. This is despite growing evidence that recently introduced populations often experience rapid evolutionary changes in morphology, behaviour, and life history. Since the capacity for species to invade is shaped by evolutionary processes, managers and decision makers can no longer regard alien species as stable genetic entities, without risking to use inappropriate management strategies.

Interspecific hybridization and polyploidization have been recognized as important features in the evolution of the invasive *Fallopia* species (Polygonaceae) in their introduced range. Because of their extensive adventive range, this complex of species provides an outstanding model to explore the diversity of patterns and mechanisms associated with hybridization during invasion. Recent evidence suggests that the hybridization patterns and their consequences for the genetic diversity and reproductive dynamics of *Fallopia* species differ among areas of the introduced range at different hierarchical scales. We will first synthesize the results of several genetic surveys conducted at different geographical scales with various hybridization patterns. The implications in term of invasiveness at the landscape scale will also be described to stress the necessity to consider the evolutionary potential of the complex when establishing management schemes against the invasive *Fallopia* complex.

Evolution in invasive plants and implications for trophic interactions and their management for biological control

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Evidence is increasing that invasive plants can undergo rapid adaptive evolution during the process of range expansion. Here we argue that evolutionary change during invasions will affect plant–antagonist interactions and thus have important implications for biological control programmes targeted at invasive plants. Using the model species *Centaurea maculosa*, we presently explore how altered selection in the new range might influence the evolution of life cycle and how this might affect subsequent biological control efficacy. The knapweed *C. maculosa* has been introduced from Europe (EU) into North America (NA) during the late 19th century, where it has become a prominent rangeland weed. We analyzed the ploidy level of more than 2000 plants from 93 native and 48 invasive *C. maculosa* populations and found a pronounced shift in the cytotype-ratio. In Europe ca 60% of the populations were diploid (2x) and 40% tetraploid (4x), while 4x clearly dominated in North America. Field observations suggest that 2x populations are predominantly monocarpic (dying after flowering) and 4x populations polycarpic. To disentangle genetic from environmental effects on life history traits, we grew in the greenhouse plants from 77 native EU populations, both 2x and 4x, and from 23 invasive 4x North American populations. We further conducted performance tests with specialist and generalist herbivores and analyzed defense traits. To test if a polycarpic habit has been negatively selected by specialist herbivores in the native, but positively in the introduced range, where specialist herbivores are absent, we started a 2x vs 4x competition experiment in the presence and absence of herbivores. Following this argument, invasive populations should be highly susceptible to introduced biocontrol herbivores and their release could reverse the presumed evolutionary shift towards a polycarpic life cycle in the introduced range. The results will be integrated with information from niche modeling and community invasibility experiments.

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Invasion genetics of two knapweeds (*Centaurea stoebe* and *C. diffusa*): microsatellites and cpDNA reveal multiple introductions, increased heterozygosity in *C. stoebe* and increased population structure in *C. diffusa*

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Biological invasions are excellent systems for studying the genetic consequences of founder events. In addition, knowing the effects introductions have on population genetic structure and variation of invaders can provide insight into the history of invasions including identifying potential areas of origin and means and rates of continued spread. We explored the population genetics of two Eurasian species that are invasive in North America, *Centaurea stoebe* subsp. *micranthos* (tetraploid spotted knapweed) and *C. diffusa* (diploid diffuse knapweed), using microsatellite loci and chloroplast DNA (cpDNA) sequences. *Centaurea stoebe* subsp. *micranthos* has higher heterozygosity within populations in the introduced range than in the native range, and cpDNA haplotype diversity does not differ significantly between ranges (Hufbauer & Sforza 2008). The patterns in heterozygosity suggest that outcrossing is occurring between individuals from different regions, and both heterozygosity and cpDNA diversity suggest that bottlenecks in population associated with the introduction were weak. In contrast, *C. diffusa* does not exhibit increased heterozygosity (Marrs et al. 2008) and it has significantly lower haplotype diversity in the introduced range relative to the native range (Hufbauer & Sforza 2008). These results suggest that the introduction of *C. diffusa* imposed a stronger bottleneck in population size than for *C. stoebe* subsp. *micranthos*. Assignment tests on microsatellite data suggest 4– 5 genetic clusters in introduced *C. stoebe* subsp. *micranthos*, each of which could represent a separate introduction. Assignment tests also show high levels of admixture and relatively little population structuring in the introduced range. Phylogeographic analyses of cpDNA haplotype data also suggest more than one introduction of *C. stoebe* subsp. *micranthos*. Indeed, three of the haplotypes of *C. stoebe* found in North America match haplotypes in species other than *C. stoebe* from the native range, opening up the possibility of cryptic invasions. Assignment tests on *C. diffusa* microsatellite data also support 4– 5 genetic clusters in the introduced range, but in this species, along with evidence for admixture, much greater structuring of populations is found in the introduced range than the native range (Marrs et al. 2008). Chloroplast DNA haplotype sequences suggest more than one introduction of *C. diffusa*, despite the reduction in diversity. These data illustrate that related and ecologically similar species with similar introduction histories can differ widely in the genetic consequences of the invasion. As is becoming widely recognized (Dlugosch & Parker 2008), successful invaders are rarely limited by genetic variation, and indeed, can experience increased variation over all, and recombination can result in genotypes not found within the native range, even in the face of low variation. These results can guide further exploration for the origins of these species, and point out locations within the introduced range with unique and diverse genetic makeup for focusing tests of current and prospective biological control agents.

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Evolution of the invasive wetland plant purple loosestrife (*Lythrum salicaria*) along a latitudinal gradient in eastern North America

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Evolution may play an important role in the establishment and spread of biological invaders. In particular, adaptation to geographical variation in growing season length may be a rate-limiting phase of invasive spread. We investigated population divergence along a latitudinal gradient in the invasive wetland plant *Lythrum salicaria*. We used a combination of glasshouse and field studies to address three key questions: Is there significant genetic variation for life history and phenological traits? Is there evidence for a genetic constraint on population divergence? Are glasshouse results representative of natural populations?

In glasshouses at the University of Toronto we grew eight plants from each of 17 field-collected maternal families from each of 20 populations (2720 total plants), representing a latitudinal gradient of 10°. We measured age of first reproduction as the number of days from germination to flowering, as well as flower size, leaf area, and seedling relative growth rate. We measured size at reproduction as the length of the main stem from the plant base to the beginning of the inflorescence. We also measured inflorescence length of the main stem as an estimate of reproductive investment.

Is there evidence of genetic differentiation among populations? Using likelihood ratio tests from mixed model ANOVAs, we found significant genetic variation, both among seed families and among populations. Population divergence occurred primarily along a latitudinal gradient, with significant clines in age of reproduction, size at reproduction, flower size, leaf area and seedling relative growth rate (RGR), but not inflorescence length. Consistent with adaptation to a shorter growing season in northern populations, plants from higher latitudes grew faster as seedlings, and flowered sooner.

Are there genetic constraints on population divergence? There was a significant, positive correlation between age and size of reproduction, suggesting an evolutionary tradeoff, whereby plants that flowered earlier did so at a smaller size. Also consistent with a genetic constraint was an increase in the skew of the frequency distribution for days to flower within populations, whereby northern populations lacked genetic variation for flowering before ~45 days post-germination. Phenotypic and genetic variance within populations also decreased with latitude, consistent with stronger stabilizing selection, or bottlenecks associated with the recent northern migration of the species.

Do glasshouse results parallel those occurring from field populations? We also conducted a field experiment to estimate genotype-by-environment interactions (i.e. glasshouse vs. field) and variation in growth and phenology among growing seasons in this large, woody, aquatic perennial. We planted ~1000 seedlings representing 13 populations from the glasshouse experiment, and monitored them for 3 growing seasons in a field site at the Koffler Scientific Reserve. Age and size of reproduction were consistent among years and environments, with R2 correlations (among population means) in excess of 90%. This suggests that the glasshouse results are representative of natural populations, and reinforces inferences concerning the genetic basis of measured traits. An ongoing reciprocal transplant experiment will test for local adaptation and directly estimate phenotypic selection on these traits at northern, southern and central locations.

Intraspecific hybridization of native and introduced *Phragmites australis* in North America

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My research conclusively demonstrates, for the first time, that native and introduced populations of *Phragmites* in North America can hybridize. Introduced *Phragmites* (haplotype M) is one of the most successful estuarine plant invaders in North America, but native *Phragmites* populations are declining in the eastern U.S., partly because they have been replaced by introduced *Phragmites*.

Despite range overlaps, hybridization has not yet been detected between the native and introduced lineages in the wild. One hypothesis is that a phenological barrier precludes cross-pollination between native and introduced populations. However, hybridization in the field should be possible given that native and introduced *Phragmites* strains are classified as subspecies, and we have now successfully hybridized them in the greenhouse. My results indicate a substantial overlap in the timing of anthesis in multiple paired populations of native and introduced *Phragmites*. Furthermore, in hand pollination studies, 87% of intraspecific hybrid crosses produced seed and 62% had rates of seed set of over 50%, a very high success rate for this species. Microsatellite analyses of both seeds and seedlings produced from the crosses indicate that native and introduced *Phragmites* did hybridize.

It is well known that interspecific hybridization can lead to the extinction of native floral and faunal gene pools and may result in increased aggressiveness in some hybrid forms relative to their parental lineages. While hybridization between native and introduced species can dilute the native gene pool, interbreeding among subspecies is not currently recognized as a serious threat to native species. *Phragmites australis* offers an excellent opportunity to investigate intraspecific hybridization, since both native and introduced lineages occur in North America and elsewhere.

Invasion history and its consequences for genetic and phenotypic variation in the invasion of the lizard *Anolis sagrei*

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Species invasions produce serious ecological and economic problems, representing a major threat to biodiversity and a substantial cost to society. At the same time, invasions provide a unique opportunity to study evolutionary and ecological processes on a contemporary timescale. I use complementary approaches integrating DNA sequences, morphological variation, and microsatellite genotypes to investigate how *Anolis* lizards (anoles) have successfully invaded new areas. A rich history of ecological and evolutionary study and the introduction of numerous species make anoles a good model system for invasions. Using mitochondrial DNA sequences, I found that multiple introductions from genetically and geographically distinct native-range sources are common in anole introductions, and contrary to expectations, genetic variation often increases in introduced populations relative to their native range (Kolbe et al. 2004, 2007a). Founder effects and population bottlenecks reduce within-population genetic variation initially, but genetic variation increases if admixture of multiple sources occurs. As a consequence, differential admixture shapes morphological and population-genetic differences among invasive populations of the brown anole (Kolbe et al. 2007b, 2008). Invasion history (the number of sources and their pattern of admixture) has a strong effect on phenotypic and genetic variation in introduced populations. My future research will test if admixture of multiple sources increases genetic variation for quantitative traits and the potential for these traits to evolve in introduced populations, and if this contributes to invasion success.

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Are we starting to face a "Homogocene"? Homogenization patterns between Europe and North America

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Widespread introduced species tend to increase the similarity of biotas across the world. This phenomenon of biotic homogenization has been reported for different regions, geographical scales and organisms. However, only few studies so far addressed homogenization on continental and global scales. Therefore, we analysed homogenization patterns of plants and vertebrates within and between the European and North American continents while controlling for climatic differences and geographic distance.

We found that, except for plants in Europe, alien plants and vertebrates lead to homogenization within North America and Europe and between the continents. Our results show that: (i) widespread species that are aliens to both continents and (ii) species exchanged between continents lead to global homogenization. Possible underlying causes for differentiation effect of alien plant species in Europe, such as human settlement history and the role of archaeophytes (aliens introduced before 1500 AD) will be discussed.

Ecological and economic impact of alien mammals in Europe

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In a first step, we evaluated the presently known ecological and economic impact of alien mammals of non-European origin in Europe. Since most knowledge about impact is descriptive, we quantified it by a transformation into numerical values. We distinguished five categories of ecological impact (impact on fauna: competition; predation; hybridisation; transmission of diseases; impact on flora) and five categories of economic impact (on agricultural plant production; agricultural animal production; forestry; human health; abiotic environment) each scaled from zero to five according to the strength of the impact. The actual distribution of a species was included into our calculations by a factor of 0.5 to 5, thus the highest total impact value per species is 5 (impact categories) × 5 (strength of impact) × 5 (area) × 2 (ecological and economic impact) = 250. The highest ecological and economic impact is caused by Norway rat (*Rattus norwegicus*) with an impact value of 160, muskrat (*Ondatra zibethicus*) impact with a value of 140 and coypu (*Myocastor coypus*) with a value of 125. Our approach allows ranking and comparing species with different types of impact and of different taxonomic and dietarian groups. Ecological impact was highest from carnivores, while economic impact is highest in rodents.

In a second step, we applied the Australian risk assessment, slightly modified to European needs, to analyse the potential risk which results from the occurrence of these alien mammals. The analysis contains three major components: (i) an analysis of risk to public safety, (ii) an analysis of establishment risk based primarily on climate matching and ecological features, (iii) an analysis of pest risk based primarily on area, habitats and ecological features. We found no risk to public safety caused by introduced mammals. The establishment risk results for 23 introduced mammals in an extreme establishment risk, 10 mammals show a high risk, 11 a moderate risk and 13 a low establishment risk. The pest risk analysis shows, independently from the establishment risk, an extreme pest risk for a majority of the species.

Based on our risk assessment predictions for the further development of introduced species are possible. Also predictions of the potential risk for the future of recent or potential invaders can be made. Since the risk assessment is climate-based potential effects within climate change scenarios can also be predicted. Generally speaking, it is very important to have a robust prediction tool to classify the potential risk of mammal species. For the near future we predict a permanent increase in the number of alien mammal species in Europe and an increase of their ecological and economic impact.

Alien vs native predators and non-lethal effects of a top predator

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Alien predators are widely considered to be more harmful to prey populations than native predators, but this traditional view has largely remained untested. We conducted a meta-analysis of the responses of vertebrate prey in 45 replicated and 35 unreplicated field experiments in which the population densities of mammalian and avian predators were manipulated. Our results showed that predator origin (native vs alien) had a highly significant effect on prey responses, with alien predators having an impact double that of native predators. There was also a significant interaction between location (mainland vs island) and predator origin, revealing strongest effects with alien predators in mainland areas. Although these results were influenced by huge impacts of alien predators in Australia compared to their impact elsewhere, they provide the first explicit demonstration that introduced predators can suppress native prey species much more than native predators do (Salo et al. 2007).

Non-lethal effects of predation may be more profound than direct predation impacts on prey populations. To study the non-lethal impacts of intraguild predation on alien predators we radio-tracked American mink (*Mustela vison*) in the Archipelago Sea, SW Finland, where the white-tailed sea eagle (*Haliaeetus albicilla*) is their main enemy. We studied the impact of eagle predation risk on mink movements, and our analyses showed that especially female mink reduced their swimming distances with increasing sea eagle predation risk (Salo et al. 2008). This restriction of female mink movements might have positive impacts on lower trophic levels if it leads to reduced reproductive output and thereby slower mink population growth. Ecosystem restoration by bringing back the native top predators may help to mitigate alien predator effects on native biota.

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Extremely high production of the non-indigenous invasive species *Corbicula fluminea*: effects on ecosystem processes and functions

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The Asian clam *Corbicula fluminea* is the major component of the River Minho estuary, almost completely dominating the benthic biomass (Sousa et al. 2007a, b). As part of a major study into the ecology of *C. fluminea*, benthic samples were collected monthly from January 2005 to August 2006. This data was used to estimate the abundance, biomass, growth, and secondary production of this non-indigenous invasive species (NIS). The annual 2005 secondary production of *C. fluminea* was estimated to be 463.8 g AFDW/m2/year, and the mean annual biomass was 160.7 g AFDW/m2, resulting in a P-ratio of 2.89/year and a turnover time of 126.4 days. Comparing the results obtained in this study with values gathered in freshwater ecosystems in which total invertebrate (or high fraction of production) was estimated, we observed that *C. fluminea* production correspond to the higher values ever recorded (Figure 1). In light of these results we conclude that *C. fluminea* is a fundamental element in the River Minho estuary, sequestering a large portion of the carbon available for benthic production and potentially altering the ecosystem processes and functions (Sousa et al 2008). This species should be considered when modelling the nutrient cycles and energy flow in this estuary and similar aquatic ecosystems where the species can reach high abundance and biomass. In addition, we discuss how this NIS can be responsible for several modifications recorded in aquatic ecosystems (e.g., changes in the phytoplankton standing stocks, increases in the water clarity and return of submerged vegetation, changes in the biotic assemblages due to ecosystem engineering processes, changes in the biogeochemical cycles and alterations in food webs).

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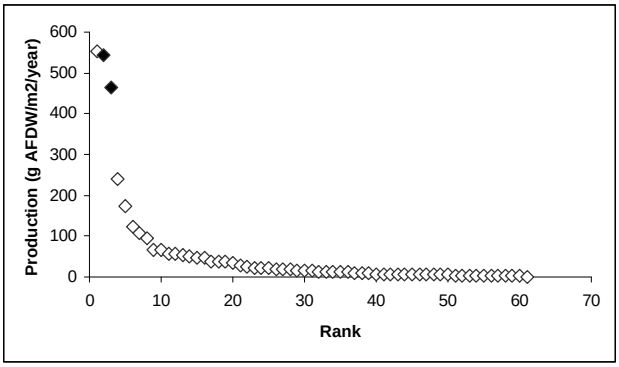

Figure 1. Ranking of secondary production values in freshwater ecosystems in which total invertebrate (or high fraction of production) was estimated. Solid quadrats correspond to *Corbicula fluminea* production in the years 2005 (lower value) and 2006 (higher value).

Evaluating direct and indirect mediation of predation by a habitat modifying invasive species *Caulerpa taxifolia* in southeastern Australia

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Habitat modifying invasive species can profoundly influence predation rates of native prey, but the potentially contrasting mechanisms by which they do so have seldom been examined. *Caulerpa taxifolia* is one of the most effective invasive species of shallow water marine systems globally, often provisioning habitat de novo in areas previously lacking in vegetated structure. This structure potentially decreases prey mortality by directly reducing predator encounter rates. However, *Caulerpa* also substantially alters physical and chemical properties of the surrounding water and sediment, potentially increasing predation rates by modifying traits of resident prey. We experimentally evaluated the direct effect of *Caulerpa* to provide refuge for the native clam, *Anadara trapezia*, and how this balances with two trait-mediated indirect interactions that may increase *Anadara* susceptibility to predators. Specifically, *Anadara*, though normally buried, in invaded areas projects from beneath the sediment, exposing itself to predators and declining in condition and predator resistance properties. Our results show that adult *Anadara* are not influenced by direct effects of *Caulerpa* on predator search and encounter rates, nor by *Caulerpa* indirect effect of increasing predator exposure of clams via their protrusion aboveground. Rather, poor condition caused by *Caulerpa* exposure enhanced *Anadara* predation mortality. Remarkably, the higher rate of mortality on poor condition clams that are normally found in *Caulerpa* occurred despite our surveys that documented *Anadara* predators spend substantially more time in unvegetated areas. Our study helps to underscore that the specific mechanisms by which habitat modifying species influence predation rates can arise not from the obvious direct effect of protective structure, but indirectly through modifications of traits of prey species responding to the habitat.

Long-term effects of an ecosystem engineer on Galápagos plant communities and their underlying mechanisms

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Most studies on impacts of introduced species compare invaded and uninvaded plots. As such impacts may vary conspicuously at temporal scales, long-term studies may provide deeper insights into ecological consequences of plant invasions. In this study, we analyse effects of *Cinchona pubescens* (quinine tree), one of the most serious invaders in the Galápagos Islands, on the resident vegetation over a period of seven years. We address *Cinchona* as a physical ecosystem engineer as the introduction of the novel growth form 'tree' in a formerly treeless environment exerts profound changes on environmental parameters. As potential drivers of change, we analysed *Cinchona* abundance and microclimate parameters, and their interactions with the resident vegetation over time.
Species richness and percent cover of plant species were measured in permanent plots (5600 m^2 in total) in the highlands of Santa Cruz from 1998 to 2005. Microclimate parameters (photosynthetically active radiation [PAR], air- and soil temperature, humidity, and precipitation) were measured over two years underneath the *Cinchona* canopy and in the open canopy (intact native vegetation) to evaluate the effect of *Cinchona* on local environmental conditions.

Results showed that *Cinchona* cover doubled and both density (stems/ha) and stand basal area more than tripled from 1998 to 2005. Cover of almost all resident plant species and species diversity decreased during the same period and was inversely related to *Cinchona* abundance. Temporal variation in the responses of species depended on *Cinchona* cover. The only species which increased in cover was the other woody invader in the area, the common guava *Psidium guajava*. From 2003 to 2005, cover of introduced herbaceous species also increased significantly. The emergence of *Cinchona* resulted in shifts of all microclimate parameters measured but the most outstanding was a significant reduction of PAR by 85 % under the canopy. Precipitation was augmented by 50 %, likely due to the interception of fog by large *Cinchona* leaves, which may result in better solubility of nutrients.

We found that *Cinchona* had substantial negative impacts on species abundance and diversity. *Cinchona* is a direct driver of change by competing with the resident vegetation for space and light but also an indirect driver by changing ecosystem parameters. The latter was shown in a previous study suggesting that *Cinchona* enhanced nutrient concentrations (mainly nitrogen and phosphorus) in the surrounding leaf litter and soil. This study along with previous research clearly establishes *Cinchona* as a significant physical ecosystem engineer. *Cinchona* trees have large per capita effects on microclimate, they are dense and occur over large areas. In addition, *Cinchona* has significant effects on the abundance and spatial distribution of other plant species. *Cinchona* seems to facilitate the spread of other introduced species which is an example of an 'invasional meltdown'. *Cinchona* impacts varied temporally over the monitoring period, which underscores the need for long-term studies of invasive species. Our results emphasize the need for control of *Cinchona* pubescens to preserve the abundance and diversity of the native Galápagos flora.

Progress towards an EU Strategy on Invasive Alien Species

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This presentation provides a synthesis of work in progress on the development of an EU Strategy on Invasive Alien Species, leading up to the publication of the European Commission's preliminary Communication on Policy Options to tackle Invasive Alien Species in November 2008. A project team led by IEEP, in partnership with the UNEP-World Conservation Monitoring Centre, is coordinating technical support to the Commission from January 2008 to June 2009. Tasks include substantive technical and policy analysis, support for online public consultation and detailed impact assessment of policy options prior to the development of final recommendations on a future strategy.

The presentation will cover two substantive project components which will be completed by Neobiota 2008. It will provide opportunities for European IAS specialists to exchange views on information presented and future policy direction.The first component provides an assessment of IAS impacts on environmental, economic and social sectors within the European Union. It builds on the findings of existing EU initiatives on invasive alien species (IAS), particularly DAISIE (Delivering Alien Invasive Species Inventories for Europe; www.europe-aliens.org) and ALARM (Assessing Large-Scale Environmental Risks for Biodiversity with tested methods; www.alarmproject.net).
The assessment is designed to substantially improve the quantification of IAS impacts at European level. The adopted methodology is based on similar assessments carried out previously, for example for the United States, Australia and the United Kingdom (Pimentel et al. 2001, 2005). It is based on compilation of both qualitative and quantitative data for each type of impact, organised by reference to different species/groups of species. Where geographic coverage of data for a group of species is limited, some information on costs/benefits is extrapolated to the EU level. The final analysis provides aggregated qualitative and quantitative information on environmental, economic and social impacts to provide as comprehensive a picture as possible of current costs and benefits of IAS in Europe

The second component provides an overview of policy options to control the negative impacts of IAS on European biodiversity, supported by an preliminary assessment of impacts of such options. The analysis builds on the 'Scope Options' report already produced for the European Commission (Miller et al. 2006) and takes account of the results of stakeholder consultations undertaken by the Commission between July 2007 and June 2008. It also covers relevant policy and legal developments at the Member State level.

The methodology for reviewing current IAS policies for Europe and evaluating future options is structured in accordance with the three-stage hierarchical principle endorsed under the Convention on Biological Diversity (prevention; early detection and rapid reaction; long-term control and containment). Particular attention is paid to prevention, as the most cost-effective option for IAS management, including possible frameworks for pathway management and risk assessment.

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Use of plant surveys, distributional data, and genetic analyses to monitor invasive populations: *Taeniatherum caput-medusae* (Poaceae) as an example of the approach

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Recent experimental evidence now indicates that the success and severity of a biological invasion may, in part, be the result of propagule pressure (e.g., multiple introductions): either through the fortuitous introduction of pre-adapted genotypes or through post-immigration evolution. This view suggests that invasions may not only hinge on the properties of species, but may also be determined by the performance of specific genotypes under specific environmental conditions. Moreover, this view also suggests that it can be difficult to predict whether an invasion will or will not occur because of post-immigration evolution through hybridization, selection, or other processes. Therefore, we believe that the most effective method of monitoring invasions should combine plant surveys, geographic distribution data, and genetic analyses to (i) ascertain the diversity of genotypes (phenotypes) introduced, (ii) determine whether additional introductions have taken place, (iii) track the movement of genotypes in the new range, (iv) determine whether hybridization events have taken place, and (v) determine whether novel genetic combinations are being generated. Based on this type of monitoring regime, certain populations can be specifically targeted for control or eradication because they pose a greater risk of ecological or economic harm. Results from our ongoing research with *Taeniatherum caput-medusae* (Poaceae) can be used to highlight the insights that can be obtained by using the approach outlined above.

Taeniatherum caput-medusae (medusahead) is a primarily self-pollinating annual grass that has invaded large areas of the western United States. Herbarium specimens reveal that likely early introduction sites for this species include Roseburg, OR (1884), Steptoe Butte, WA (1901), Klamathon, CA (1903), Los Gatos, CA (1908), Mountain Home, ID (1930), Goldendale, WA (1938), Payette, ID (1944), Elgin, OR (1944), and Lapwai, ID (1946). Forty-five populations from across this region were analyzed for their allozyme diversity, and the genetic variability for 12 of these populations was also assessed using random amplified polymorphic DNA (RAPD) analysis. Across all 45 populations, a total of nine multilocus genotypes were detected. Two of these genotypes exhibited heterozygosity at one or two loci, and appear to be the product of hybridization. Based on the number of genotypes, we suggest a minimum of seven separate introductions of *T. caput-medusae* into western U.S. Five distinct multilocus genotypes were detected in eastern Washington alone, indicating that multiple introductions can occur across a relatively small geographic area. Survey data and herbarium specimens indicate that the grass was not collected in Utah until 1988, thus the detection of a unique multilocus genotype in Salt Creek, Utah, may be evidence for a relatively recent introduction event. Allozyme and RAPD data were in general agreement: using RAPDs, a total of 16 multilocus genotypes were observed across all 12 populations. However, RAPDs detected the presence of a unique genotype in a population in California which was not detected using enzyme electrophoresis.

Taken together, these data point to the effectiveness of this approach in monitoring important aspects of an invasion, and can provide the information needed to make effective management decisions.

Predicting the future of weed invasions at the national to landscape scale

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Predicting where invasive plants will have their greatest impact will increase the speed and effectiveness of management. This includes assessing potential impacts through time and space in order to prioritise management actions before those impacts are realized. Predictions can be made at a range of scales. Predictions made at the national scale can help set national priorities and policy. Predictions at the landscape, catchment or regional scale can help direct local funding priorities at a scale most relevant to directing on-ground management actions. We developed modelling approaches to predict invasions at both a national and a regional scale.

We use parkinsonia (*Parkinsonia aculeata*), a well-studied Neotropical shrub that is highly invasive across northern Australia, as our test species. It is widespread in northern Australia, occurring from the arid interior to the wet-dry tropics and from seasonally inundated wetlands to upland habitats. Although widely distributed, it is still considered to be an emerging problem in most regions.

The climate-modelling package CLIMEX was used to predict the potential distribution of parkinsonia across Australia. CLIMEX is a physiological model that uses native-range distribution and abundance data, supplemented by other data sources where possible, to fit growth parameters (temperature and moisture requirements) and stress parameters (e.g., heat stress and cold-wet stress). Although widely used for invasive species, we developed it further by conducting a sensitivity analysis to test how well specific parameters could be fitted using only native-range data. Key parameters relating to temperature and moisture requirements for growth could not be fitted using native-range data, and this uncertainty greatly affected predictions in Australia. However, an alternative data source (ecological data from Australia) allowed these parameters to be fitted, and predictions to be made with confidence.

Bayesian belief networks were used to predict invasion at the regional to landscape scale. The model was structured to predict suitability (where parkinsonia will establish and persist), susceptibility (which suitable areas are most at risk of invasion) and consequence (which susceptible areas will result in the greatest negative impacts on environment and economy). Expert knowledge (obtained through a stakeholder workshop and from scientists) were integrated to identify the factors most likely to influence species' occurrence and abundance. The model was initially developed for the Desert Channels Region (south-west Queensland). Its adaptability was subsequently tested in two other regions. All three regions are primarily pastoral (cattle) and have serious problems with parkinsonia invasions, but they differ in several potentially important respects, including climate, soils, hydrology, topology, prevalence of fire and the size and management systems of pastoral properties. This technique proved to be very robust, especially given the constraints in available spatial data, and the variable quality in scientific understanding and expert opinion on this species.

Recommendations were developed as a consequence of model predictions, and are expected to result in a fundamental shift in the way that resources are allocated to managing this species in Australia. We expect our modelling approaches can be readily applied to a wide range of invasive organisms.

Modelling the spread of invasive alien plants: integrating habitat distribution models and interacting particle systems

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Forecasting the spread of alien species is considered an essential tool for proactive management of alien species. Empirical studies usually demonstrate that habitat templates and dispersal processes interact in determining the spatial pattern and rate of invasive spread. Most modelling efforts, however, either disregard dispersal or take insufficient account of spatial variation in habitat suitability.

Here we demonstrate how to integrate two widely used modelling tools, species distribution models delivering habitat-based information on potential distributions and interacting particle systems which simulate spatio-temporal range dynamics as dependent on neighbourhood configurations, into a common framework. We then compare the performance of our integrated modelling approach with those of purely dispersal or purely habitat driven alternatives in an attempt to reconstruct the recent spread of the invasive annual plant ragweed (*Ambrosia artemisiifolia*) across Austria.

Simulations based on habitat information only correctly predicted prevalent infestation of susceptible areas but did not adequately reproduce the autocorrelated spread patterns of *Ambrosia*. On the other hand, if dispersal was spatially constrained but variation in habitat quality was neglected, the simulated invasion was realistically clustered but ragweed spread was predicted to affect regions which are in fact unsuitable to the species. Only the integrated model adequately captured both aspects of spatial pattern formation.

Planning an appropriate response to an invasion problem is greatly facilitated by knowledge of where and when colonisation by an alien species is to be expected. Our integrated modelling approach offers a flexible tool for improved forecasts of spatio-temporal invasion patterns from landscape to regional scales and should hence help to enhance management efficiency. As a further advantage, scenarios of environmental change can easily be incorporated by appropriately updating habitat suitability layers. Given the susceptibility of many alien species to both land use and climate changes taking such scenarios into account will increasingly become relevant for the design of proactive management strategies. We discuss the consequences for managing invasion events and present future research avenues of this approach.

How can the DAISIE inventory of insect species alien to Europe help in forecasting future invasions?

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The 2005–2008 European project DAISIE (Delivering Alien Invasive Species Inventory in Europe) aimed at delivering the first continental inventory of alien species of animals and plants already established in Europe. A total of 1315 insect species alien to Europe were recorded to be established up to now. The rate of establishment of these species significantly increased during the second half of the 20th century, the mean number of species arriving per year during the period 2000– 2007 being twice as large as that observed in 1950– 1975, with the contribution of Asia becoming prevalent over that of North America. Most species arrived accidentally with human activities, less than 10 % were introduced deliberately for biological control. The trade of ornamental plants in all its forms (e.g., plants for planting, cut flowers, seeds, bonsais) was observed to be the dominant way of arrival. For the moment, most species show a rather limited distribution, restricted to 1– 2 European countries, and ca 60% stay in habitats related to human activities in urban and semi-urban areas, especially parks, gardens and hedges along the roads, rather than in (semi)natural habitats such as forest. However, it cannot be excluded that the present situation only corresponds to the time lag necessary for alien insects to build up large populations before invading natural habitats. Special attention was paid to phytophagous species, which represent more than 50% of the alien species. Nearly half of the species associated with trees and shrubs only attack exotic trees planted in Europe, usually their original hosts. Broad-leaved trees, fruit trees and conifers are the most colonized groups but unexpectedly large representation of tropical trees, especially palms, eucalyptus and acacias, was noticed. It is expected that global warming will trigger this process.

Coleoptera followed by Hemiptera largely dominate the alien insects, and aphids (Aphididae) and diaspidid scales (Diaspididae) are the families showing the highest numbers of representatives. A comparison of the relative representation of families within the established alien fauna with that observed in the interceptions by quarantine services revealed large discrepancies; aphids and scales are very little intercepted probably because they are little represented in the quarantine lists in Europe. Another comparison of the relative representation of insect orders in the native and alien entomofauna in Europe indicated a significant over-representation of the hemipterans in the alien entomofauna whilst hymenopterans and lepidopterans are under-represented. A deeper analysis including a comparison of the biological traits susceptible to facilitate the establishment of these alien species is under progress.

Assessing the risk posed by an invasive predator on native predators: the example of *Harmonia axyridis*

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The environmental effects of an invasive species on native biodiversity are often observed and measured long after their introduction and establishment. However, to develop and implement conservation strategies, it is desirable to assess in advance the future effects of newly invading species and identify the native species that are most at risk. In this presentation, we will describe a method developed to assess the risk posed by an invasive predator, the harlequin ladybird *Harmonia axyridis*, on native ladybirds in Europe. This risk can be considered as the product of the likelihood that a given ladybird species encounters *H. axyridis* in the field, and the consequence of this encounter through direct predation and competition for food.

To assess the likelihood of encounter, ladybird larvae and adults were collected in various habitats and ecosystems recently invaded by *H. axyridis* in Switzerland. Niche overlap indices, cluster analyses and canonical component analyses were used to assess which species most often encounter *H. axyridis* in the field. Data were compared to published data found in the literature. *Harmonia axyridis* was found in nearly all habitats surveyed. However, niche overlap was greater with arboreal aphidophagous species found on broadleaved trees than with ladybirds found mainly or exclusively in grasslands or on conifer. The European species that will most likely encounter *H. axyridis* during their lifetime are *Calvia* spp., *Adalia* spp. and *Oenopia conglobata*.

The consequence of direct predation was assessed in laboratory studies by carrying out various competition tests between *H. axyridis* and indigenous species. These tests showed that most native ladybird species are vulnerable to intraguild predation by *H. axyridis*, but some species, such as *Anatis ocellata* and *Calvia quatuordecimguttata*, may be at least partially protected through physical and chemical defensive mechanisms. The consequence of competition for food was estimated on the basis of published information on the dietary requirements of the ladybird species.

The likelihood of encounter, the consequence of intraguild predation and the consequence of competition for food were each assigned to a numerical scale, and a total risk index score was calculated as the product of the likelihood of encounter and the sum of the two types of consequences. From this assessment, *Adalia bipunctata*, *Adalia decempunctata*, *Calvia decemguttata* and *Oenopia conglobata* emerged as the species most at risk from the invasion of *H. axyridis*. The applicability of this method to other invasive predators will be discussed.

Enhancing the UK non-native risk assessment scheme

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The UK non-native risk assessment (UKNNRA) scheme provides a procedure for analysing the risks posed by any non-native taxon in the United Kingdom, particularly those that fall outside the established pest risk assessment programme for crop pests. The UKNNRA is based on the well-established European and Mediterranean Plant Protection Organization (EPPO) Pest Risk Analysis scheme, with significant modifications to ensure that it can assess all taxa on common scales of likelihood and impact. An additional feature of the scheme is its explicit treatment of uncertainty at each step of the assessment process. Although produced by a consortium based in the United Kingdom, the scheme can be used for any area. The scheme can be used for species that are absent from an area, or for those that have already been intentionally or unintentionally introduced. Already introduced species can be assessed for impact, and can be used as a check on the predictive capacity of the assessment for introduction, establishment and spread, based on the proven experience of new species already present. Since the presentation at Neobiota 2006, further work has been undertaken to improve the scheme, taking into account some of the difficulties experienced when operating the scheme and developments in invasion biology, risk assessment and risk management procedures. The principal developments are to: (a) enhance areas where the current scheme is difficult to use or could lead to inconsistencies, (b) provide a risk management scheme that sets out for policy makers and practitioners what options are feasible for action and (c) make the scheme more user-friendly, both for the risk analyst and the reader by providing a web interface.

Risk assessment of invasive alien species introductions via European inland waterways

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European network of inland waterways facilitates the transfer of invasive alien species (IAS) across European inland waters and coastal ecosystems, which requires appropriate risk assessment-based management options to address risks posed by human-mediated introductions of these species. During the development of methods to assess the risks of IAS introductions via European inland waterways we considered the DPSIR framework ('Driving forces', 'Pressure', 'State', 'Impact', 'Response') to structure developed environmental indicators in the socio-economic context. In addition, considering the current gap in addressing IAS in the river basin management in Europe, our goal was to develop and test relevant risk assessment protocols and water quality indicators on IAS for possible consideration in the Common Implementation Strategy of the EC Water Framework Directive and as part of a holistic risk-based management of European river basins.

Owing to the high degree of scientific uncertainty when dealing with such a global and complex ecological issue as large-scale intercontinental and intra-continental introductions of IAS, the qualitative model of risk assessment was selected for risk assessment of IAS introductions via European inland waterways. The present variant of this model of risk assessment of IAS introductions, tested for selected assessment units within the main inland water invasion corridors, includes seven main components: (1) Identification of main invasion gateways, routes and corridors in Europe; (2) Selection of ecosystems as assessment and management units (AUs) within invasions corridors/invasion network; (3) Identification and analysis of pathways of IAS introductions within the ecosystem AU – 'Driving forces' according to the DPSIR framework; (4) Assessment of inoculation rates within the ecosystem AU (propagule pressure) – DPSIR 'Pressures'; (5) Assessment of biological contamination level of the ecosystem AU - DPSIR 'State'; (6) Assessment of invasiveness of the established in the ecosystem AU alien species (potential biopollution risk) - DPSIR 'Impacts'; (7) Development of an online Risk Assessment Toolkit with early warning service for reporting of environmental indicators and recommendations for risk management to stakeholders – DPSIR 'Responses'.

Monitoring the response of alien and native species to control measures: can we achieve a synthesis?

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In the last few decades, the field of biological invasions has become increasingly focused on the impacts to the environment and biodiversity, rather than solely to agriculture and human health. Thus there are a significant number of control programs being undertaken, for which biodiversity conservation is a stated aim. However, few of these programs identify the native species at risk, let alone establish effective monitoring strategies to demonstrate the success or otherwise of control efforts in reducing alien species numbers and saving native species (Reddiex et al. 2006, King & Downey 2008). There are several factors which contribute to this situation, being (i) a lack of acceptable monitoring protocols, leading to inadequate monitoring measures (such as hectares treated), (ii) ineffective reporting processes, (iii) lack of a centralised database to compile and analyse data across sites, (iv) an assumption that control alone will lead to native species recovery, (v) a lack of information on the native species at risk and which species to monitor, (vi) a lack of practitioners with the appropriate skills to undertake monitoring programs, (vii) insufficient resources and time allocated to monitoring, and (viii) most control programs are undertaken by land managers or contractors with an agricultural background who also lack the necessary skills to undertake monitoring.

To resolve this problem we have developed a monitoring manual for alien plant species and the native plant species they threaten, which uses a three tiered approach to ensure that some level of effective monitoring is undertaken by all land managers (King et al. 2008). The first tier or standard monitoring protocols is aimed at the general user and includes maps of the sites, measuring control activities and the native species at risk, photopoints, observational data to support the photopoints, and expenditure incurred. The second tier or advanced monitoring protocols is designed for users who have undertaken monitoring previously and includes more detailed methods involving transects and quadrats, as well as those included in tier one. The last tier or research protocols includes information on how to determine causality associated with the control of alien plants and the recovery of native species. It again builds on the two previous tiers, so that analysis can be undertaken across all three tiers. The data collected will be centrally stored, analysed and reported back to stakeholders. Such monitoring protocols are essential for evaluating the effectiveness of alien species control programs and for effective adaptive management. Currently such information is unavailable which has significant consequences for altering the funding cycles, policy and management. Thus while we are a long way from a synthesis on monitoring alien plant control programs, especially with respect to assessing the recovery of native species, we are developing a system which if adopted should lead to a standardised base level approach – which is long over due.

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Concerted action against further spread of *Ambrosia artemisiifolia* in Germany

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The North American plant species *Ambrosia artemisiifolia* (Asteraceae) was known to occur in Germany since 1860; however, stands were mostly scattered and casual for a long time. Only in recent decades, more and more established stands were recorded, most of them in the warmer parts of the country and in cities. A relation to global warming seems likely, and further spread may lead to a situation similar to that in warmer European regions, where *A. artemisiifolia* has become abundant and troublesome.

In order to discuss the potential threat of the species, an interdisciplinary working group was founded at the Julius Kuehn Institute comprising experts from the fields of plant health, allergology, meteorology, ecology and botany. With the help of Swiss colleagues, the working group designed a national "Action Programme Ambrosia" (www.jki.bund.de/ambrosia) in 2007. The programme has three aims: (i) to educate the broad public and policy makers about the negative effects the plant has on public health, agriculture and, possibly, biodiversity; (ii) to monitor existing stands of the plant in order to gain a comprehensive overview of its occurrence in Germany, and (iii) to trigger measures against further introduction and spread and for the control of individual stands.

In the first season of the programme the plant has received wide attention in the press and other media. Several authorities in the Federal States have supported the programme by collecting monitoring data and by implementing control measures. They were mainly in the plant health and nature conservation/environment sector. The common effort lead to the knowledge of at least 638 stands. The majority of the stands are still small, but some large stands were recorded, e.g. long linear stands along motorways. Many plants have been destroyed, but more efforts are needed to enhance the effectiveness of the control measures. The bird seed industry has been informed about the problem of contamination of sun flower seeds with *Ambrosia* seeds.

POSTERS

Section 1

Invasion patterns, pathways and spread

Kashmir balsam as an emerging invader

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Asiatic *Impatiens balfourii* Hook. f., Kashmir balsam, is cultivated as ornamental plant in many places of the world. In first edition of Flora Europaea the species is mentioned as naturalised only from France, Switzerland, Italy and Hungary. In last 50 years, however, the species became more widespread in southern and central part of Europe. On account of this, it seems important to analyse the species invasion history and the identification of regions that might be invaded by it.

Impatiens balfourii grows naturally in western Himalayas between altitude of 1500 and 2500 m a.s.l. It flowers late in the summer (end of July–August, in Europe often until frosts). The plant was introduced to culture in Montpellier Botanic Garden, France, and Edinburgh Botanic Garden, Great Britain in 1901. It was cultivated in Italy since 1903, and since 1918 in Hungary. At present the species is cultivated in a large part of Europe, as far to the north as southern part of Scandinavia, in Estonia, Romania and Bulgaria, also in USA, Canada, Japan, Australia and New Zealand.

Reconstruction of its invasion was a difficult task because of taxonomic problems. In older papers the species was often misidentified with *I. amphorata* Edgew. (= *I. bicolor* Royle) and *I. insignis* D.C.; it was even described as new species both from Italy and Switzerland (*I. mathildae* Chiovenda, *I. insubrica* Beauverd). In Montpellier Botanic Garden the balsam was observed as spontaneous as early as 1906 and since 1916 it was spreading in Piemont, Italy. It was present in southern Switzerland in the 1920s. Later its secondary distribution widened: Belgium 1952, Spain 1961, Hungary before 1965, Denmark 1973, Slovakia 1988, Portugal 1990, Netherland 1994. At present it is occurring spontaneously in southern and central Europe from northeastern Portugal to Denmark, Slovakia, countries of former Yugoslavia and Greece, in recent years spreading also in central and southern Italy. In Great Britain and Ireland *I. balfourii* occurs only as casual plant, most probably due to cool summers. There are data on its occurrence in USA (especially western seaboard, also in Wisconsin), Japan and SE Australia. It is a problematic species in Andorra and included in black lists in Spain and Switzerland. In France it is growing in at least 67 of 95 departments.

Future climate changes can create favourable conditions for *Impatiens balfourii* (longer vegetation period) and enable its further expansion in temperate regions of the world.

Detection of weed invasion patterns based on herbarium samples from New Zealand

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We analyzed the Christchurch herbarium (CHR) data of 12401 samples to detect the invasion pattern of 408 weed species in New Zealand. We fitted polynomial surface models and cubic nearest neighbour interpolation models on data that consists of coordinates and year of first occurrence for each species. We calculated invasion gradients at each data point to indicate the direction where the fitted year of first detection increases most steeply. The distribution of the directions indicates whether the invasion of each species has occurred to the same general direction across the island or if the invasion pattern is more variable. In addition to the spatial analysis, we fitted linear, exponential and sigmoidal models on the cumulative number of samples of each species and selected the best of the three models for each species according to the Akaike information criterion. We treated the North and the South island of New Zealand separately in each analysis.

The fitted polynomial model revealed more general direction of species invasion than the interpolation model, which revealed more local patterns. The species differed widely in their colonization pattern, but some general trends can be detected. In the South Island, it is common for invasions to begin at the East Coast and advance towards the Southern Alps. In the North Island, invasions more commonly start from the West. In many cases, however, there seem to be more than one source of invasion and considerable variation in the age of herbarium samples at adjacent locations.

The sigmoidal model best described the accumulation of samples in nearly half of the species. A sigmoidal accumulation curve indicates a species that has increased in abundance and become so common that it no longer attracts sampling. Thus, a large proportion of the weeds in this herbarium data can be considered established. The linear and exponential models describing the remaining of the species in equal proportions. Linear accumulation of samples in herbarium data indicates constant sampling of a species that does not increase in abundance. Exponential accumulation increasing interest in sampling the focal species in the herbarium, which we indicate as a sign of fast and continuing range expansion of the species. The time of first occurrence of the species in the data does not differ between the models, indicating that the time from introduction does not affect the accumulation of samples.

We interpret our results with some caution because species abundance and spread may not be accurately representation in herbarium samples. It can be argued that herbarium samples are biased towards rare species, which are likely to be more interesting for botanists than common and abundant species. The bias can be beneficial for detecting first occurrences of a species, but distort the view of species abundances. For abundance estimations it is also advisable factor out sampling efforts by comparing invader and endemic species' sampling rates.

Gunnera tinctoria: an invasive species, localised distribution on Achill Island, Co. Mayo, Ireland

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There is now considerable evidence that invasive plant species can have a major detrimental long-term impact on biodiversity (Vitousek et al. 1996). Predicting the future spread and impact of plant invasions is, however, limited because of the absence of detailed information that can be used to identify the habitats and localities most susceptible to invasion. In order to address this question we have mapped the distribution of the invasive species *Gunnera tinctoria*, Achill Island, Co Mayo, Ireland and examined the relation between habitat type and plant distribution.

A baseline map of the present distribution of *G. tinctoria* on Achill Island was created during 2006–2007. The island was monitored by foot, following all roads and paths. Areas not accessible by roads or paths such as coastal and higher mountainous areas were also covered as extensively as possible. Using 1:7500 maps and a GPS (Global Positioning System), individual plants and plant stands were located, estimates of percentage cover and habitat type recorded. Using GIS software, distribution maps were produced, total area invaded and the spatial correlations between the plant occurrence and habitat type, distance from roads, human developed land, waterways and the sea were calculated. The range of habitats where *G. tinctoria* was found included: grasslands, coastal cliffs, waterways, roadsides and bog. Grasslands were the most prominent by total area, while roadside and waterways were both second in number of locations. Achill Island is largely covered by bog and heath, these habitats were largely uninvaded by *G. tinctoria*, and most occurrences were due to garden waste dumping. Also, *G. tinctoria* was mostly restricted to or at sea level. Most notable is the correlation with human developed areas, although occurrences outside of these do exist such as on coastal cliffs.

The results of this study on the distribution of *G. tinctoria* will help to identify the areas most susceptible to invasion and those where a significant loss of biodiversity might be expected. This also establishes a baseline for future monitoring and the identification of priority areas for eradication, control or prevention.

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Distribution of alien plant species along the elevation gradient in the Alps: establishing climatic limiters

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Mountain areas are increasingly threatened by invasive alien plants as a consequence of anthropogenic changes. This phenomenon is attracting ecologists' attention since it provides the opportunity to study the invasion process starting from an early stage and to analyze the mechanisms underlying plant invasions along distinct environmental gradients that vary according to elevation. Results from these studies also give useful knowledge for the development of management policies to prevent and control invasions in order to conserve natural ecosystems with high native biodiversity.

Studies on alien plants in mountain systems are mostly from Mediterranean or tropical and non-European regions where heavily invaded areas and a high number of aliens also above timberline can be found. On the contrary recent investigations in the Swiss Alps (Becker et al., 2005) showed that alpine areas are still poorly or not invaded though many species have raised their elevation limits during the past decades and global warming could further enhance this trend. At the moment, research on plant invasions into mountains is progressing thanks to several scientific programmes and in particular to the activity of the MIREN (www.miren.ethz.ch; Dietz et al. 2006).
First aim of this work was to assess the actual distribution of alien plants in five alpine valleys in relation to the elevation gradient. Presence and cover (%) of alien and native species were recorded in 20 m^2 plots positioned every 1.5 km riverside, from 200 to 2000 m a.s.l., in valleys affected by high human impact. Second aim was to relate the observed elevation limits of alien plants to climate variables in order to identify and quantify the constraining factors. Multiple regression was used to calculate spatial models of temperature and precipitation indexes (dependent variables), derived from the observed data collected from Arpa Piemonte automatic stations, considering geographic (latitude and longitude) and topographic (elevation, aspect, slope) data as independent variables, derived from the DEM.

Preliminary results obtained by quantile regression show that the number and cover of alien species decreases among groups of plots positioned in the intervals 200–500, 500–1000 and 1000–1500 m a.s.l., with an elevation limit of 1300 m. Canonical Correspondence Analysis revealed that degree days and number of frost days are among the variables, which drive the distribution of aliens, and logistic regression was used to quantify the threshold values of the two variables, beyond which aliens are more likely to be absent than present.

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Alien species of mammals in biosphere reserves of Russia

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We analysed the results of survey of 37 Russian biosphere reserves concerning the presence of alien species of mammals, their pathways of penetration, and impacts on protected ecosystems. The largest number of alien species is observed in Tsentralno-Chernozemny, Prioksko-Terrasny, and Voronezhsky biosphere reserves (15, 12, and 11 species, respectively), the smallest number (only one) is in Barguzinsky, Kedrovaya Pad, Taimyrsky Reserves. The maximum proportion of alien species compared to the total fauna of mammals is observed in Tsentralno-Chernozemny (32.6%) and Astrakhansky reserves (26.9%). Many mammal species were intentionally introduced in reserves, including the present-day biosphere reserves, during the Soviet time. *Neovison vison* and *Nyctereutes procyonoides* are found in many biosphere reserves now. Several species were intentionally introduced and settled down in biosphere reserves to enrich their fauna, i.e. *Sciurus vulgaris* (Great Volzhsko-Kamsky and Teberdinsky), *Castor canadensis* (Sikhote-Alinsky), *Capreolus pygargus* (Prioksko-Terrasny), *Bison bonasus* (Kavkazsky and Teberdinsky). Mammals which were introduced nearby protected areas often penetrated to biosphere reserves as well. They are *Lepus europaeus*, *Sciurus vulgaris*, *Marmota bobak*, *Castor canadensis*, *C. fiber*, *Martes foina*, *Sus scrofa*, *Cervus elaphus* and *C. nippon*. The introduction of *Neovison vison* caused the highest damage. It replaced native *Mustela lutreola* in many biosphere reserves, including Vodlozersky, Voronezhsky, Nerusso-Desnyanskoye Polesiye, and Ugra reserves. The adverse effect of *Ondatra zibethicus* on aquatic plants is regularly observed. There are also many records of adverse activities of *Nyctereutes procyonoides*. Adverse effects of other intentionally introduced mammal species occur less often.

Much work was done to reintroduce some species in biosphere reserves, such as *Ovibos moschatus* (Taimyrsky), *Desmana moschata* (Nerusso-Desnyanskoye Polesiye), *Bison bonasus* (Prioksko-Terrasny), *Castor fiber* (Laplandsky, Oksky, Prioksko-Terrasny and Tsentralno-Lesnoy). The reintroduction of *Castor fiber* is most visible since it is a species which actively transforms environment. So, in Prioksko-Terrasny biosphere reserve, *Castor fiber* built many dams and ponds for 60 years of existence and changed the hydrological and temperature regime of rivers and streams. Synanthropic rodents accompanying humans (*Mus musculus*, *Rattus norvegicus* and *R. rattus*) were accidentally introduced in many biosphere reserves. They often inhabit villages, settlements of rangers, or their vicinities. Their impact on natural ecosystems of biosphere reserves is usually low.

The mammal fauna of Biosphere Reserves is often extended by self-spreading. *Sciurus vulgaris* and *Lynx lynx* appeared in Kamchatka and became common inhabitants of Kronotsky biosphere reserve. One of the species which actively extends its distribution area is *Sus scrofa*. The effect of *Sus scrofa* is easily recognizable; it does notable damage to many biosphere reserves. Thus, in Prioksko-Terrasny Biosphere reserve, *Sus scrofa* penetrated from adjacent hunting farms in 1960. Its activities cause great damage to herbaceous plants of forest clearings. Small areas of oak stands and poor harvest of acorns in some years make wild boars serious competitors of roes and deer. *Alces alces* is self-spreading in Astrakhansky, Voronezhsky, Katunsky, and Tsentralno-Chernozemny biosphere reserves. This species began to do great damage to undergrowth and underbrush. As a result, it was necessary to introduce some measures to regulate its number.

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Alien species on a very isolated island: the case of Malpelo, 35 years after the first invertebrate records

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Malpelo is a very isolated island located 370 km off the nearest coast of the American Continent. It is not only the distance to the continent, but also small size and inaccessibility what kept the island almost undisturbed until few decades ago, when the first scientists explored its surface and the Colombian Navy established a permanent vigilance station there. After the first extensive survey of Malpelo invertebrate fauna, performed in 1972 (Wolda 1975), few attempts were made to identify the potential of introduced species that the presence of humans on the island might have triggered. Based on intensive hand collections of specimens on the eastern side of Malpelo, where the influence of humans is strongest, we recorded ca 40 species new to the island (Table 1). The most outstanding among those new records are *Tetramorium bicarinatum* and *Solenopsis* sp., both worldwide recognized alien species with a high damaging capacity. Some other new records include predatory species of web spiders (Theridiidae), also with a high detrimental potential to the island's invertebrate community. In addition, some of the species recorded during the expedition of 1972 were not recorded (10 out of 40), which lead us to conclude that they might be extinct, at least on the eastern side of the island. Although Malpelo was recently declared World Heritage Site (UNESCO), among other important conservation designations received at regional and national levels, the future of its unique invertebrate fauna might be at risk. Given that the emerged surfaces of Malpelo are not used for tourism, some basic and relatively easy to apply methods to prevent the arrival of alien species could be performed, all of them related to managing and inspecting the Colombian Navy supplies (food, construction materials, etc.), which we think are the main vectors for the undesirable introductions.

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Table 1. Comparison between the three invertebrate inventories performed on Malpelo Island.

Taxa	Wolda 1975	Álvarez et al. 1999	Calero et al. 2008 (this study)
Classes	6	5	7
Orders	21	13	26
Families	24	25	31
Morph species	40	40	82

Community and landscape-scale patterns of alien plant species on Mediterranean coastal dunes

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Coastal areas, and in particular coastal dunes, are ecosystems strongly affected by the invasion of alien plants. However, few researchers have focused on alien species incidence in different community types along the coastal zonation in the Mediterranean basin. In this study we aim, in the first place, to analyse specifically the distribution and quantity of aliens in the different plant communities present along sandy shores on coastal dune landscapes in central Italy. Secondly, we seek to explore, through a detailed mapping approach, the spatial pattern of one of the most invasive alien plants on the Tyrrhenian coast, *Carpobrotus* aff. *acinaciformis* (L.) L. Bolus, hereafter iceplant.

The study was performed on recent dunes (Holocene) of the central western coast of Italy. The vegetation landscape was randomly sampled by recording plant species in 2m × 2 m plots. Even though iceplant is a low creeping chamephyte, we were able to map it correctly on the basis of a CORINE land-cover map. After that, we calculated several patch structure metrics and analyzed the distribution of iceplant patches, by focusing on boundaries and electivity between iceplant and other land cover classes.

Ordination identified six plant communities corresponding to the typical zonation described for the Tyrrhenian sandy coast of Central Italy (Acosta et al. 2003). In particular, we identified communities related to the beach, foredunes, main dune ridge, transition dunes and fixed dunes. Although the total number of aliens is relatively low, what is important to highlight is the distribution pattern and the abundance of some of the aliens in specific sectors of the vegetation zonation. The perennial community of transition dunes appears most affected by invasion processes. In this community the most frequent alien was iceplant. At the landscape scale, iceplant patches were preferentially distributed on foredunes and transition dunes and were generally large and of irregular shape. Moreover, results from the electivity analysis suggest that the introduction of iceplant tends to be associated with the local urban settlement network, since iceplant is often in contact with artificial surfaces and residential areas. In fact, in this area house gardens face towards the sea and are the probable source of propagules, which colonize the neighbouring coastal dune mosaic expanding through vegetative spread.

Our results show that iceplant patches substitute specifically the most typical vegetation types of the coastal zonation and confirm the relationship between coastal dune landscape fragmentation and the presence and distribution of iceplant. This alien species reaches high cover values, apparently lowering cover of native species by competition for space or other resources, or by other mechanisms. This invasion process appears to seriously endanger the survival of transition dune plant communities such as those with *Crucianella maritima*, which are rare and protected (sensu Habitat 92/43/CEE Directive) along the entire Italian coast.

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Non-native macroinvertebrate species in the northern Adriatic coralligenous assemblages

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In the northern Adriatic Sea, as in many other parts of the Mediterranean basin exist peculiar submarine rocky habitats mainly produced by accumulation of calcareous incrusting algae, growing at low light levels (sciaphilic conditions) and forming the base on which a rich fouling and building fauna developed. These organogenic reefs are known as "coralligenous" (Ballesteros 2006). In the northern Adriatic Sea they are numerous and lie at depth between 9 and 40 m. The ecological role played by these habitats is extraordinary. They are true oases of biodiversity and represent a unique hard submarine substrate in the northern Adriatic, which is naturally protected against trawl fishing, provides shelter for a large variety of marine invertebrates and acts as a natural nursery for many species of fishes, to which it provides food, protection and suitable places for reproduction. Numerous studies on these habitats (Mizzan 1992, Gabriele et al. 1999, Casellato et al. 2006, Casellato & Stefanon 2008) reported a total number of 480 macroinvertebrates (this is only a first estimate), particularly molluscs, crustaceans, polychaetes, cnidarians and porifers. Some of them, originally coming from Levantine seas or from Atlantic coasts, are present in Adriatic for a long time, introduced via canals Suez and Gibraltar and Dardanelli Strait. Other, recently recorded (Casellato et al. 2006), are new for the Adriatic Sea, not yet reported in the checklist of Italian marine fauna. They are native to other Mediterranean areas, such as northern African coast, or to southeast Asia. This is the effect of the global climate change, which is altering the geographic ranges of marine invertebrate species as well as fishes. Present-day Adriatic marine biodiversity, as well as other Mediterranean seas, is undergoing rapid alteration, because of an increasing occurrence of warm-water biota. Higher temperatures favour the introduction and establishment of exotic species, thereby changing trophic relationships within the communities and homogenizing biotas. It has been known that the Mediterranean is under a process of "tropicalization" and its effect can be detected also in Adriatic. We expect to find more new species in these environments in the future, because they are the only naturally protected infralittoral hardy substrate in north Adriatic.

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European map of alien plant invasions based on the quantitative assessment across habitats

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Recent studies using vegetation plots have demonstrated that habitat type is a good predictor of the level of plant invasion, expressed as the proportion of alien to all species. At local scale, habitat types explain the level of invasion much better than alien propagule pressure. Moreover, it has been shown that patterns of habitat invasion are consistent among European regions with contrasting climates, biogeography, history and socio-economic background. Here we use these findings as a basis for mapping the level of plant invasion in Europe. We used 52,480 vegetation plots from Catalonia (NE Spain), Czech Republic and Great Britain to quantify the levels of invasion by neophytes (alien plant species introduced after AD 1500) in 33 habitat types. Then we estimated the proportion of each of these habitat types in CORINE land-cover classes and calculated the level of invasion for each class. We projected the levels of invasion on the CORINE land-cover map of Europe, extrapolating Catalonian data to the Mediterranean bioregion, Czech data to the Continental bioregion, British data to the British Isles, and combined Czech-British data to the Atlantic and Boreal bioregions. The highest levels of invasion were predicted for agricultural, urban and industrial land-cover classes, low levels for natural and semi-natural grasslands and most woodlands, and the lowest levels for sclerophyllous vegetation, heathlands and peatlands. The resulting map of the level of invasion reflected the distribution of these land-cover classes across Europe. High levels of invasion are predicted in lowland areas of the temperate zone of western and central Europe and low level in the boreal zone and mountain regions across the continent. Low level of invasion is also predicted in the Mediterranean region except its coastline, river corridors and areas with irrigated agricultural land.

Lessepsian fish migrants in the Adriatic

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The catch of *Terapon theraps* in 2007 brought the number of Lessepsian fish migrants that were recorded in the Adriatic Sea. Occurence of *T. theraps* is of particular interest since its record was first for the Mediterranean and was found a great distance from the usual distribution area. Similar are the cases of *Pampus argenteus* and *Epinephelus coioides*. The latter was considered rare and recent invader and its presence in the Mediterranean was acknowledged only from the coast of Israel, hence its presence in the northernmost part of the Adriatic, which is the northernmost record in the Mediterranean, is rather surprising. Considering record of *P. argenteus*, one specimen was caught in 1896 in front of Rijeka. This is the only record of this species in the Mediterranean, hence its presence is even more surprising. Nevertheless, this record undoubtly represents the first confirmed Lessepsian fish migrant in the Mediterranean Sea. Furthermore, one specimen of *Hemiramphus* was recorded at the entrance of the Adriatic Sea, along the Albanian coast in 1986, as *Parexocoetus mento*. In the same year, one specimen of *Parexocoetus mento* was also recorded in Albanian coastal waters. Albanian coastal waters yielded another record of a Lessepsian fish in 1995, when a single specimen of *Saurida undosquamis* was caught. In the summer of 2000, a specimen of *Sphyraena chrysotaenia* was caught in the Bay of Gornji Molunat. In the summer of the same year, a specimen of *Leiognathus klunzingeri* was captured near the island of Mljet in the southern Adriatic. This record represents the northernmost occurence of this species in the Mediterranean Sea. Another migrant, *Stephanolepis diaspros*, was recorded in the southern Adriatic in the summer 2002. This record is also the first occurence of a member of this family (Monacanthidae) for the Adriatic Sea. Two specimens of *Siganus rivulatus* were captured by the beach near the islet Bobara (southern Adriatic, Croatian coast) in autumn 2000. This is also the northernmost occurence of this species in Mediterranean Sea. In 2006 two specimens of *Fistularia commersonii* were recorded in the Adriatic.

There are many indicies pointing out that climate change on a global scale has changed assemblage of Adriatic ichthyofauna and as a consequence new species are present in this area. The Adriatic Sea is becoming a westward distribution path of Lessepsian migrants; it would be interesting to observe this invasion on a larger time scale especially in the context of the response of species to the new enviroment. We conclude that biological invasions still did not negatively affect infigenous Adriatic ichthyofauna. However, increthe asing abundance of some thermophilous species could potentialy shift ecological balance in unpredictable directions. We empasize the need for further research and continuous evaluation of the status of migrating species.

Alien component of halophyte communities of Ukraine

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The halophyte vegetation of Ukraine is represented by communities, which belong to seven phytosociological classes: Bolboschoenetea maritimi, Thero-Salicornietea strictae, Salicornietea fruticosae, Festuco-Puccinellietea, Crypsietea aculeatae, Juncetea maritimi and Molinio-Juncetea. The flora of these vegetation communities consists of about 280 species of vascular plants. The alien component is represented by 33 species, of which 18 (54.5%) are neophytes and 16 (45.5%) archeophytes. The largest proportion of alien species is recorded in the class Crypsietea aculeatae (15.8% of the total number of species occurring in these communities), occurring in alluvial sites. A number of alien species penetrate in communities of classes Molinio-Juncetea (8.7% of the total number), Juncetea maritimi (6.3%) and Festuco-Puccinellietea (5.7%), which is caused by intensive grazing of the meadows. Pioneer communities of a flat seaside, Thero-Salicornietea strictae, are also affected by alien species (7.4%). Two alien species (7.1%) were recorded in the class Bolboschoenetea maritimi and four (5.3%) in Salicornietea fruticosae. The most widespread alien species of the salt territories of Ukraine are *Xanthium strumarium*, *Erysimum repandum*, *Bromus squarrosus*, *Atriplex tatarica*, *A. prostrata* and *Althaea officinalis*. The following five alien species occur in 60–100% of vegetation relevés with cover up to 25%: *Atriplex tatarica* (in the associations Artemisio santonicae-Elytrigietum elongatae, Salicornio-Puccinellietum fominii var. Limonium suffruticosum, Lepidio latifolii-Puccinellietum limosae, Artemisietum tauricae, Halimionetum pedunculatae), *Apium graveolens* (Triglochino-Glaucetum maritimae), *Bromus squarrosus* (Cynancho acuti-Lepidietum latifolii, Lepidio latifolii-Puccinellietum limosae), *Sinapis alba* (Cynancho acuti-Lepidietum latifolii) and *Sonchus arvensis* (Festucetum regelianae).

Seven invasive alien species massively replace native species: *Anisantha tectorum*, *Artemisia absinthium*, *Cardaria draba*, *Carduus acanthoides*, *Centaurea diffusa*, *Descurainia sophia* and *Lepidium ruderale*. The quarantine invasive species are represented by *Ambrosia artemisiifolia*. The main factor of their distribution are human-induced changes to land use in Ukraine. *Anisantha tectorum* is a species with the highest constancy (IV, occurring in 61–80% of vegetation relevés). It is a diagnostic species of the association Agropyro elongati-Inuletum salicinae (class Festuco-Puccinellietea) and also occurs in association Glycyrrhizetum glabrae. *Lepidium ruderale* and *Cardaria draba* reach constancy class II in plant communities. *Lepidium ruderale* occurs in six associations of the classes Festuco-Puccinellietea and Thero-Salicornietea strictae, where it grows mostly scattered; however, in association Bassietum hirsutae its cover is 5–10%. *Cardaria draba* occurs in communities of four associations of the above classes. Other invasive species participate in communities with a low constancy and cover.

To decrease the rate and the level of synantropization of the halophyte vegetation of Ukraine and preserve natural biodiversity, further development of measures for monitoring invasive species is necessary.

Investigation of invasive plant species in Armenia

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Until present time the problem of invasive species was not in the focus of attention in Armenia. Within the last 50 years segetal flora and vegetation of this country was investigated more or less in detail. Concerning alien invasive plant species no special investigations has been carried out. For new species recorded in Armenia, herbarium samples were stored in the herbarium of the Institute of Botany of the RA (ERE). Species that were introduced intentionally, used for town and settlement greenery or artificial afforestation and further penetrated to natural ecosystems were not paid any attention. The first national report on Armenian biodiversity (1999) included a brief section dedicated to alien invasive species and introduced a short list of species, which has been now almost totally revised by us. This list includes both alien and indigenous expansive species. The main reason for the lack of studies on invasive plant species of Armenia is probably underestimation of the importance of this problem by the scientific community and governmental structures. It was assumed that due to the montane character of the country and absence of large plain territories invasive species could not harm greatly the natural flora and vegetation of Armenia. Thanks to our efforts the attitude towards the problem of invasive species of Armenia has changed slightly. In 2005, the research of invasive species was supported with governmental funding and the topic included the spread of main invasive and expansive species in the territory of the Republic. For full up to date investigation this funding is insufficient, but the first step has been done. Based on the reviews of literature and herbarium material and on preliminary field investigation we created a list of species that require immediate attention (Annex 1). This list contains species known to be invasive in other regions of the world, those recently revealed as new to Armenia and registered indigenous expansive species. Since 2005 we started to collect data on the spread of these species, their ecological characteristics and level of penetration in natural ecosystems.

The species of the most concern is currently an alien tree *Ailanthus altissima*, which is spreading in natural ecosystems of the north and south of Armenia, as well as in disturbed ecosystems of the central part of country. Other introduced species (*Gleditschia triacanthos*, *Helianthus tuberosus*) are still relatively rare in natural ecosystems. *Robinia pseudoacacia* penetrates into natural ecosystems rather intensively in the North Armenia. However, taking into consideration the high invasion potential of these species, the control of their spread is necessary. Other species that occur only occasionally (*Ambrosia artemisiifolia*, *Galinsoga parviflora*, *G. ciliata*, *Sphaerophysa salsula*) also require a constant control of their spread. However, indigenous expansive species, especially those growing plentifully in abandoned fields, require the most attention, as they form reserves of seed and penetrate into natural ecosystems.

Reconstruction of the invasion of neophytes in changing riparian plant communities of the Nitra river basin (SW Slovakia)

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Although environmental conditions have changed in time and space, many ecological models do not take into account such changes and consider invasive species in an invariable, almost homogeneous habitat. In the Nitra river basin historical documents provide the first reports about channel regulations (mill channels, property boundaries etc.) in 1433 and 1496. The expansion of neophytes was connected with new geographical discoveries, transportation, the Turkish invasion, changes in riparian plant communities related to the regulation of channels (new uncovered, deforested areas, locally artificial and drier river banks) and intense creation and exploitation of alluvial meadows. The existing dikes were maintained by the local people, e.g. in 1571. In the 17–18th centuries there were extensive meadows in the Nitra river basin and the wet meadows were proposed to be drained (e.g., in 1787). The first big regulations of the Nitra river channel were done at the beginning of the 18th century at the so-called Sihot in Nitra, but no major interventions into the river network were made until the 19th century. In 1851 the first co-operative action against flooding was established on the left bank of the river Váh including a part of the Nitra river. The left, less important branch of the Nitra river, called Cetínka, in the 1960s "became overgrown with reed". The increased flows in spring and sudden thaws of ice caused inundation of wide alluvia of the Nitra still in the mid 19th century (e.g., in 1863, 1868). Millers, in order to have enough water, built water-gates. In 1868 a part of the Nitra downstream channel was cleaned "from sludge, cyperus and mainly from tree and shrub roots" and trees in the distance of 2–3 m from the river bank were uprooted. The deforestation created new sites for nitrophilous tall-herb communities in which alien plants occur. The poster deals with changes in species composition of communities in changing riparian habitats. For instance, the evaluation of floristic records from the mid 19th century showed that the representation of alien species in riparian communities increased from 12.5% of the total species number to more than 50% (Figure 1).

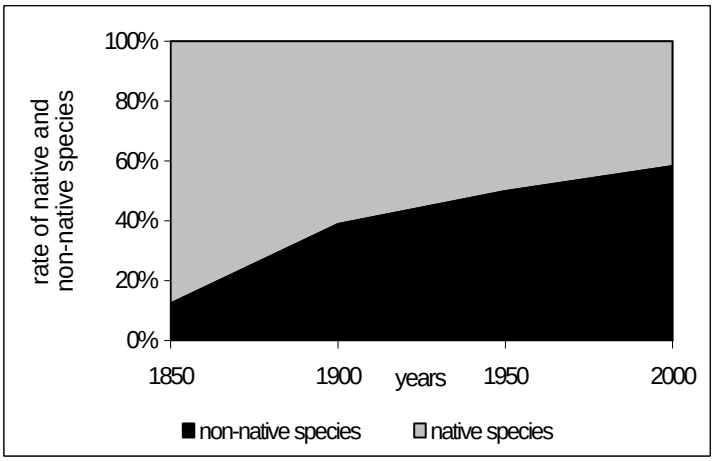

Figure 1. Proportion of alien plant species (including archeophytes and species of doubtful origin) in riparian plant communities of the Nitra river (1850–2000).

Community diversity and long-term invasibility patterns in synthesized Mediterranean grasslands: a trait-based approach

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This poster reports the findings of a trait-based approach to a long-term natural invasibility field study in constructed Mediterranean grasslands of varying initial diversities and compositions. Our aim was to investigate the relationship between the occurrence and performance of resident and invader species in a community across a diversity gradient. Initial resident communities were constituted by 1, 2, 4, 8, and 18 species and were established and maintained by weeding for 3 years. Subsequently, by cessation of weeding, we allowed natural invasion from the neighbouring grassland to occur. Three components of invasibility, i.e. species richness, density and aboveground biomass of invaders per plot, have been monitored for five years. In our analysis we refer to "all invaders" (i.e. all species not belonging to a specific plot mixture) and to "external invaders" (i.e. just the species that were not included in the experimental sowed species pool at all). Furthermore, values of species traits and characteristics such as family classification, life form, shoot growth, height and several Ellenberg indicator values were obtained from databases, floras and literature. In order to link categorical traits of residents and invaders we used Spearman's rank correlations and fit separate Generalized Linear Models with resident richness as explanatory variable and all invaders' number, density and biomass as response variables. We also used Wilcoxon rank-sum tests to check for bigger than expected by chance differences in size between resident and invader species, using predicted and observed height distances for every diversity treatment level. Finally, ordination techniques were used to investigate distances between residents and invaders in the trait-space. Using a 45 species × 11 traits & characteristics data matrix we performed a Detrended Correspondence Analysis to test for important patterns in species distributions along the trait-space.

In general, species richness, density and biomass of all invaders decreased significantly with the increase in initial species richness, suggesting a negative effect of resident diversity on the invasibility of communities. This effect was mainly explained by differences in several traits and characteristics between resident and invader species. Strong negative correlations between residents and all invaders were found for most of our categorical species traits. These results were also supported by the GLMs, indicating that invaders similar to resident species in a plot will be less abundant. When we used only the external invaders the above patterns were weaker. In species-rich plots there were significant and higher size differences between residents and all invaders suggesting that the outcome of invasion depends on size and similarity levels. Successful invaders must be functionally different enough from residents to invade. Species-rich plots are supporting communities with a broader and more complex resident niche space and as long as the size of the local species pool is relatively small and constant fewer invaders establish. Invasibility in our plots is driven by limiting similarity and niche overlap between the initial and surrounding species pool as they seem to control coexistence and abundance of species.

Pathways of invasion of the tubenose goby (*Proterorhinus marmoratus*) into the Kuibyshev water reservoir (Middle Volga, Russia)

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Expansion of tubenose goby *Proterorhinus marmoratus* (Pallas, 1814) from its natural distribution area, observed in last decades, is caused by several anthropogenous factors. In the cascade of the Volga water reservoirs the acclimatization of this species was extremely asynchronous, i.e. the colonization of the cascade was not proceeding consistently from the south to the north (Naseka et al. 2005). This work is based on the material collected in the Kuibyshev water reservoir (the largest reservoir in the Volga cascade). The observations were performed during 2002–2007 at several sections and permanent stations in Volzhsky and Kamsky stretches of the Kuibyshev water reservoir. The samples were collected using horizontal and vertical active sampling gear.

Despite that the presence of the tubenose goby was indicated in Cheboksary reservoir (Klevakin et al. 2004) situated above stream from Kuibyshev reservoir and in the low stream of the Kuibyshev reservoir (Aleev at al. 2003), its acclimatization has not been yet completed. In particular, during our extensive investigations in 2006 we did not find this species in the Kamsky stretch. In the Volzhsky stretch we captured the species first in 2004. In the estuary part of the Svijaga gulf of the Kuibyshev water reservoir tubenose goby was captured only in 2007, but is yet to be found in the upper part of the Svijaga gulf.

The occurrence of tubenose goby has radically changed from several individuals in the beginning to the formation of big populations at the later stages of the observations. The number of specimens caught in one station in September 2005 and 2006 did not exceed 10 specimens (catch per unit effort, CPUE). In September 2007, however, the abundance of gobies at some stations was much larger, reaching 119 specimens on CPUE at maximum. Mean abundances of tubenose goby in this area was estimated as 1.0, 2.8 and 21.5 specimens on CPUE for the September of 2005, 2006 and 2007, respectively. Relative frequency of occurrence increased more than doubled, from 40.0% in 2005 to 87.5 % in 2007. Thus, the complex and long process of the establishment of tubenose goby population in the Kuibyshev water reservoir, despite of some generalizing papers (Naseka et al. 2005), is far from being completed.

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Distribution and abundance of the natural regeneration of alien and native tree species within a managed forest

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Most studies that describe invasive tree species within forests focus on areas dominated by alien species so there is a lack of information on invasive processes in larger spatial scale. The main aim of this study was to describe the distribution, frequency and abundance of alien tree species spontaneously appearing within a managed forest.

The study was conducted in the Niepolomice Forest, Poland (50°02' N, 20°22' E) in 2004–2005. The forest is partly deciduous (dominated by common oak *Quercus robur* and hornbeam *Carpinus betulus* in the northern part), and partly mixed conifer broad-leaved (dominated by Scots pine *Pinus sylvestris* in the southern par). There were 105 permanent plots (100 m^2; one plot per ca 25 ha of a forest) established under deciduous canopy and 97 plots located within the mixed forest. At first, all plants in the plot were identified, the percentage of area shaded by overhead foliage in different layers of the forest was estimated, all young trees measured and classified into three size classes (<0.5 m; > 0.5 m but lower than 1.3 m; >1.3 m with diameter at breast height smaller than 7 cm).

The seedlings and saplings of native species grew in 70% of plots (alien species absent), while alien species occurred in 1% of plots (with natural regeneration of native tree species not observed). In almost 10% of plots there was no regeneration of tree species. In 5% of plots alien tree species regenerated and were more abundant than native species. In almost 12% of plots natural regeneration of native tree species prevailed over that of alien trees. More than 7,300 seedlings and saplings of 21 species were recorded. Only three alien species, black cherry (*Padus serotina*), red oak (*Quercus rubra*) and black locust (*Robinia pseudacacia*) were found within plots, but the number of seedlings and saplings of these alien species reached almost 10% of all regenerating tree species. There were only three stands with adult (cultivated) red oak in the overstorey tree layer and no stands with black cherry mature trees. The probability of finding a plot with regenerating black cherry or red oak was almost the same (11% and 12%, respectively), but black cherry was more frequent in stands dominated by Scots pine, while red oak under canopy dominated by common oak or hornbeam. The natural regeneration of black cherry was much more abundant than that of red oak. Extremely high values of native seedlings and saplings reached 600 individuals per plot, while for alien species it reached 144 plants.

The alien species are not markedly frequent and abundant within this area. However, although there were no mature trees of black cherry the natural regeneration of this species was very numerous.

Invasive neophytes in the Eastern Alps

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Despite the large amount of studies on different aspects of neophyte flora in Europe, we still know little about its effects in the (Eastern) Alps. What are the consequences of increasing infestation of semi-natural habitats in this region? The present study offers some answers to this question. North Tyrol (Austria) and southern adjacent region South Tyrol (Italy) were chosen as a study area. The whole area encompasses about 18,000 km^2, of which 10,600 km^2 belong to North Tyrol. Here, 80% of the area is located above 1200 m a.s.l.; however the neophyte flora is almost exclusively restricted to the area below this altitude. This results in a high concentration of neophytes in the remaining 20% of the area. The total flora of the North Tyrol consists of about 2300 taxa, of which almost 22% are neophytes.

The study focuses on the invasive taxa *Buddleja davidii*, *Fallopia japonica*, *F. sachalinensis*, *F. ×bohemica*, *Impatiens glandulifera*, *I. parviflora*, *Senecio inaequidens*, *Solidago canadensis* and *S. gigantea*. Based on the data from the biotope mapping of North Tyrol (initiated by Tyrolean provincial government, done by Institute of Botany, University of Innsbruck), the North Tyrolean floristic database (Tiroler Landesmuseum Ferdinandeum, W. Neuner) and the data from the South Tyrol collected by Wilhalm et al. (Naturmuseum Bozen), semi-natural habitats infested with neophytes were selected, and 683 pairs of infested and not infested sites of the same biotope type were studied during 2006– 2007. Flora and vegetation of the study sites were analysed floristically and by using the Braun-Blanquet scale.

The competitive taxa like *Fallopia japonica*, *F. sachalinensis* and *F. ×bohemica* cause the most dramatic decrease in plant diversity. The *Fallopia* cover of about 75% and higher almost completely inhibits the establishment of herb layer. This is particularly noticeable along the rivers and streams in the east of the North Tyrol (Lower Inn valley). In addition, a high number of *Fallopia japonica* sites recorded in the past actually belong to the hybrid *F. ×bohemica*, which shows a stronger impact on diversity than its parents. *Solidago canadensis* penetrates into semi-dry and dry grassland and causes a sharp decline in diversity. *Solidago gigantea* partly forms monocultures in alluvial forest along the valleys of Lech and Inn rivers. *Buddleja davidii* is a pioneer species on gravel benches along mountain streams and crushed rocks. In addition to these sites, the presence of neophytes was isnpected in another 137 randomly selected habitats (listed as valuable“biotop” in North Tyrol). More than 50% of sites are invaded by at least one of the invasive taxa mentioned above.

Factors determining spread of an invasive species *Pinus strobus*

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Understanding spatial dynamics of invasion in a specific landscape requires knowledge of landscape structures (such as different numbers, sizes and connectivity of patches that can be invaded), local population dynamics of the species and dispersal ability of the species. The aim of our project is to build a spatially explicit landscape level model of spread of an invasive tree species, *Pinus strobus*, in a sandstone area in the Czech Republic. To parameterise the model we collected detailed data on current distribution of the species in the landscape, distribution of habitats suitable for the species in the landscape, data on population dynamics of the species and on its ability to disperse.

The results revealed a high number of suitable but still unoccupied habitats in the landscape that are still available for invasion. The species displayed a high local population growth rate supporting its high ability to spread. Our data also indicate that the species can disperse far from seed trees (up to 750 m) supporting the fact that the species has high potential to continue spreading by a relatively fast rate. By combining all this information we are able to predict the rate of spread of the species in each particular area and evaluate the relative importance of the input parameters for the observed rate of the spread. We are also able to identify which populations are the most important sources of invaders and should thus be preferentially removed and habitats that are most endangered by the invasion and should thus be preferentially monitored to stop the invasion in early phases.

Habitats in the native distribution range as predictors of the invasion success of alien plants

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This study focuses on the role of habitats occupied by 282 Central European neophytes (alien plants introduced after 1500 A.D.) in their native distribution range and asks which native habitats donate most alien species, what is the correspondence between habitats occupied by species in their native and invaded distribution range, and what is the invasion success of species originating from different habitats? Most likely to naturalize are species associated in their native range with thermophile woodland fringes (81%), cultivated areas of gardens and parks (75%) and broad-leaved deciduous woodlands (72%). The largest proportions of invasive species recruit from those that occur on riverine terraces and eroded slopes, or grow in both deciduous woodland and riverine and lakeshore scrub. When the relative role of habitats in the native range as determinants of the probability that a species becomes invasive is assessed in concert with other factors (species' residence time, life history, region of origin), the direct effect of habitats is negligible. However, effect of native habitats on patterns of invasions observed in Central Europe is manifested by large differences in numbers of species they supply to the invaded region. More than 50 neophytes recruit, respectively, from dry grasslands, ruderal habitats, deciduous forests, inland cliffs, rock pavements and outcrops, and tall herb fringes and meadows; these habitats also donate the highest numbers of invasive species (7–13). Casual species recruit from a wider range of habitas in their native range than they occupy in the invaded range; naturalized but not invasive species inhabit a comparable spectrum of habitats in both ranges, and successful invaders occupy a wider range of habitats in invaded than in native range. This supports the idea that invasive phase of the process is associated with changes in biological features which allow extension of the spectrum of habitats invaded.

Common sunflower (*Helianthus annuus* subsp. *annuus*) on arable land in the Czech Republic

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Common sunflower (*Helianthus annuus* subsp. *annuus*) is recorded in the Czech Republic since the 1960s. This species occurred mostly as a ruderal on railways and river ports. It was reported twice on arable land but its presence was only temporary. In 2004, we found a dense population of common sunflower on arable land. It could become a problem weed in sunflower crops due to the non-availability of a selective herbicide; as a weed, this species could infest other crops, which currently suffer from volunteer sunflower occurrence, such as maize, beet or soybeans

Common sunflower is self-incompatible and thus hybridises with sunflower. Thus, common sunflower can receive crop genes, including potential transgenes and act as a transgene reservoir. Common sunflower flowers late in the season, when flowering of sunflower crop is already over. But when volunteer sunflower plants are present, this temporal isolation is broken. In our tests realised in 2006, commercial sunflower variety Alexandra produced flowers from 6 July to 3 August, while common sunflower, grown on the same location, produced flowers between 27 July and 28 September. There was only a short overlap in both flowering periods when less than 10% of plants flowered in the same time. However, the situation is completely different when compared with flowering of volunteer plants of hybrid origin. These morphologically and phenologically variable group included plants with different flowering time resulting in total flowering period from 13 July to 7 September, covering the major parts of flowering periods of both crop and common sunflower. Thus, volunteer sunflower plants can act as a bridge making gene exchange between crop and common sunflower possible, which can become a big problem if transgenic cultivars are planted.

Crop-wild-weed complexes are not too common in Central European agriculture as the majority of crop species have no close relatives in indigenous flora of this region. But in last decades, weedy forms of crop species were unintentionally introduced in agrophytocoenoses making weed management more complicated. The best known is the case of weed beet, which causes yield losses in sugar beet stands. Another example is weedy proso millet acting as a weed in many wide-row crops. In the near future, the same situation could arise with the common sunflower. In Central Europe, common sunflower is still a rare adventitious species. It can act as a weed in crop stands of sunflower, where it cannot be managed chemically. In areas with higher acreage of sunflower crop, common sunflower can become a problematic weed.

Invasive crustacean species in Croatian section of the Danube and Drava rivers

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Within last several decades European rivers have been invaded by numerous non-indigenous species (NIS). As presence, distribution and impact of invasive aquatic species in Croatia is mostly unknown, a project aimed at determining invasive species status has recently been initiated at the Department of Zoology, Faculty of Science, University of Zagreb. This work presents initial results of the research on distribution of invasive crustacean fauna in Croatia.

Research was conducted at the Croatian section of Danube river (10 locations) and its tributary, river Drava (12 locations). Information on distribution of non-indigenous crustaceans has been gathered for the total of 27 sites (research and literature data for respective rivers). Baited LiNi traps and hand search were used for crayfish sampling and benthos nets for macrozoobenthos sampling. Literature data on invasive freshwater crustaceans in the respective rivers in neighbouring countries were also inspected in order to detect potential records in bordering areas.

Altogether we recorded 10 non-indigenous invasive crustacean species: one decapod, five amphipods, one isopod and three mysidacea species. In the Danube river non-indigenous crustaceans were recorded at all sites, while in Drava they were recorded up to the 212th kilometre from river mouth. The spiny-cheek crayfish (*Orconectes limosus*) was caught only in the Danube and its smaller tributaries in the area of Nature Park Kopacki rit. The most widespread NIS was *Dikerogammarus villosus* (recorded at 17 of 27 sites). It was found at all sites in the main course of the Danube river, and at all sites in Drava River up to 212th kilometre upstream. At the most upstream site of its record, it coexists with the native species *Gammarus roeseli*.

It is assumed that at examined Danube sites, *Orconectes limosus* has significantly reduced or displaced populations of native narrow-clawed crayfish (*Astacus leptodactylus*), which has not been recorded by our sampling. Following the defined size classes for *O. limosus*, caught specimens were 3–4 years old, which indicates that the population has been established in the area for at least 5 years. Since one of the records was only 3 kilometres downstream from the confluence with Drava, there is a potential risk of *O. limosus* spread to Drava watercourse.

Plant invasions in floodplain habitats of lowland rivers: a case study from the south-eastern Czech Republic

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Riparian systems show one of the highest proportions of non-native species in the current landscape. Common explanation is that vegetation along watercourses is affected by specific processes, e.g. frequent disturbances, high propagule pressure and a long history of human impact. However, very few attempts were made to to compare the occurrence of invasive species in different vegetation types in river floodplains, although this is important for understanding of the invasion process in riparian vegetation and also has implications for invasive plant management.

This study provides such comparison and determines the relationship between non-native species and selected landscape characteristics. Two segments of the floodplains of the Dyje and Morava rivers (about 90 km of river courses) were sampled in the south-eastern part of the Czech Republic. Stratified random sampling design was used to avoid subjective choice of sites with invaded vegetation. Thus, the results are supposed to show undistorted pattern of plant invasion among plant communities. The sampling plots (in total 135) were stratified according to the habitats types of the Natura 2000 habitat mapping and inundation maps (floods occurring once in 20 and 100 years). Main types of vegetation and presence of invasive species were estimated in the circles with 100 m diameter around each plot. Specific features of adjacent landscape (roads or watercourses) were also recorded.

Habitats with the highest proportion of invasive species, neophytes and archaeophytes, were ruderal sites and forests clearings, i.e. those with the most distinctive disturbance regime. Neophytes had stronger affinity to woodlands and associated habitats like tree plantations or forest clearings, whereas archaeophytes occupied semi-natural vegetation like mesic and alluvial meadows. The most successful species were: *Aster lanceolatus* s. lat., preferring forest clearings; *Acer negundo*, dominating the non-native tree plantations; and *Solidago gigantea* in ruderal vegetation.

Significant positive correlation between the numbers of archaeophytes and neophytes was found across all habitats, which suggests that habitat types prone to invasion of one species group are also suitable for another one. The number of invasive species increased in plots with more invasive plants in their surroundings. Regression trees revealed that habitat type was the most important factor separating plots with high and low numbers of archaeophytes, neophytes and invasive species. For the subset of invasive species, the second most important factor was flood frequency; significantly higher proportion of invasive species was found in plots from areas, which are frequently flooded. Archaeophytes were more abundant in plots located closer to roads and the proportion of neophytes increased with frequent inundations. These results indicate that certain floodplain habitat types are at a higher risk of plant invasion; especially when exposed to repeated inundation in a short time period.

New records of neophytes from the "Ruhrgebiet", a hotspot of alien species in Germany

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Based on numerous investigations the urban agglomeration "Ruhrgebiet" (Northrhine-Westphalia) is regarded as one of the most important hotspots of alien species in Germany (e.g. Weiss et al. 2005, Keil et al. 2007). Remarkable recent records of new aliens concern mostly ergasiophygophytes (plants escaped from cultivation): *Adiantum raddianum* on walls, *Ambrosia trifida*, *Miscanthus sinensis*, *Rodgersia podophylla*, *R. aesculifolia*, *Chaerophyllum byzantinum*, *Nasella tenuissima*, *Phytolacca esculenta* in nitrophilous ruderal vegetation, *Sauromatum venosum*, *Pachysandra terminalis*, *Aucuba japonica*, *Euonymus fortunei*, *Lonicera henryi*, *Hedera colchica* along forest edges, *Onoclea sensibilis*, *Lysichiton americanus* in semi-natural forests (Fuchs 2008), and *Quercus cerris*, *Viburnum rhytidophyllum*, *Arum italicum* and *Trachystemon orientalis* in urban industrial forests and brownfields.

The high abundances of alien species within this region are associated with numerous gardens and public greens, great human population and high habitat diversity, including industrial wasteland. The enormous area of former industrial sites in different successional stages, dense network of traffic and streams, consisting of the rivers Rhine, Ruhr, Emscher, Lippe and the Rhein-Herne-Channel, as well as existing ancient forests promote the the establishment of alien species.

Numerous casual alien species, epecophytes (naturalized only in man-made habitats) and agriophytes (naturalized in natural/semi-natural vegetation are reported (Düll & Kutzelnigg 1987). Many of these epecophytes and agriophytes are close to naturalization and deserve closer attention to prevent their dispersal.

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Freshwater invasions in Great Britain: looking to the future through a review of past invasions

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Non-indigenous freshwater species have caused large ecological and economic impacts to Great Britain over the last two centuries. In response, a number of policy and management initiatives have been launched to prevent further establishments and to reduce the impacts of those already present. Here we have assembled the first list of all non-indigenous freshwater species known to be, or to have previously been, established in Great Britain, their date of first record and vector of introduction. This provides the necessary base-line data for assessing the success of new policies.

A total of 115 non-indigenous freshwater species are currently established in Great Britain; a further 18 species were once established but are now extirpated. Between 1800 and 2000 the number of species increased at an accelerating rate, correlated with growth in human population and GDP. Although the construction of large reservoirs in Great Britain occurred over a short period, this overlapped with high rates of new species establishment, indicating that habitat modification, as well as socio-economic factors, may have been an important driver of species establishment. Non-indigenous species now account for 20% of fish, 12% of plant, 54% of amphibian and 88% of decapod crustacean freshwater species richness in Great Britain. The ornamental trades have been the vector of introduction for the greatest proportions of both intentionally (72%) and unintentionally (37%) introduced species. Great Britain is a wealthy island region and thus has a high potential for preventing the arrival and establishment of further invasive species. Ways in which our data could enhance new policy are discussed.

Alien species of mammals in ecosystems of Russia

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The main criterion to classify mammal species as alien was the extension of their distribution areas. There are 62 mammal species registered as alien in Russia. The order Rodentia accounts for 42% of alien species, Carnivora for 25.8%, Artiodactyla for 14.5%, while other orders are insignificantly represented (Soricomorpha, Lagomorpha, Chiroptera, and Erinaceomorpha). Twenty-five percent of alien mammal species stay close to places of introduction, 50% occur only in certain regions and 25% are aliens in many parts of Russia. The invasion of most alien mammal species occurred in the 20th century. Archeoinvaders (introduced before the 18th century) include real synanthropic species: *Mus musculus*, *Rattus norvegicus, R. rattus*, and agrophilous rodents: *Microtus arvalis* and *M. levis*. Nowadays all these species are common inhabitants of vast territory of Russia.

The penetration of alien mammals into new areas is different. We discuss four possible ways: intentional introductions, reintroductions, accidental introductions and self-spreading. Intentional introduction is deliberate delivery of animals outside their native area (20 species in Russia). For the past decades, mammals were more often introduced for protection purposes, e.g. *Mustela lutreola* and *Desmana moschata*. As a result of intentional introduction, five new species appeared in the fauna of Russia (*Ondatra zibethicus*, *Neovison vison*, *Procyon lotor*, *Castor canadensis* and *Oryctolagus cuniculus*). *Nyctereutes procyonoides*, *Cervus nippon*, *Sciurus vulgaris*, *Desmana moschata* and *Lepus europaeus* are alien in regions far from their native distribution areas. Reintroduced mammal species (14 in Russia) differ from those described above by lower impact on ecosystems. *Bison bonasus* and *Ovibos moschatus* were reintroduced after they had completely disappeared from Russia; *Marmota bobak*, *Castor fiber* and *Martes zibellina* after disastrous reduction in their numbers, considerable decrease and fragmentation of distribution areas. Nowadays the historic distribution of these species is almost restored. There are 10 mammal species in Russia accidentally introduced outside their native areas. *Crocidura leucodon*, *Suncus murinus* and *Suncus etruscus* are sometimes introduced into Russian ports. *Myodes rutilus* was accidentally introduced to the Komandor Islands. The secondary distribution area of *Mus musculus*, *Rattus norvegicus* and *R. rattus* is much larger than the native one. These species increased their distribution tanges with the help of humans and are considered dangerous alien species in various countries of the world. Most alien mammal species (42) have extended their areas by themselves, penetrating into new places outside their native distribution or places of introduction. This holds for *Sus scrofa*, *Alces alces* and agrophilous rodents in particular.

Alien species were classified into three groups: (i) Real synanthropic species, causing great damage and with impact on humans and domestic animals; (ii) agrophilous rodents, known as field vermin. (iii) Alien mammals introduced in natural ecosystems differ in their impact on natural biota. *Castor fiber*, *Ondatra zibethicus*, *Nyctereutes procyonoides*, *Canis familiaris*, *Neovison vison* and *Sus scrofa* are very dangerous in most regions.

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Assessing climate change induced invasion risk of protected areas: a case study with black locust in Austria

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Designation of protected areas in order to regulate human land use and assure persistence of endangered ecosystems and habitats for endangered species is nowadays a common policy. One unresolved problem associated with static networks of nature reserves is that they do not account for spatial and temporal variation in ecological processes and ecosystem properties and disregard the dynamic nature of species ranges. The latter aspect is especially relevant in the face of large-scale environmental changes like global warming which will potentially shift the distribution of suitable habitats for many species, natives and aliens, along latitudinal and altitudinal gradients.

Climate warming may not only drive endangered species out of reserves but might also foster the invasion of exotics into protected areas. This might especially be the case in temperate regions like non-Mediterranean Europe where the current distribution of many alien plants, in particular, is thought to be mainly limited by climatic constraints. If these exotics compete with the species to be protected, or alter habitat quality and ecosystem functioning, a climate warming driven range expansion into yet un-invaded reserves might hence further devaluate the long-term conservation value of such areas.

In this case study, we chose North American black locust (*Robinia pseudacacia* L.), which is one of the most problematic alien plants in Europe. Introduced during the 17th century, it has now become naturalized throughout the warmer regions of the continent and invades nutrient-poor dry and semi-dry environments. Due to its symbiotic nitrogen fixing nodule bacteria establishment of black locust in previously nutrient poor habitats modifies nutrient circles and increases productivity sustainable. Therefore, species composition in affected sites is seriously altered and seldom species with high conservation value are likely to disappear.

Here we show how predictive species distribution models (SDM) can be linked with spatial distribution and size of protected areas (designated Natura 2000 areas), to assess current and future invasion risk for reserve networks. In an “ensemble forecast” we simultaneously applied four different regression techniques for modelling species distribution. To account for differences in recently published climate change (CC) scenarios we used four different combinations of Global Circulation Models (GCM) with emission scenarios to predict potential habitat patterns, i.e. infestation probabilities (IP), of black locust for the years 2050 and 2080, respectively.

Averaging across the four SDMs used, proportion of highly endangered areas within the Austrian Natura 2000 network could be calculated for all CC-scenarios. Currently, ~34% of Natura2000 areas (~4.031 km2) represent suitable habitats for black locust. Models indicate an increase between 6% and 8% by the year 2050, depending on the CC-scenario used. The influence of the CC-scenario is even more accentuated when looking at the year 2080: 8% to 17% area increase.
We discuss the advantages of “ensemble forecasts” as well as the differences in prediction results due to the CC-scenarios in use. Furthermore, we highlight the application potential of this approach for assessing the invasion risk of nature conservation reserves.

The alien shrub *Rosa rugosa* in a near-natural coastal landscape: reconstructing and predicting invasion patterns

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Little is known about establishment and vegetative expansion of invasive alien plants at a landscape scale. This knowledge is necessary to predict future invasions and to improve management recommendations. We chose the alien shrub *Rosa rugosa* in coastal dunes of NW Denmark (2354 ha) for reconstructing patch establishment and growth over a period of 50 years, and for predicting future invasion over 30 years. In this area related studies on seedling establishment (Kollmann et al. 2007) and distribution of *R. rugosa* patches in relation to landscape variables have been done (Jorgensen & Kollmann 2008). All *R. rugosa* patches were GPS-mapped in 2004, and five series of aerial photographs were used for reconstructing the invasion process. *Rosa rugosa* invaded the study area after 1949; most patches established after 1989, and establishment has increased exponentially. In the period 1984–2004, the establishment rate was 0.02 patches.ha^{-1}.year^{-1}. *Rosa rugosa* occurred clumped, and 94% of the patches had a distance of <50 m to the nearest neighbour in 2004. Area increment by vegetative growth was on average 16.4% per year, and it decreased exponentially with patch size. In 2004, the species had invaded 0.3% of the study area. If only vegetative expansion of existing patches is considered, the species will cover 3.9% by 2034, assuming current environmental conditions and no management. When including establishment of new patches, species cover will increase to 9.5% in 2034 (Figure 1). This invasion will have considerable negative effects on biodiversity in the coastal dunes which are designated as the first national park in Denmark. The results are discussed with respect to improved monitoring, modelling and control of invasive alien plants.

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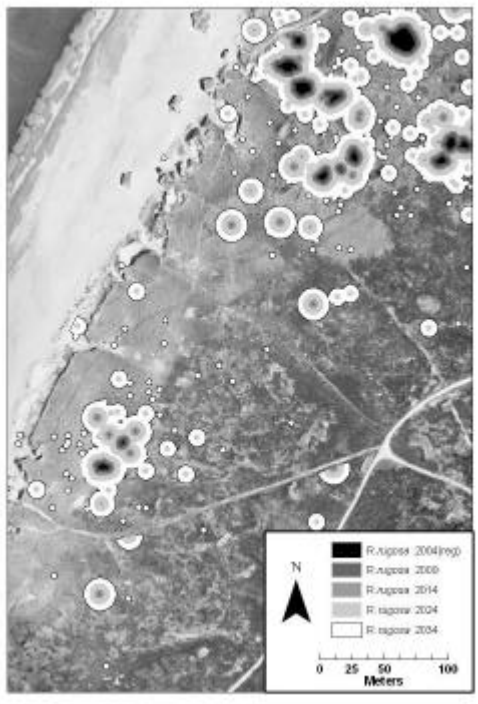

Figure 1. Modelling vegetative expansion and establishment of new patches of *Rosa rugosa* (2004–2034) in the central parts of the dunes of NW Denmark (aerial photograph 2004, COWI).

Is south Poland threatened by invasion from *Lycopersicon esculentum*?

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Lycopersicon esculentum Mill. (Solanaceae) is native to South America. It is not known from the wild but probable area of its origin is Ecuador and Peru. It was introduced into Poland in the 18th century and currently it is a very usable popular plant. *Lycopersicon esculentum* is an annual plant, with long vegetative period and high temperature requirements. It has a branching stem, up to 150 cm, with divided leaves. Its five-fold flowers are gathered into umbellar twisted inflorescens. It produces big red, round and juicy berries. The species prefers urban sites and is mainly dispersed by wind, water and humans (Tokarska-Guzik 2005). In the Czech Republic *L. esculentum* is a casual neophyte (Pyšek et al. 2002). It is considered as invasive species on the territory of Lithuania (Gudžinskas 1998). However, in Poland it is considered as a kenophyte (neophyte) growing in human-made habitats. Because it is becoming more frequently recorded, we suppose that it may be potentially invasive in the south of Poland.

We analysed botanical records from 1974 up to now, using published and herbarium materials, in order to describe frequency and distribution of *L. esculentum* in the wild and define its habitat preferences. Moreover, we undertook a pilot survey in areas with favourable conditions for the spread of this species. We collated 30 records of *L. esculentum* in the south of Poland, gathered information about vascular plants occurring in this region and analyzed the range of the occupied habitats. *Lycopersicon esculentum* occurs mainly in human-made habitats: urban areas, roadsides, track-ways, dumps, ruins and agricultural sites. Furthermore, it also occurs in natural and disturbed riparian habitats.

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Weed coevolution as a predictor of migration success: diversity and biogeography in smallholder maize fields of Mexico and Zimbabwe

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Evolutionary history has not been examined sufficiently as a criterion for predicting migratory success. Theory predicts and some empirical data suggest the areas of origin of a crop to be the general area of origin of coevolved weeds. These longer-evolved weeds would have an advantage over species with a shorter evolutionary time in the agroecosystem, and migrate more successfully. It is well-known that many European weeds have a Near Eastern origin, and then accompanied European agriculture to other parts of the world, but data are scarce for other crops and systems. We compared two regions with a shared crop, traditional, small-scale agriculture, similar physiographic traits, but little direct contact, one of which is the area of origin of the crop (Mexico). The species richness, diversity and biogeography of the maize weed flora was compared between two rural villages each of Oaxaca, Mexico, and Honde Valley, Zimbabwe. The Mexican maize fields had a higher species richness and diversity than the Zimbabwean ones. Species richness and densities were higher in the villages that receive more rainfall. Mexican fields had almost 80% American species and very few weeds of African origin, whereas Zimbabwe had 32% of American and half of African origin. These data support the hypothesis that origin matters.

First observation and reproduction record of the zebra mussel *Dreissena polymorpha* in Lough Neagh

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The zebra mussel *Dreissena polymorpha* (Pallas, 1771) was first observed in Ireland in 1997 on the lower part of the navigable Shannon system (McCarthy et al. 1997) although it is believed that the species may have arrived in 1994 (Minchin & Moriarty 1998). Since this time the species has been spreading throughout Ireland aided by anthropogenic activities. Following the observation of 5 adult specimens of *D. polymorpha* on the hull of a boat moored in Kinnego Marina, Lough Neagh in 2005, a preliminary investigation was undertaken to assess whether zebra mussels were present throughout the Lough. Before this time Lough Neagh was believed not to be infested with *D. polymorpha* (Maguire & Sykes 2004). Lough Neagh is the largest freshwater lake in the United Kingdom. The Lough is in an advanced state of eutrophy having shifted from a mesotrophic state during the early part of the twentieth century as a result of agricultural expansion and intensification in the surrounding areas. The Lough is a prime example of near natural habitat and as such is subject to a variety of environmental listings and conservation designations including: Area of Scientific Interest (1965 re-designated ASSI 1992), RAMSAR site 1973 and Special Protection Area 1998.

A preliminary investigation found 44 settled juveniles on debris collected from 20 sites around the Lough Neagh shore. No adults were observed and no plankton sampling was carried out. As a result of these findings a more comprehensive study was undertaken in October 2006 in order to determine if a breeding population of *D. polymorpha* had become established within Lough Neagh. The aim of the investigation was to assess the current status of the zebra mussel in Lough Neagh by observing the species at the dispersal, settlement and post-settlement stages of their life cycle. Plankton tows, spat collection and shoreline surveys were carried out. Veliger larvae were found for the first time, in the plankton in Lough Neagh, in October 2006. Densities of 0.021 veligers per m^3 were observed. Spat collectors showed settlement at 6 out of the 7 sites sampled at a mean density of 523.8 juvenile zebra mussels per m^2. No adult zebra mussels were found on natural substratum in the Lough during the shoreline survey. However 24 adult zebra mussels were found on the hull of a boat moored in Lough Neagh. These adults ranged in size from 7.5 to 24 mm. Projections on likely introduction time were made based on predicted age of the adult zebra mussels. Introduction time is estimated to have been between late 2002 and early 2004. The data collected during the study suggests a breeding population of zebra mussels is present in Lough Neagh and provides unique baseline data for future study in monitoring of the zebra mussel spread.

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Non-indigenous land snail *Monacha cartusiana* in the Czech Republic

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Non-indigenous land snail *Monacha cartusiana* (O. F. Müller, 1774) is spreading from its original range in the Mediterranean to the Western and Central Europe. The number of populations recorded in the Czech Republic has significantly increased especially in the last 15 years, which makes this species a good model for evaluation of factors facilitating the invasiveness of land snails.

The distribution of xerophilic invertebrates certainly changes. Nowadays, some of them inhabit larger areas in the northern parts of Central Europe than 50 years ago. Can we regard the occurrence of *M. cartusiana* as an invasion? Phylogenetic and phylogeographic analysis of *M. cartusiana* populations in comparison with other related species assess the intraspecific diversity and test the hypotheses about origin of newly established populations.

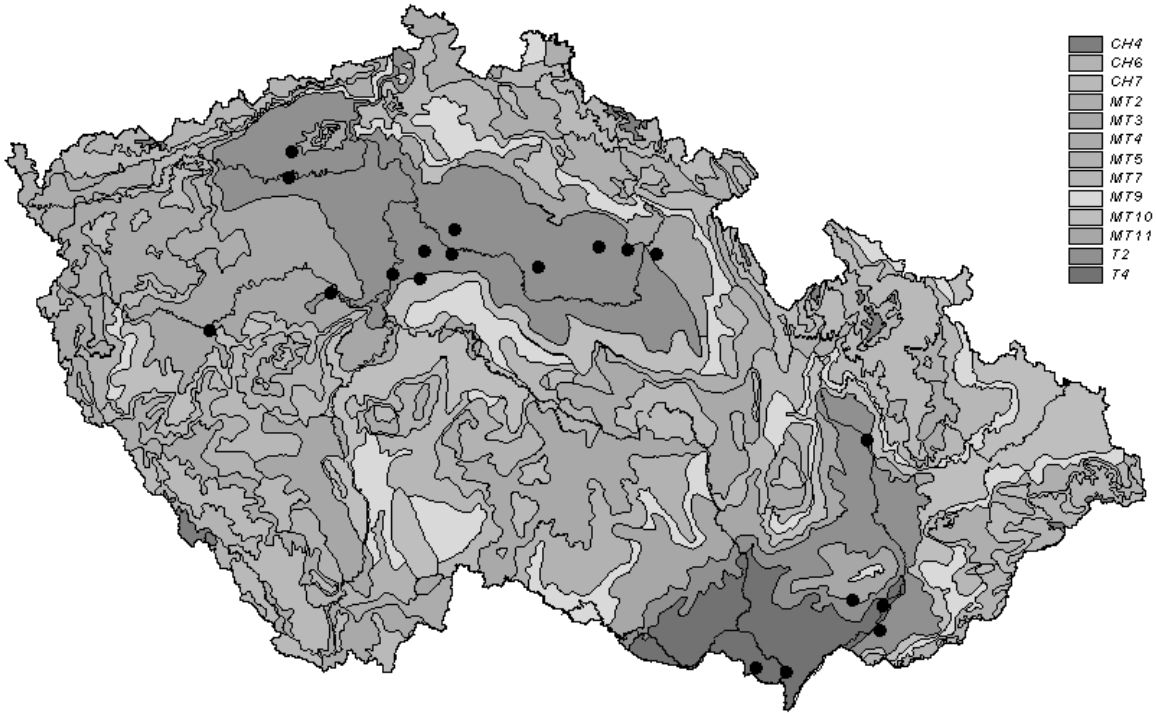

Figure 1. Distribution of *Monacha cartusiana* in the Czech Republic (2007). Climatic regions of CZ: dark (T4, T2) = warm areas; light (CH4-CH7) = cold areas; point = occurrence. © Quitt et al. 1971, Míkovcová 2007.

Invasive alien plants in Croatia: a case study in the city of Zagreb

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Invasive species are nowadays recognized as the second most important cause of biodiversity loss, just after direct habitat destruction. Besides the conservation point of view, invasive alien plants have a strong negative environmental and economic impact. In addition, some species pose a great problem to public health (e.g., allergenic plant *Ambrosia artemisifolia* L.).

According to Inventory & Monitoring Protocol – Invasive Alien Plants (IMAP Programme) we started with preliminary plant IAS actions in Croatia and prepared (first Survey Level): (i) national criteria and standards for terminology and categories for alien flora (harmonized with European as well as global standards) and (ii) preliminary list of invasive alien plants for Croatia. This should be a good basis in preparation of next actions against IAS in Croatia, e.g. monitoring and prevention. As there is no organised effort in IAS monitoring on the national level, we started with case studies of invasive alien plants throughout continental and mediterranean parts of Croatia. Here we present preliminary plant IAS inventory for the the biggest, capital city of Croatia: the city of Zagreb in the continental part of the country. Plants data are incorporated within the special part of the Flora Croatica Database (http://hirc.botanic.hr/fcd/InvazivneVrste/Search.aspx) and are available as standard taxon sheets for each taxon with automatic generation of distribution maps. Here we present the most important and/or most widely distributed taxa. Such monitoring is actually a part of the second Survey Level (Reconnaissance) recommended by IMAP Programme and could be used by local and national authorities for further actions against IAS.

Taxonomically problematic plants native to Eastern Europe and invasive in North America: case studies, research priorities and implications for control

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Clear understanding of taxonomic patterns of invasive or potentially invasive plant species is crucial for predicting and controlling their invasions. However, despite research focus on invasive plants, there are still many unresolved taxonomic and nomenclatural issues, including those concerning plants invasive in North America and native to Eastern Europe and adjacent areas. Sometimes these problems result from nomenclatural misunderstandings, while in other cases the taxonomic and nomenclatural discrepancies reflect profound specific and infraspecific differentiation processes within native ranges of invasive species.

An analysis of official US and Canadian lists of invasive plants revealed at least 110 most important taxa with native ranges in or partly covering Ukraine and adjacent areas of Eastern Europe. Of these taxa, at least 15% of species or species aggregates of several genera can be considered highly problematic taxonomically. Several case studies are considered in more detail.

Vincetoxicum rossicum (Kleop.) Barbar. is a highly invasive species in North America; however, identification of North American plants remains uncertain because of existing taxonomic problems with its East European congeners, and especially peculiarities of *V. rossicum* within its native range (limited distribution, restricted habitats and other ecological features). It seems also that the nomenclatural type of *V. rossicum* at KW does not fit perfectly the characters of North American plants. Several problematic species of *Vincetoxicum* were recently described from SE Ukraine, which further complicated the taxonomic situation.

Introduced plants in North America are often known under widely circumscribed or even misapplied names, while their precise taxonomic identity remains unknown or ignored. *Euphorbia esula* L. (sensu latissimo) is a well-known example of a highly polymorphic aggregate. Opinions vary greatly as to the number, circumscription and distribution of species in that group, and proper identification of introduced races remains tentative. A widespread invasive knapweed species was mostly known in North America under the misapplied name "*Centaurea maculosa*"; currently it is treated as *C. stoebe* L. subsp. *australis* (Pancic ex A. Kern.) Greuter (*C. micranthos*, *C. biebersteinii*); nomenclature of its hybrids is unresolved. *Carduus nutans* aggregate is also represented in Eastern Europe by several morphologically and geographically different but intergrading entities.

For such taxonomically problematic taxa, concerted international and multidisciplinary efforts are needed, involving diverse methods: from traditional "herbarium taxonomy" and nomenclatural research to ecological and phytosociological, biogeographical, molecular phylogenetic, and phylogeographical studies involving sampling from various parts of both native and non-native ranges of species in question. In Ukraine the areas crucial for sampling and studying taxonomically problematic groups of native plants behaving as invasive elsewhere are located mostly in the steppe and forest-steppe zones, especially in the south-eastern and central parts, and also Crimea; plus adjacent areas of Russia down to the the Caucasus. These physiographic zones are comparable by local climatic, vegetational and other features to some North American regions most invaded by our target species, in particular, the Great Plains, Prairie Provinces of Canada, with some species also established in other regions (Atlantic Northeast and Pacific Northwest, the Rocky Mountains and the Great Basin).

First record of *Bucephalus polymorphus* (Digenea) from Austrian waters

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The digenean *Bucephalus polymorphus* Baer 1827 is a holarctic fish parasite, which has been reported from various sites and hosts. Its life cycle includes two intermediate hosts and a final host. The first intermediate host is the bivalve *Dreissena polymorpha*, where cercariae of *B. polymorphus* develop, showing the highest intensity of emergence from June to October (Batturo 1977). Cyprinid fishes have been reported to be the most important second intermediate hosts, but metacercariae were recovered from other fish taxa as well. As the final host a variety of piscivorous fish have been described, amongst others percidae and siluridae (Bauer 1987). There are several reports of *B. polymorphus* amongst others from east Europe and Germany, but there has not been any record of this parasite from Austrian waters before.

The round goby *Apollonia melanostoma*, syn. *Neogobius melanostomus* (Pallas), has been reported as an intermediate host for *B. polymorphus*. This fish species is new to Austrian waters itself, as it has invaded the coastal region of the Baltic Sea, the North Sea and the large European freshwater systems in the 1990s from its Ponto-Caspian origin. It also reached the Great Lakes of North America during this period. Between May and October 2007 a total of 79 specimens of *A. melanostoma* from three different sampling sites of the Danube River in Austria were examined for parasites. In addition 12 bighead gobies *Neogobius kessleri* (Günther, 1861), a neozoon in Austria as well, were also dissected. The sampling sites were a basin of the port of Vienna (Winterhafen Freudenau), an artificial anabranch of the Danube in Vienna (Neue Donau) and the estuary of the Ybbs River, which is situated approximately 100 km upstream of Vienna.

The following parasite taxa have been recovered: protozoans *Trichodina* sp. and *Ichtyophthirius multifiliis*, two crustacean species *Paraergasilus brevidigitus*, *Ergasilus sieboldii* and two monogenean genera *Gyrodactylus* sp., *Dactylogyrus* sp., cystacanths of the acanthocephalan *Acanthocephalus lucii*, metacercariae of the digeneans *Diplostomum spaethaceum* and *Thylodelphys clavata* and adults of the digeneans *Nicolla skrjabini* and *Bunodera nodulosa*. As a first record for Austrian waters metacercariae of *B. polymorphus* were found on the skin and fins of the fish, with prevalences reaching up to 78%, but not from all sampling sites: they were found on fish from the Winterhafen and the Donauinsel site, but not from the Ybbs site. The reasons for the different occurrence of the parasite are unknown.

Assuming a westbound invasion of fish and parasites, it seems possible, that the fish have reached the Ybbs site, but the parasite has not yet arrived. On the other hand the different ecological situations at the sampling sites could contribute to the restricted occurrence of *B. polymorphus*: the eutrophic water situation in Vienna could enhance the occurrence of *D. polymorpha* and together with the low flow velocity at the two Vienna sites the strong development of *B. polymorphus* is facilitated, in contrast to the Ybbs site, where conditions are less antropogenically influenced.

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Occurrence of neophytes in agrophytocoenoses: a field survey in the Czech Republic in 2006–2007

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Neophytes are progressively more numerous in arable fields and their proportion significantly increased during the second half of the 20th century (Pyšek et al. 2003). According to the invasive status of neophytes, Richardson et al. (2000) distinguish casual, naturalized and invasive species. The casuals are species, which can grow and flourish in an area, but do not form self-replacing populations. Naturalized species reproduce consistently and sustain populations over more than one life cycle without direct intervention by humans. Invasive plants are naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants.

In 2006 and 2007, a phytosociological survey was carried out in selected farms in the Czech Republic located in various climate and soil conditions. The altitude varied between 200–650 m a.s.l. Observations were conducted in cereals and root-crops. Weediness was evaluated in June and July in cereals and from late July to the beginning of October in root-crops. In total, 169 phytosociological relevés were recorded, 113 in organic and 56 in conventional farms. In total, 170 weed species were found (volunteer crops were not included). The native/alien status was classified for each taxon (following Pyšek et al. 2002). For individual species, the frequencies of occurrence were calculated, based on the presence of the species in a relevé.

Among observed species, 58% were archaeophytes (98 species), 36% apophytes (61 species) and 6% neophytes (11 species). Seven neophytes are considered as invasive: *Veronica persica* Poiret, *Amaranthus retroflexus* L., *Amaranthus powellii* S. Watson, *Matricaria discoidea* DC., *Conyza canadensis* (L.) Cronquist, *Galinsoga parviflora* Cav. and *Galinsoga quadriradiata* Ruiz et Pavón. Three species are naturalized: *Datura stramonium* L., *Consolida orientalis* (Gr. et Godr.) Schrödinger and *Oxalis fontana* Bunge, and one casual: *Abutilon theophrasti* Med. Three neophytes are classified as alien expansive weeds (sensu Jehlík 1998): *Abutilon theophrasti*, *Amaranthus powellii* and *Consolida orientalis*. These species are regularly introduced into the Czech Republic, posses high level ecological adaptability and reproductive ability in synanthropic habitats, especially on cultivated arable land. In our survey, all of them occurred in low altitudes (200–350 m a.s.l.).

The following frequencies were found for individual species: *Veronica persica* 31.4%, *Amaranthus retroflexus* 18.9%, *A. powellii* 10.7%, *Matricaria discoidea* 7.1%, *Conyza canadensis* 4.1%, *Galinsoga parviflora* 3.6%, *Datura stramonium* 1.8%, *Galinsoga quadriradiata* 1.8%, *Consolida orientalis* 1.2%, *Abutilon theophrasti* 0.6% and *Oxalis fontana* 0.6%. *Oxalis fontana* occurred only under the organic farming system, while *Abutilon theophrasti* only under conventional farming.

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Contribution on invasive alien plants in the Mountains Lotru

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Situated between the Valleys of the Sadu and Lotru Rivers, the Mountains of Lotru are built of crystalline schytes of the Getic layer, which lend monotony to the relief. Jurassic limestones in the Mountains of Turcinu are also present. The main summits reach 1,700–1,800 m a.s.l. and are dominated by several higher peaks, the highest being Steflesti (2,244 m). Towards the near valleys tributary to the Lotru River and especially towards the Olt River, there is a series of secondary backs in the shape of a lower plateau (900–1,200m), corresponding to the Gornovita area.

The intensive abiotic activity, but not only that, has brought about the invasion of non-native species in natural and semi-natural degraded ecosystems in Romania. The geobotanical research in the Lotru mountains in the last years resulted in the identification of 25 invasive alien species. For each species of invasive alien plants in the researched territory, we present information on distribution, ecology and the vegetation in which tit invades. The majority of these species are ruderal. A significant number are deliberately grown for decorative and forestry purposes, especially by the employees of the forestry institutions in that area. This situation has a negative impact on natural and semi-natural ecosystems in the region studied, because the deliberate transplantations of some species were not done properly and estimated impact on the biodiversity is not taken into account. Other species were introduced unintentionally as a consequence of human negligence, when the phyto-sanitary regulations are not followed. The use of pesticides in agriculture is only accidental. Due to the unsuitable agricultural practices and use of herbicides, some segetal species spread.

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Factors responsible for the occurrence of alien plant species at the medium scale

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Based on the distribution data from the grid mapping of flora (192 grid cells of 0.52 km^2 with information on complete floristic composition) and 2076 vegetation samples from various habitats, main environmental drivers influencing the distribution of alien species in the Ještedský hrbet range (northern Bohemia) were determined using multiple regression and spatial autoregressive models. From 1089 species, 22% were non-native. Within a grid cell, 103–325 native species and 4–85 non-native (thereof 1–50 naturalized and 3–27 invasive) occurred. Variance partitioning of data responsible for spatial autocorrelation and environmental factors revealed that pure spatial effect was relatively low (from 0.5 to 1.65%). However, for environmental factors a high variance was detected (24.0% for invasive taxa and 46.8% for native) and common effect of environment and geographical position was 10% for native species and 32% for other groups. The number of alien and native species was negatively influenced by increasing altitude and forest cover, which accords with the results of an earlier study from comparable area based on species composition (Petrík & Wild 2006) or studies condcted at various scales (Petrík & Bruelheide 2006). The main factors determining the distribution of alien species were (particularly for invasive taxa) linked with migration corridors in the landscape, i.e. the length of water courses and routes in a given grid cell. Most of aliens are concentrated in disturbed and nutrient-rich non-forest anthropogenic habitats and avoid oligotrophic species-poor forests on steep slopes (e.g., fragments of species-poor acidophilous beech forests). Invasive species are scattered in various semi-natural habitats, while naturalized species are concentrated mainly at anthropogenic sites. The positive correlation between the numbers of native and alien species in a grid cell is probably due to increasing environmental heterogeneity and variability of habitats at the coarse scale studied (Chytrý et al. 2005). Nature conservation should focus on sustainable management of valuable habitats and building of artificial migration corridors in the landscape should be carefully considered.

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Time and space: can we understand patterns of invasion in Mediterranean coastal areas?

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Theory suggests that the impacts of alien species on total diversity may vary across scales, with potentially negative effects at very fine (and extremely coarse) scales, but positive effects at intermediate scales (Rosenzweig 2001). However such ideas have rarely been tested (Stohlgren et al. 2002). Historical surveys potentially provide a useful source of information to assess the impacts of alien species on native diversity; however they rarely provide sufficient spatial information to allow test of scale-specific impacts.

Here we present the results of two case studies on the French Mediterranean and Sardinian coasts. The sites were surveyed for the first time in the 1950s and have experienced intensive anthropogenic pressure over the last 60 years. We repeated the surveys in 2007 and 2008, to assess the impacts of alien species on native diversity over time and across spatial scales, by looking at the changes in alpha diversity and spatial turnover (beta diversity). We used both alien species richness and occurrence to assess the change over time, adopting a multi-scale sampling design to derive information across scales.

The first case study revealed a significant increase of alien species richness over time and a positive correlation with that of native species in both the past and recent survey, although weaker in the most recent one. Differences in slopes of the native–alien relationship across scales suggest differences in the spatial turnover of these two groups, with alien species distribution being more uniform than the native one. We will test if these patterns hold in a similar climatic area, by using the second case study. We hope that these two case studies will contribute to a more general understanding of the impacts of alien species on native diversity over time and across a range of fine to medium scales.

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Freshwater mollusc species invasive in Romania

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In Romania, the study on invasive mollusc species began with the marine ones. Invasive freshwater bivalve species were only studied from the faunistical point of view, but genetic variability of the populations of these species colonizing new habitats has not been considered. The first three specimens of *Sinanodonta woodiana* were collected from fish farms in Cefa–Oradea in 1979 (Sárkány-Kiss 1986) and represent the first record of this species in Europe. In Romania, *S. woodiana* was reported from Caras river (1998), Dobrogea (Isaccea, Harsova and Macin, 1997), the Danube Delta (1998), Zavideni dam lake, Olt river, Timis river (2000), Cerna river, including the Cerna valley at the confluence of this river with Danube (2004). Upstream and downstream of Giurgiu at the Danube river (km 480) mature and juvenile shells were recorded, but also living specimens in a population at the km 514 of Danube. Mature living specimens of *S. woodiana* were recorded in Drobeta Turnu Severin in 2005. These records from important aquatic basins confirm that this species developed stable populations in the Romanian sector of the Danube. From the analysis of present and historical data it seems that the invasion of *S. woodiana* in Romania proceeded from the Danube entrace to the country to the Danube Delta and the process did not take longer than 10 years (Sárkány-Kiss et al. 2000).

The first living specimens of *Corbicula fluminea* collected from the Romanian sector of Danube were juveniles (3–4 mm), taken from the Iron Gates area, at Berzeasca, by Skolka and Gomoiu, in the winter of 1997 (Skolka & Gomoiu 2001). Later, in 1999, living specimens were collected from the Danube, at Vadu Oii (Bij De Vaate & Hulea 2000). Subsequent reports of this species (2004 from the Danube, at Galati, 2005 from the Danube, km 929 – unpublished data) confirm the presence of some stable populations of this species in the Romanian sector of the Danube. To the date, this species was not found in the main tributaries of the Danube in Romania but in the near future, *Corbicula fluminea* will likely be found in these new habitats.

In Romania, *Dreissena bugensis* was reported from the Danube, at Cernavoda, in 2004. The species was also found by the authors in Drobeta Turnu Severin in 2005. At that time this was the most westward collecting point reported for the species in Europe.

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Impact of landscape structure on the distribution of neophytes in Latvia: an example of two areas

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In order to understand the relation between the distribution of non-native, particularly invasive plant species, and landscape patterns, two model areas in Latvia (Nature Park Abava Valley and Kemeri National Park – KNP) were explored in 2004–2007. The study areas represent typical landscape features of Latvia: Abava Valley is a relatively densely inhabited rural mosaic-type landscape while KNP is dominated by large uniform forest and bog patches, criss-crossed by roads, scattered settlements and grassland patches. All detected localities of neophyte species and their geographical coordinates were fixed. Species distribution was generalized using a regular 1 × 1 km grid, number of species within a quadrate were counted and correlated with landscape variables, e.g. cover of forest and wetland, presence and type of streams, roads and railways, cover and type of human settlements and other human-created objects (disturbed habitats and potential donor areas) within each quadrate.

Close relationshop between human affected areas and the density and diversity of naturalized neophyte species was found. In both areas roadsides, forests in the vicinity of settlements, grasslands and fallows were found to be the most vulnerable to non-native plant invasions. Landscape history plays a significant role proving that more densely inhabited and historically intensively used lands are related to higher density and diversity of neophyte species. Fragmentation of habitats and human-caused disturbances are the main reasons for scattered distribution and higher density of invasive neophytes. In some cases intentional introductions or garden throw-outs in remote areas have been the initial sources for invasions of vast areas. Long-term use of lands and comparatively high density of human settlements in Abava Valley allowed alien species to penetrate to remote areas, while in the extensively used Kemeri National Park with its large, untouched forest and bog areas most of neophyte localities are closely related to settlements and roads. Roads are significant migration corridors in both areas, while rivers are conduits of alien species only in the vicinity of intensively used urban or agricultural areas, rarely invaded in longer stretches downstream of the donor area.

Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs

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The poster presents the first estimate of the composition and structure of alien plants occurring in the wild in the European continent (Lambdon et al. 2008), based on the results of the DAISIE project (2004–2008), funded by the 6th Framework Programme of the European Union. The area of interest covered 48 European countries/regions and Israel. In total, the database contains records of 5789 alien plant species in Europe (including those native to a part of Europe but alien to another part), of which 2843 are alien to Europe (of extra-European origin). The research focus was on naturalized species; there are in total 3749 naturalized aliens in Europe, of which 1780 are alien to Europe.

The highest diversity of alien species is concentrated in industrialized countries with a tradition of good botanical recording or intensive recent research. The United Kingdom (857), Germany (450), Belgium (447) and Italy (440) are countries with the most naturalized neophytes. The number of naturalized neophytes in European countries increases with increasing precipitation but only in climatically warm and moderately warm regions. Of the neophytes alien to Europe, 50% arrived after 1899, 25% after 1962 and 10% after 1989. At present, approximately 6.2 new species are arriving each year. Most alien species have relatively restricted European distributions; half of all naturalized species occur in four or fewer countries/regions, whereas 70% of non-naturalized species occur in only one region. Intentional introductions to Europe (62.8% of the total number of naturalized aliens) prevail over unintentional (37.2%). Most aliens in Europe have a native range in the same continent; considering aliens to Europe separately, 45.8% of species have their native distribution in North and South America, 45.9% in Asia, 20.7% in Africa and 5.3% in Australasia.

The data currently available are of varying quality and need to be further assessed with respect to the invasion status and residence time of the species included. Collating an integrated database on the alien flora of Europe can form a principal contribution to developing a European-wide management strategy of alien species.

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Cameraria ohridella on the northern borderline of the distribution of its host tree

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Aesculus hipocastanum grows naturally in Asia Minor, Greece and Albania. It has been introduced as an ornamental tree in most European countries. In 1721 it was introduced to Denmark for use in gardens, parks along roadsides and even in forests. It support wildlife and is now self propagating.

The horse chestnut leaf miner, *Cameraria ohridella* was discovered in Denmark for the first time in 2002, the same year as in Sweden and England. Since then it has spread over the country with a bit slower speed compared to other European countries. The slower spread is probably due to the fact that longer distance between host trees demands more introductions before establishment.

The phenology of *C. ohridella* has been monitored by use of pheromone traps in the last five years. Three flight periods were discovered as a rule, which is more frequent than in the southern and central parts of Europe. However the last flight period takes place when foliage of the host tree is unsuitable for egg deposition or even after it has wilted. The consequence of this on the population dynamics of the leaf miner is discussed. The flight activity takes place in spite of rather low temperatures. Whether this be taken as an indication of the place of origin is also discussed.

Urban environment: the bridgehead for the establishment of alien invasive insect species depending on climate change

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With climate change invasive species introduced and established in central Europe are likely to expand their distribution range northward. Urban climate is usually a few degrees warmer than the surrounding open land. For introduced species demanding warm conditions this could make the difference between the success and failure of establishment. Examples of such insect species are given, e.g. *Pulvinaria regalis*, *Agrilus sinuatus* and *Otiorhynchus* spp. The role in early detection and consequences are discussed.

Climate change consequences on the distribution of the Ponto-Caspian species in the coastal lagoons of the Central Baltic

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Ponto-Caspian fauna crustacean species (mysids and amphipods) have been introduced intentionally in the inland reservoirs or reached the lagoons and estuaries of the central Baltic via interconnected river systems. Some of the Ponto-Caspian crustacean species (gammarid species and mysid *Hemimysis anomala*) have reached the north-eastern parts of the Baltic (including the artificial Neva lagoon), while introduced mysids *Paramysis lacustris* and *Limnomysis benedeni* are more restricted to the southern Baltic. It is expected that the distribution of Ponto-Caspian fauna is generally limited by the biotope availability, salinity and temperature. According to the latest forecasts for the Baltic climate change may result in significant sea level rise, decrease of salinity and increase in temperature, especially during winter period. Assuming these predictions a Curonian lagoon – Baltic sea circulation model was run to assess possible changes in salinity and temperature. The results obtained were collated to the available information of present distribution of Ponto-Caspian crustacean species, geographical range of population characteristics (number of generations) and experimental salinity tolerance data. The analysis revealed that the expected changes in salinity are more important factor deciding the distribution of Pont-Caspian species than the foreseen temperature variations.

Distribution of alien plant species in the Dyje floodplain forests, southern Moravia, with emphasis on *Aster lanceolatus*

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Floristic inventory of the floodplain forests along the Dyje river in southern Moravia commenced in 2006 as a part of the institutional research plan MSM 215648902/01/05/01. The aim of the inventory is to determine all vascular plant species occurring in particular parts of forest stands (segments), and among others, to monitor alien species. The total study area in 2006 was 1600 ha, divided into 480 segments. We recorded 595 species of vascular plants, including 98 woody species in the study area. We found 80 alien species; their number varied from 0 to 25 species per segment, with an average of 5.9 species per segment. Furthermore, we focused on the distribution of nine species classified as invasive in the Czech Republic: *Acer negundo, Aster lanceolatus* and related taxa, *Bidens frondosa, Conyza canadensis, Erigeron annuus, Impatiens glandulifera, I. parviflora, Populus* × *canadensis* and *Solidago gigantea*. Special attention was paid to *Aster lanceolatus* (present in more than 50% of segments) and its impact on species diversity.

Mapping of the distribution and abundance of nine plant species, serious invasive weeds in Santa Cruz, Galápagos Islands (Ecuador)

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The non-native species on terrestrial and insular environments has become a serious worldwide problem. In the Galapagos Islands, invasive plants threaten both agricultural and natural habitats, causing damage to the welfare of farmers and native fauna and flora, and affect tourism and inhabitants. Approximately 700 taxa of introduced plants were found in the Archipelago. Avocado (*Persea americana*), blackberry (*Rubus niveus*), cedar (*Cedrela odorata*), quinine (*Cinchona pubescens*), elephant grass (*Pennisetum purpureum*), guajava (*Psidium guajava*), lantana (*Lantana camara*), passion fruit (*Passiflora edulis*), and sauco (*Cestrum auriculatum*), are the most invasive plants in the agricultural zone and park area of Santa Cruz. Basic information on the distribution of these species is required to plan eradication programs and find reasons for the invasions. A tentative of mapping these species has been developed by the Galapagos National Park (GNP) in areas where the mentioned species are found. This research is proposed to map the spatial distribution and abundance of those alien plants in the Santa Cruz Island, and validate the previous results. A mobile Geographic Information System connected to a Handheld Global Positioning System (GPS) was used for plotting. Sampling territories in patches of invasive species were randomly established to take measurements of cover-abundance, according to the priorities of GNP. The determination of interactions of aliens with native species and ecosystem are also discussed; that for, information about plants' biology, phenology, and competitive ability were collected from the literature. The information and georeferenced maps of the islands were provided by the cooperation partners GNP and the Charles Darwin Research Station (CDRS). Analysis of data was done with Open Jump software with General Public License (GPL) and ArcGIS®. Multilayer analysis of all the available shape files, and interpolation by ordinary kriging of sampled points were performed to create the maps of spatial distribution of the nine invasive plants. These species are distributed according to the humidity available at determined vegetation zones. Generally, these plants prefer habitats at higher altitudes than that of coastal sites, with bigger amounts of rainfall, and close to areas influenced by humas. The maps predict areas prone to invasion by the nine alien plant species. Some issues with the possible utility of these introduced species cause conflicts when control and eradication are suggested. Nevertheless, the present results are available to the management authority of the GNP as a basis for decision making.

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Invasive arboreal species of Rosaceae family in the Daugavpils city (Latvia)

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The issue of invasive species is very important for the entire territory of Latvia. In general, 206 invasive plants are known in the state, most of them concentrated in arboreta, old rural parks, and green areas of cities. In Daugavpils, the second largest city of Latvia, this becomes an important problem. Daugavpils is situated in the south-eastern part of Latvia and compared to the rest of the country it has relatively continental climate. One of the parameters of continentality are rather large amplitude of air temperature, ranging from 36.4 to –43.2 °C in Latvia, which hinder the spread of invasive trees. This is a reason for their relatively small ranges. Distribution of invasive species in the city was recorded in 0.5 km grid cells using a GPS.

The range of species has considerably increased recently, with approximately 45 established species up to now, 19 of them from the Rosaceae family. Invasive taxa of Rosaceae in the city occur in forest stands, around cabbage-patches, cemeteries, in ruderal biotopes, along railway lines and near factories (Figure 1). The first research of invasive species in Daugavpils was carried out at the end of the 19th century (Lehmann 1985), whereas in the rest of Latvia, research had already started from the end of the 17th century. The most often encountered species *Amelanchier spicata*, currently registered in the whole city, has spread in the wild from the beginning of the 1940s. The spread of other species is slightly slower: *Cotoneaster lucidus*, *Malus domestica*, *Pyrus communis*, *Prunus domestica*, *Prunus cerasifera* var. *divaricata*, *Cerasus vulgaris*, *Aronia prunifolia*. Quite widespread are *Rosa pimpinellifolia* 'Plena', R. *rugosa*, *Sorbaria sorbifolia*, *Spiraea chamaedryfolia*, *S. media*, *S. alba*, S. × *billardii* and *S.* × *rosalba* (Suhovilo 2005). Several North American hawthorn species (*Crataegus douglasii*, *C. horrida* and C. *macracantha*) are found occasionally on edges of plantations but do not show signs of invasion. All invasive species was classified in four levels according to their invasiveness.

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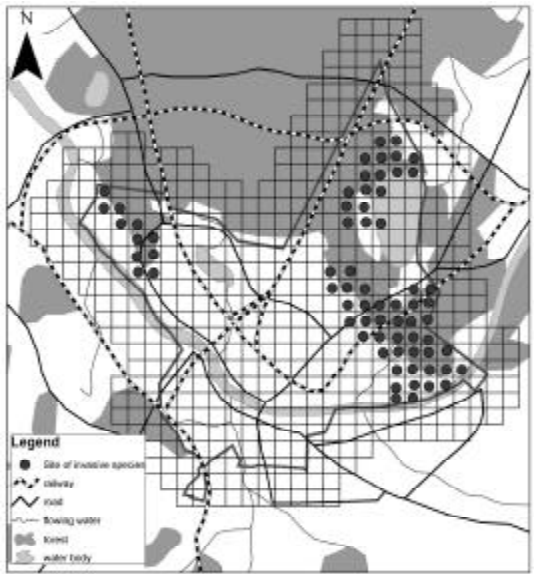

Figure 1. Location of invasive species of the Rosaceae family in the Daugavpils city, Latvia.

Widespread distribution of an invasive crustacean *Artemia franciscana* in France: morphological, genetic and morphometric data

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New parthenogenetic and sexual populations of *Artemia* were found along the French Atlantic and Mediterranean coasts. In order to determine the specific status of these populations, we used referential populations of *A. franciscana* (from USA) and *A. salina* (from Algeria, Tunisia and Egypt). We present a genetic study using the variability of the developmental caudal gene in these populations (Copf et al. 2003). In addition, morphological investigations of the frontal knob and penis using the scanning electronic microscopy (SEM) were conducted to support the molecular data. The usefulness of a third morphological trait (the ratio of spine clusters on the frontal knob) for the *Artemia* systematics is discussed in the light of a statistical analysis using morphometric traits.

This study reveals that all French sexual populations of *Artemia* belong to the species *A. franciscana* (Kellog, 1906) and not to *A. salina* (Linnaeus, 1758) accepted as a sexual native species in Mediterranean area. Recent publications from the south of Europe and north of Africa (Amat et al. 2005, Mura et al. 2006) are congruent with our conclusions. The progressive replacement of the parthenogenetic and endemic *Artemia* species by the sexual and introduced species coming from North America is fast and recently seems to accelerate. The new French *Artemia* distribution is an additional example of the impact of an American invasive species, probably introduced by humans, on European biodiversity.

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Wind and water seed dispersal of the alien tree species *Fraxinus pennsylvanica* in floodplain forests of the river Elbe, Germany

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The floodplain forests of the Middle Elbe (Saxony-Anhalt, Germany) fall under a special protection status due to their location in a biosphere reserve. Solid appearances, high dominance and advanced spreading of the alien tree species green ash (*Fraxinus pennsylvanica* Marsh.) conflicts with the preservation of the valuable floodplain forests and site typical biocenosis.

Fraxinus pennsylvanica is primarily wind-dispersed. Results about the dispersal distances (mostly long-distance dispersal) are interesting for getting an idea about the dispersal potential in the key process of the expansion of this species. For calculating seed dispersal shadows for *F. pennsylvanica* I used one part of the model 'WaldStat' (Stoyan & Wagner 2001, Wagner et al. 2004). Basically, I calculated the seed dispersal with log-normal distribution as density function and combined this model with Mises-distribution following Batschelet (1981) as an instrument to characterise dispersal directionality. In the case of long-distance dispersal (LDD) the 95th percentile was used. For green ash LDD in the anisotropic case amounts 178 m with main wind direction and only 9.3 m against this direction. The prediction for the mean dispersal distance (MDD) values 37 m. In regards to allometric relations the model calculates the number of seeds per single tree. The model estimates for a seed tree with a diameter at breast height of 40 cm is 220,000–230,000 seeds.

Water dispersal is an additional pathway in floodplain forests. Hydrochory as a secondary dispersal may exceed the results and patterns of wind dispersal. The trait buoyancy (floating capacity) is an indicator parameter for the potential of a species to be dispersed by water. The numbers of floating seeds were carried out at the intervals 5 min, 1 hour, 2, 4, 6, 9 hours, 1 day, 3 days and 1 week (after Van Diggelen & Boedeltje in Knevel et al. 2005). Mean floating capacity was determined when 50% or 90% of seed have sunk. The evaluation was done with a logistic function. The comparison between common ash and green ash shows that seeds of green ash are able to float four times longer (t_{50} = 53.5 h) than seeds of common ash (t_{50} = 12.4 h). This was the first demonstration of hydrochory for *F. pennsylvanica*.

The dispersal provides opportunity for recruitment in new locations, but without suitable conditions for germination and establishment the invasion will not be successful. Germination experiments showed that seed contact with water can change the germination response and affect the establishment chances of new individuals after seed travel in water. These results make it possible to estimate the possible spreading success of green ash.

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Spread of alien invasive *Impatiens balfourii* in Europe and its temperature, light and soil moisture demands

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Impatiens balfourii was introduced in the beginning of the 20th century from the Himalayas to southern Europe where it was able to establish. In recent years an increasing number of more northern situated occurrences were found. An overview of the current distribution of *Impatiens balfourii* in Europe is given and new records for Germany are presented. To explore the range of potential habitat conditions, vegetation relevés and autecological experiments were conducted. Gas exchange measurements showed an optimum of net photosynthesis at 25–35 °C and light saturation above 500 µmol m^{-1} s^{-1} PPFD without any signs of photoinhibition. A moisture gradient experiment showed that *Impatiens balfourii* prefers fresh soils of moderate dampness. In contrast to the native *I. noli-tangere* and to alien species *I. glandulifera* and *I. capensis*, which prefer moister or even wet habitats, *I. balfourii* resembles in its soil moisture demands the alien *Impatiens parviflora*, which originates also in Central Asia and is invasive in Europe. In contrast to all other established *Impatiens species* in Europe, *I. balfourii* is able to colonize open habitats with high light intensities. Against this background, a further expansion of *Impatiens balfourii* in Europe appears to be likely.

Invasive lepidopteran species in the Czech Republic: a survey

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In total, 13 invasive species of Lepidoptera have been registered in the Czech Republic, i.e. 34% of all alien Lepidoptera and 11% of all invasive insect species (Šefrová 2005, Šefrová & Laštuvka 2005). These species were found for the first time as follows: *Argyresthia thuiella* (Packard, 1871) – 1988, *A. trifasciata* Staudinger, 1871 – 1995, *Caloptilia roscipennella* (Hübner, 1796) – 1905, *Cameraria ohridella* Deschka & Dimic, 1986 – 1993, *Coleophora spiraeella* Rebel, 1916 – 1937, *Cydia molesta* (Busck, 1916) – 1951, *Eupithecia pulchellata* Stephens, 1831 – 1997, *Hyphantria cunea* (Drury, 1773) – 1950, *Parectopa robiniella* (Clemens, 1863) – 1989, *Phyllonorycter issikii* (Kumata, 1963) – 2000, *P. leucographella* (Zeller, 1850) – 1995, *P. platani* (Staudinger, 1870) – before 1920, and *P. robiniella* (Clemens, 1859) – 1992. Among the above species, 10 are monophagous (or narrowly oligophagous) and develop on introduced plant species. The remaining species, *P. issikii*, lives on native *Tilia* species, *C. molesta* is broadly oligophagous, both on native and alien Rosaceae and only one species, *H. cunea* is polyphagous on trees. The origin of the invasive Lepidoptera is in North America (4 species; 31%), SW Asia (3; 23%), E Asia (3; 23%), Europe (2; 15%) or unknown (1; 8%). More than half of these species have no (or unknown) economic or ecological negative impact, six of them are considered as pests, especially to ornamental plants and only two could affect biodiversity by their high abundances (*Cameraria ohridella*, *Hyphantria cunea*).

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Which landscape parameters determine the abundance of invasive plant species in an urban area?

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The present study compares relative importance of habitat availability and several landscape-level parameters on the abundance and species richness of 43 invasive neophytes in a medium-sized city of Hradec Králové, eastern Bohemia, Czech Republic (50°11' N, 15°52' E). Independent and conditional effects of landscape-level parameters as well as effects of habitat availability on the abundance of invasive species were tested. The variation partitioning shows comparably sized unique effects of habitat availability and landscape factors, as well as relatively large overlap in their explanatory power. In another analysis, the influence of distance from the center on abundance of invasive species was tested and explained at least 1% of variability. In addition, the effect of residence time of present invasive species on their current status is evaluated.

Native plant diversity reduces invasibility of montane grasslands

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The diversity–stability hypothesis predicts that a high diversity should enhance the stability of an ecosystem. Diversity comprises both the number of species and the number of functional groups present in a community. One measure of ecosystem stability is the resistance of a community to invasion of exotic species. To investigate the relationship between diversity (the number of plant species and the number of plant functional groups) and stability we set up two seed addition experiments using four non-indigenous plant species, all known as successful invaders, in montane grasslands in Central Germany. In the first experiment, which was carried out at a landscape scale, we added seeds to 20 grassland sites which represented a large gradient of plant diversity. In the second experiment, that was established at one of the sites, we added seeds to plots where either legumes or non-legume forbs were previously excluded by herbicides. Generally, the grasslands were inherently resistant to invasions, as three of the four non-indigenous species were hardly able to establish themselves. Although some seeds germinated of all four plant species in both experiments, seedling emergence was independent of species richness and functional diversity. Results from the second year showed, however, that establishment and survival of one of the invaders (*Geranium pyrenaicum*), was negatively affected by resident species richness (Figure 1a). Similarly, the establishment and plant cover of *G. pyrenaicum* was higher when other forb species were excluded (Figure 1b) indicating that functional group diversity in addition to species richness determines the invasion success. Thus, we could confirm the hypothesis that diversity begets stability of montane grasslands in terms of increased resistance to invasion for at least for one of the four non-indigenous species.

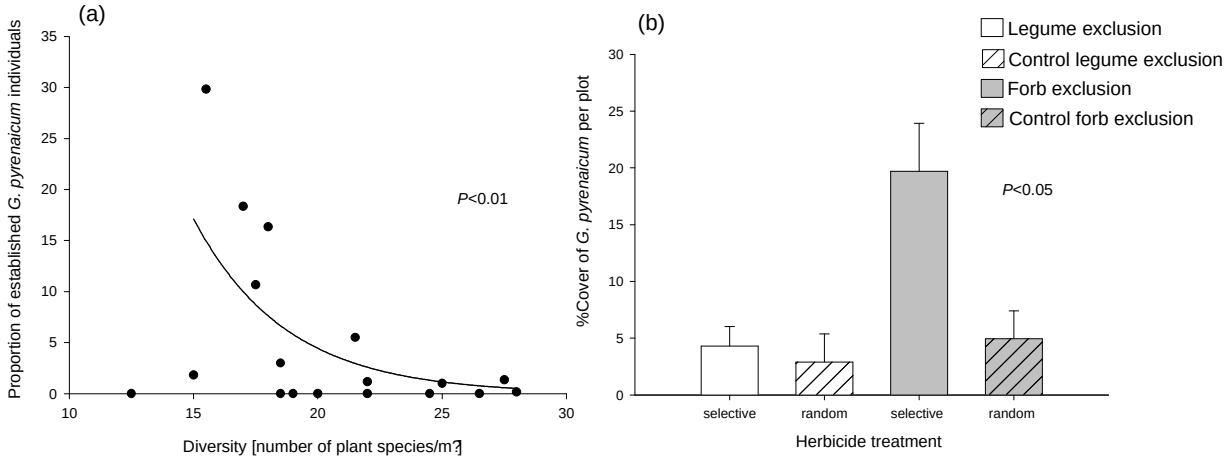

Figure 1. Establishment success of *Geranium pyrenaicum* two years after adding seeds to (a) 20 grassland sites along a large gradient of plant species richness, and to (b) experimental plots where plant functional groups were previously excluded.

Invasive plants species and agriculture in Armenia

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Armenia is a newly independent country situating in the South Caucasus. The change of political and economic systems, privatization of agricultural lands within the last 15 years have lead to serious changes in land tenure structure. Now agriculture is very important branch of Armenian economy, it brings about 25% into the GDP. Land with agricultural potential constitutes 1,391,400 ha (46.8% of the total area of Armenia). However, by 1990 only 16.4% of this land was arable (35% for annual crops, 5% for perennial crops). Similarly to other Eastern European countries the period of economic transition seriously affected the development of the country agriculture. After land privatization many small farmer enterprises were established. Now one farm has on average only 1.4 ha of agricultural land (including 1.1 ha arable). There are about 1.2 million land pieces for arable land. Small enterprises give about 98% of agricultural product. However, small individual economies cannot use modern technology, fertilizers, pesticides, and have become unprofitable in the majority of cases. As a result the process of enlargement of agricultural economies started, but big territories of agricultural land became abandoned, and were not utilized during last years. They became a source of seed of many plant species like *Cirsium arvense*, *Cirsium incanum*, *Cirsium vulgare*, *Geranium tuberosum*, *Leucanthemum vulgare*, *Cardaria boissieri*, *Carduus hamulosus*, *Carduus nutans*, *Conium maculatum*, *Lepidium latifolium*, *Lepidium ruderale*, *Peganum harmala*, *Silybum marianum*, *Tanacetum vulgare* and others. These species are indigenous to Armenia and growing on disturbed and ruderal places. Now they started to spread intensively in abandoned fields and penetrate into natural ecosystems. Armenia is now the main route between Iran and Georgia and further Russia. The deficiency of the state quarantine service facilitated the entry of new alien plant species, in particular along transport routes. Also, some of the large stocks of crop seeds received as humanitarian assistance were contaminated by weeds. Many species of weeds spread in the fields, orchards and vineyards, and then penetrate into natural ecosystems. These weeds are: *Acroptilon repens*, *Centaurea diffusa*, *Scandix stellata*, *Cardaria draba*, *Verbascum georgicum*, *Anthemis triumfettii* and others.

The investigation of potentially invasive species in Armenia may be very important for different countries around the world. Biological control of alien pests is commonly used in many countries worldwide. Being one of the richest centers of biodiversity, Armenia may provide potential material (insects, fungi and other) for fighting species invading natural ecosystems both in the country and abroad. It should be mentioned that many of invasive plant species in Armenia have the same potential and are pollutant in the natural ecosystems in other countries. For example, 38 species of Armenian flora are very dangerous invasive species in North America, and four Armenian plant species are included in the list of “100 of the World’s Worst Invasive Alien Species” (ISSG/IUCN).

Does *Cameraria ohridella* threat the natural stands of *Aesculus hippocastanum* in Albania, Bulgaria and Macedonia?

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In the framework of the SCOPES project "Non-indigenous insects and their threat to biodiversity and economy in the Balkans" an ecological impact of *Cameraria ohridella* Deschka & Dimic in natural stands of horse chestnut, *Aesculus hippocastanum* L., in Albania, Bulgaria and Macedonia was assessed. Five natural stands of *A. hippocastanum* were investigated during 2006– 2007. In Albania surveys were made in the natural stand Radigos-Librazhd (altitude 862 m a.s.l.), in Bulgaria (Dervisha, 150– 450 m) and Macedonia (Zli dol, 1196 m; Garska reka, 865 m and Suvi dol, 8189– 1359 m). There are very few mature trees remaining at Albanian and Macedonian sites and seedlings around these trees were not abundant. In contrast, the Bulgarian stand consists of a 10 ha compact forest.

The horse chestnut leafminer *C. ohridella* was detected in all natural stands investigated. Two generations of the moth were observed in Albania and Macedonia. The trees were not heavily infested by *C. ohridella* compared to what is observed on planted trees in Europe (less than 10% of the leaf surface mined in 2006 and less than 5% in 2007). Three generations of the moth were observed in Bulgaria. A total defoliation in August, made by the second summer generation of the moth, occurs in the reserve Dervisha every four years.

Results so far showed that the infestation by the moth is not a major threat for Albanian and Macedonian stands. It is difficult to discuss the future of natural horse-chestnut stands in the Balkans since there are other factors affecting the condition of the trees. The fungus *Guignardia aesculi* (Peck.) often causes more damage than *C. ohridella*. In Albania horse chestnut has become very rare because of extensive harvesting, especially during the 1990s.

A review of non-native scale insect species (Hemiptera: Coccoidea) in Bulgaria

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In the framework of the SCOPE project "Non-indigenous insects and their threat to biodiversity and economy in the Balkans" a first analysis of alien scale insect species in Bulgaria have been made. Based on bibliographic sources 35 species of scale insects are considered non-native (20 diaspidis, 6 coccids, 6 pseudococcids, 1 margarodid, 1 eriococcid, 1 ortheziid). The first list of scale insect species of Bulgaria (Tschorbadjiew 1938) reported 23 species on 24 different host plants. Among them *Saissetia coffeae* (Walker, 1852), *Aspidiotus nerii* (Bouché, 1833), *Aonidiella aurantii* (Maskell 1879), *Chrysomphalus aonidum* (Linnaeus 1758), *Lepidosaphes pinnaeformis* (Bouche 1851), *Parlatoria ziziphi* (Lucas) 1853), *Unaspis euonymi* (Comstock 1881) and *Pseudococcus citri* (Risso, 1813) are non-native. Since then 27 alien species of scale insects are reported from Bulgaria. The number of reports of introduced scale insect species increased in 1964– 1968, when 16 species were reported due to active investigation. The largest number of introduced scale insects originated from the tropics (12 species) followed by Asia (8), America (7), Africa (3) and Australia (1 species). Some of the species are of unclear origin due to contradictions in the literature (4 species). The majority of Bulgarian non-native scale insect species are from the family Diaspidide.

The aim of this study is to provide information on alien scale insect species in Bulgaria, based on literature sources; for each species the date of the first detection, validation source, zoogeographic area of origin and host plants are given. We consider this analysis to be a starting point for future investigations.

Invasive species of the Kraków-Czestochowa Upland (South Poland)

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Invasive species are currently the subject of investigations by numerous authors who study their classification, history of spread and impact on native plant cover. They are defined as plants of alien origin able to produce often very numerous fertile offspring which spreads at long distances from the parent individuals, and have properties that enable them to occupy large areas (Pyšek et al. 2004).
The aim of the study is to identify invasive vascular plant species in the Kraków-Czestochowa Upland (South Poland) and illustrate their influence on the transformations of plant cover in this area. Floristic studies in the Kraków-Czestochowa Upland were conducted in 1999– 2003 using the cartogram method. The study area was divided according to the methodological tenets of the "Atlas of distribution of vascular plants in Poland – ATPOL" (Zajac 1978) into 660 grid cells of 2 km. The results of studies on the flora of this region, based on own field investigations, literature, herbarium collections and the current version of ATPOL database, were summariyed in a monograph (Urbisz 2004). The study includes species of alien origin which arrived into the studied area after the year 1500 and are permanently naturalized there (kenophytes). Invasive species were identified on the basis of following criteria: frequency of occurrence, average size of the populations, diversity of invaded habitat types, degree of the natural character of occupied habitats. Fifty-three of the 168 naturalized species are invasive. The most invasive species occurring in the investigated area are *Impatiens parviflora*, *Solidago canadensis*, *S. gigantea* and *Reynoutria japonica*.

Considering the concentration of localities of these species, it is difficult to identify a specific part of the study area which contains extraordinarily numerous sites of their occurrence; their distribution is largely uniform. A relatively larger number of their localities may be noticed in areas with a high intensity of anthropic pressure (especially in the vicinity of major cities, but also in sites that are frequently visited by tourists, e.g. Ojców National Park and some nature reserves such as Góra Zborów or Parkowe).

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New invasive gall midge in Slovakia

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The invasive species *Obolodiplosis robiniae* (Haldeman 1847) (Diptera: Cecidomyiidae) was recorded on the black locust (*Robinia pseudoacacia* L.) in 2006. These findings were the first records of the species in Slovakia. The gregariously feeding larvae induce the margins of the leaflets to thicken and bend downwards, forming the characteristic leaf margin roll galls. Damage of the leaves depends on the number of larvae living in the galls.

The field surveys were carried out in 2007 to record the distribution of the species and infestation ratio of black locust trees. The gall midge was observed throughout south of Slovakia with the exception of the southern part of central Slovakia, where the species was observed just sparsely (Figure 1). The infestation ratio of black locust trees was evaluated during three periods: May–June, July–August and September–October, and accounted for 15–39%, 9–53% and 6–49%, respectively. The most frequent infestation ratio fluctuated from 10–30%. The infestation ratio of single leaves varied from 4–100%. In general, the infestation was highest during July–August and slightly declined during September–October. The higher infestation was recorded within cities than around villages. The gall midge is multivoltine and our observations indicate supposedly three generations per year in Slovakia.

In location of the first record of *O. robiniae*, a number of its larvae were parasitized by an associated parasitoid, *Platygaster robiniae* Buhl & Duso, 2007 (Hymenoptera: Platygastridae). This is the first record of this species in Slovakia. The percentage of the rolling leaf margins with parasitized larvae ranged from 0.4% to 39.5% within checked locations. Along with the dominant *P. robiniae*, few other hymenopterous parasitoid species from the families Torymidae, Eupelmidae, Eurytomidae, Trichogramidae, and Pteromalidae were recorded. The results show that *O. robiniae* is already abundant in Slovakia. Although the species is currently not a pest, it is necessary to pay attention to its future occurrence and possible economic importance.

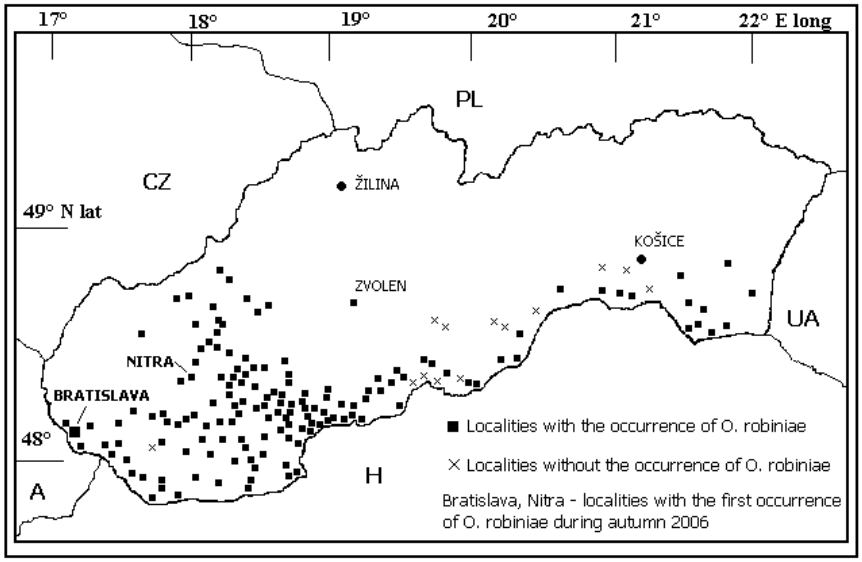

Figure 1. The occurrence of the gall midge, *Obolodiplosis robiniae* (Diptera: Cecidomyiidae), in Slovakia during 2007.

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"The Black Book" of Middle Russia

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"The Black Book" is a synopsis of invasive plant species of Middle Russia. It comprises biological data on invasive species, including the dynamics spread in secondary distribution ranges. Estimation of economic damage, as well as of possible use of invasive species is presented. The synopsis includes alien species, that (i) occur natural plant communities and/or damaged habitats (open sands, regenerating peatbogs etc.); (ii) are naturalized; and (iii) occur in at least of 75% of administrative units of Middle Russia. Local invasions, occurring in a limited territory, are also considered, e.g. rapid naturalization of *Adenocaulon adhaerescens* (Far East) and *Veronica filiformis* (Caucasus) only in Moscow, or invasive populations of *Robinia pseudoacacia* only in southern regions of Middle Russia.

There are 52 widely distributed invasive taxa: *Acer negundo*, *Acorus calamus*, *Amaranthus albus*, *A. retroflexus*, *Anisantha tectorum*, *Atriplex tatarica*, *Heracleum sosnowskyi*, *Ambrosia artemisiifolia*, *Amelanchier spicata*, *A. alnifolia*, *Aster ×salignus*, *Bidens frondosa*, *Cardaria draba*, *Chamomilla suaveolens*, *Crataegus monogyna*, *Cyclachaena xanthiifolia*, *Echinocystis lobata*, *Elaeagnus angustifolia*, *Elodea canadensis*, *Elsholzia ciliata*, *Epilobium adenocaulon*, *E. pseudorubescens*, *Erigeron canadensis*, *E. strigosus*, *Erucastrum gallicum*, *Euphorbia peplis*, *Festuca trachyphylla*, *Fraxinus pennsylvanica*, *Galinsoga ciliata*, *G. parviflora*, *Helianthus tuberosus*, *Hippophae rhamnoides*, *Hordeum jubatum*, *Impatiens glandulifera*, *I. parviflora*, *Juncus tenuis*, *Lepidium densiflorum*, *Lupinus polyphyllus*, *Oenothera biennis*, *Oxalis stricta*, *Poa supina*, *Populus alba*, *Puccinelia distans*, *Reynoutria × bohemica*, *R. japonica*, *Senecio viscosus*, *Solidago canadensis*, *S. gigantea*, *Sorbaria sorbifolia*, *Symphytum caucasicum*, *Sisymbrium wolgense* and *Xanthium albinum*.

Taxonomic compositions of alien and invasive components in the flora of Middle Russia differ. Asteraceae (13%), Poaceae (13%), Brassicaceae (9%), Rosaceae (8%) and Fabaceae (7%) are most represented among aliens, Asteraceae (27%), Poaceae (10%), Brassicaceae (8%), Rosaceae (6%) and Onagraceae (6%) among invasive species. Among naturalized species, 51% are from North America. Comparative analysis of naturalized taxa from European Russia northwest, Middle Russia, Ukraine, and Poland indicated a group of nine species, seven of which originate from America (*Acer negundo*, *Ambrosia artemisiifolia*, *Erigeron canadensis*, *Galinsoga ciliata*, *G. parviflora*, *Helianthus tuberosus*, *Echinocystis lobata*), two from Central Asia (*Impatiens glandulifera*, *I. parviflora*).

Analysis of the composition and distributional patterns of invasive species showed that (i) the majority of species achieved a wide distribution in Middle Russia within a few decades (Figure 1); (ii) the starting period of invasion is scarcely documented in literature and herbaria); (iii) substantial part of invasive species in Middle Russia resulted from intentional introduction. As a rule, these invasive species have been in cultivation for a long time and only then started to penetrate in local plant communities. Many of them species have been cultivated in botanical gardens (*Echinocystis lobata*, *Bidens frondosa*, *Chamomilla suaveolens* and others); (iv) almost all invasive species of Middle Russia flora arrived from the secondary distribution ranges and their spread there represents only a part of their invasion in Europe.

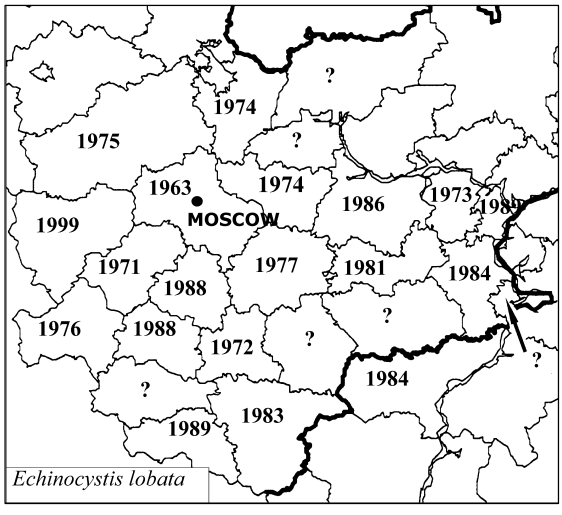

Figure 1. The history of invasion of *Echinocystis lobata* in Middle Russia.

The contribution of bird seed, traffic and mowing machines to the spread of *Ambrosia artemisiifolia*

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Ambrosia artemisiifolia is an invasive annual plant, which is mainly dispersed by man. Ragweed is suggested to be spread by seed import, pet fodder (Bohren et al. 2005), floods, soil movements, and by harvesters and reapers as well as vehicles on highways (Lavoie et al. 2007). All these distribution vectors have not yet been proved experimentally for ragweed, although the role of traffic in species spread, including that of invasive species, is generally accepted (von der Lippe et al. 2005, Rooney 2005). As a first step the potential role of birdseed was assessed (Vitalos & Karrer 2008), because it was suggested as important source for dispersal. Although *Ambrosia* seeds were found in seven out of 19 products (however, only in two of them in significant amounts), their germination rate was very poor. Thus, we assume that the role of birdseed in the dispersal of *Ambrosia* has been overestimated up to now.

Next we tested the ragweed spread along roadsides by using seed traps. The traps were sampled every month from September till February and inspected for ragweed seeds. Altogether, only eight ragweed seeds were found, all of them within the range of 25 m from the edge of the established population. Thus we suggest that dispersal along roadsides does occur but the number of transported seeds is quite low. The contribution of machines which mow the shoulders along highways and country roads appears to be more important. The material that stuck to the mowers was removed, dried and searched for ragweed achenes, which were also tested for germination capacity. Up to 370 g of dry matter were found to stick to the mowing machines, 179.4 g on average. On average there were 28 seeds/100 g dry matter, varying from 0 to 89 (Figure 1). Therefore we conclude, that mowing machines strongly contribute to the spread of *A. artemisiifolia*.

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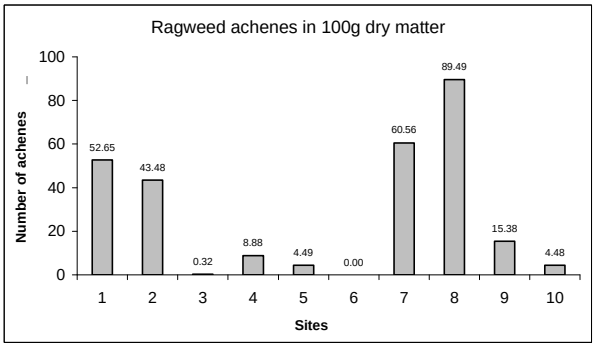

Figure 1. Average number of achenes per dry matter of *Ambrosia artemisiifolia*.

Alien plant species as a source of intractable weeds in Poland

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The economic and environmental effects of biological invasions are widely known. Alien weed species have significant economic impact on agriculture. In Poland, among the most troublesome weeds of arable fields, non-indigenous plants comprise a significant part. There are species problematic on the national (e.g., *Apera spica-venti, Echinochloa crus-galli, Setaria pumila, Avena fatua, Galinsoga parviflora, G. ciliata, Matricaria maritima* subsp. *inodora, Amaranthus retroflexus*) as well as regional scale (e.g., *Avena strigosa, Alopecurus myosuroides*) (Rola & Rola 1996, Wegrzynek et al. 2008). Intractable alien weeds are representatives of two groups: archaeophytes, established in Poland before the 15th century, and neophytes, which arrived since then (Zajac et al 1992, Tokarska-Guzik 2005). They belong mainly to Poaceae and Asteraceae family. The vast majority of them are summer annuals and repoduce by seed, while native problematic segetal species are usually perenials reproducing also vegetatively (e.g., *Elymus repens*, *Convolvulus arvensis*, *Cirsium arvense*). The distinguishing features of alien species causing trouble in agriculture are the ability to form ecotypes resistant to herbicides and production of large amounts of seed (Rola & Rola 1996, 2002, Wegrzynek et al. 2008). Besides yield loss, massive occurrence of weeds is also a serious threat to the diversity of flora of arable fields.

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Exotic invasives species in the Canary Islands: a fragile European atlantic territory with great richness in endemic species

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On Canary Islands, The area of 7,447 km^2 and 1.583 km of shoreline is divided in seven major islands and numerous small islets. Since the times it was colonized by the Europeans, it was the centre of strong migratory currents both to the islands and away from them (mainly to southern and central America), being exposed through trading exchanges between three continents to the arrival of all kinds of aloctonous species. This has notably increased in the last 50 years due to tourist development and modern communication, which affect the transport of goods and people between the islands and with outside territories, including the transport of crude oil for a local refinery and the distribution of fuel for consumption on the islands. Furthermore, the increase in production of fruit and vegetables, as well as the trade in ornamental plant and pet species, has resulted in a considerable increase in the number of escapes to the natural environment, which eventually constitute true biological invasions. In this paper we present some examples of the chorology and ecology of exotic plant species, which already constitute serious, difficult to eradicate pests, and some examples of potential invasive species.

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Invasive species in the Kyiv urban area (Ukraine)

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The Kyiv city agglomeration (Kyiv urban area, KUA) is situated in the central part of the eastern European plains, at the border of the forest and forest-steppe physiographic and vegetation zones. According to the data, the total non-native flora (past and present) of KUA consists of 610 species of vascular plants belonging to 307 genera and 71 families (data base in Microsoft Access in preparation). This flora a higher floristic diversity than alien fractions of other Ukraine's urban floras.

The modern non-native flora of the area, as of 1997–2007, consists of 356 species belonging to 207 genera and 62 families. Its stable component (consisting of naturalized species) is represented by 203 species, 147 genera, 51 families (mostly from North America and East Asia). In the modern alien flora of the KUA, there is an almost equal ratio of stable and unstable components, 54% and 46%, respectively, which indicates some stabilization of the species composition. The main trends in the naturalization of alien plants of the Kyiv region are detected. During 100 years, 133 species increased their degree of naturalization (as a rule, in a short period of 40–10 years). The group of invasive and dangerous alien species consists of 30 species, with Asteraceae most represented (11 species). The data on non-native species were analyzed by origin, time and way of immigration, distribution, biological and ecological characteristics and interspecific relationships. Thirteen species became naturalized in the first half of the 20th century, 17 from the end of the 1970s to now. These species are widespread and abundant in the city and adjacent towns and villages. At present, some species further spread within the area studied, e.g. *Ailanthus altissima* (Mill.) Swingle, *Galinsoga urticifolia* (Kunth) Benth., *Heracleum mantegazzianum* Sommier & Levier, *Quercus rubra* L., *Echinocystis lobata* (Michx.) Torr. & A. Gray, species of genus *Reynoutria* Houtt., *Helianthus* L. and *Solidago* L. There are also numerous cases of invasions by some plants by escape from cultivation in the city and adjacent areas, e.g. escapees from Kyiv botany gardens: *Iva xanthiifolia* Nutt., *Impatiens parviflora* DC., *Oxybaphus nyctagineus* (Michx.) Sweet, etc. This group of ergasiophytes (species intentionally introduced and cultivated by man, and then spread from places of their cultivation) consists of 230 species (43 families). Taking into account the increased role of ergasiophytes in the structure of non-native flora and vegetation (both in terms of the number of species and their growing participation in plant communities), more attention should be paid to the naturalization ability of newly introduced cultivated plants.

Penetration of invasive anthropophyte species into the Polish Carpathians

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Within Poland, the Carpathians occupy 19,600 km^2, which amounts to ca 6% of the national territory. The vegetation cover of this area is still primarily comprised of native species, although in recent decades, intensive colonisation by newcomers, i.e. alien synanthropic plants (kenophytes) can be observed. At present, there are 133 species of kenophytes, which constitute 44% of their total number in Poland (Tokarska-Guzik 2005). Out of the list of species occurring in the Carpathians, 63 are common taxa and 70 are relatively rare. Among the most common species, 20 demonstrate significant invasions into semi-natural and natural communities.

When invasive species are studied, it is important to know their rates of expansion. For seven such species (*Bidens frondosus*, *Digitalis purpurea*, *Impatiens glandulifera*, *Rumex confertus*, *Solidago candensis*, *S. gigantea* and *Veronica filiformis*), published maps of their distribution in Poland and in the Carpathians, from 50 or 30 years ago, are available. This makes it possible to determine the rate and direction of expansion, as well as to identify possible centres of dispersal. Also interesting, is their ability to penetrate into higher elevations, which poses an obvious threat to the most valuable plant communities in the Carpathians. During the studied period, some invasive species increased the number of their localities, in some cases by more than a hundredfold (e.g., *Solidago gigantea*).

In terms of vertical distribution, in the case of *Digitalis purpurea*, the highest number of locations is situated in the lower montane zone with the maximum elevation of 980 m a.s.l. The other species have their centres in the foothill zone, reaching into the lower montane zone with single locations. Migration routes of all species into the Carpathians follow river valleys. Almost all the taxa concerned have certain connections with the centres of dispersal in the ruderal communities of towns and large villages. The geographical aspect of migrations is also interesting: *Rumex confertus* and *Veronica filiformis* spread from the east and their distribution has not yet covered the whole of the Carpathians. *Bidens melanocarpus*, *Solidago canadensis* and *Digitalis purpurea* have dispersed from the west. Two invasive species, *Solidago gigantea* and *Impatiens glandulifera*, have spread throughout the Carpathians and therefore it is difficult to identify the direction of their expansion.

The Carpathian Foothills in Poland, showing the highest intensity of expansion, has been much modified by this anthropogenic impact. The penetration by invasive species of the lower montane zone in sites not yet disturbed by man should be viewed with due concern.

POSTERS

Section 2

Mechanisms of species invasiveness

What explains the invasion success of the aquatic mud snail *Potamopyrgus antipodarum* (Hydrobiidae, Mollusca)?

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The spread of non-native species is one of the most harmful and least reversible disturbances in ecosystems. Species have to overcome several filters to become a pest (transport, establishment, spread, and impact). Few studies addressed traits that confer the ability to overcome these steps in the same species. The aim of this study was to review available information on the life-history and ecological traits of the mud snail, *Potamopyrgus antipodarum* Gray (Hydrobiidae, Mollusca), native to New Zealand, in order to explain its invasive success at different aquatic ecosystems around the world. A wide tolerance range to physical-chemical factors has been found to be a key trait for successful transport. A high competitive ability at early stages of succession can explain its establishment success in human-altered ecosystems. A high reproductive rate, high capacity for active and passive dispersal, and the escape from native predators and parasites explains its spread success. The high reproductive capacity and ability to monopolize invertebrate secondary production can explain its high impact on invaded ecosystems. However, further research is needed to understand how other factors, such as population density or the degree of human perturbation, can modify the invasion success of this aquatic snail.

Alien plants in Greece: an analysis of their life history traits

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Biological invasions are an important part of the human-induced environmental changes, often resulting in significant losses in economy and the structure and function of invaded ecosystems. The more we know about the biology and ecology of alien taxa the best we can prevent and control their invasions. The current work attempts to analyse ecological characteristics of alien plants of Greece and is a part of a broader study on the alien species in Europe (DAISIE project, www.europe-aliens.org, see Lambdon et al. 2008). Based on an an extensive survey of the existing literature, data on taxonomy, distribution, chorology, habitats, introduction pathways and several life history traits (e.g., life and growth form, reproductive characteristics etc.) were collected.

The alien vascular flora of Greece consists of 327 taxa, representing ca 5% of the extant flora of the country. The confirmed naturalized taxa amount to 42% of the total aliens and casuals to 26%, leaving 32% of taxa with uncertain or uknown status. Most of the aliens are of American origin (39%), followed by those of Asiatic (19%), which is in accordance with the fact that in the Mediterranean islands non-European species are more abundant than European exotics (Lloret et al. 2004), and similar to the situation in other Mediterranean countries (e.g., Cyprus). Over 70% of taxa are herbs, while shrubs and trees account for 15% and 8%, respectively. Although vegetative propagation and clonal growth are considered typical of successful aliens (Lloret et al. 2005, Milbau & Stout 2008), annual herbs were found to prevail (over 47%) among the naturalized plants. Woody species increased to 26%, apparently due to the frequency of cultivated introductions, as is the case in the British Isles (Crawley et al. 1996).

Late flowering (from late spring to autumn), a trait associated with alien abundance and invasiveness (Lloret et al. 2005, Milbau & Stout 2008) characterizes 60% of the aliens while only less than 6% flower in autumn/winter and 20% in spring. Although the duration of flowering was not associated with invasiveness in our study, the flowering period of 66% of aliens in Greece ranges from 3–6 months, with 9% of them flowering for up to 12 months. Besides, in 14% of all aliens and 21% of naturalized species flowering spans over more than two seasons.

Multiple or at least more than two seed dispersal modes and agents (excluding dispersal by man) characterize 60% of aliens (68% of the naturalized). Most species possess dispersal adaptations (telechorous dispersal). Medium- and long-distance seed dispersal prevails. As in other studies from the Mediterranean region (Lloret et al. 2004, 2005), adaptive or non-adaptive zoochory was the most frequent mode of dispersal, followed by anemochory and unintentional anthropochory.

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Exotic grapevine rootstocks invade European floodplains

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In the 19th century, North American Vitis species were introduced to Europe as rootstocks. Over the years these rootstocks have been selected for adaptation to different vineyard regions of Europe. They mainly escaped from dumping places or abandoned vineyards and have invaded alluvial networks where they currently form large populations. Vegetative reproduction and abiotic-driven seed dispersal lead to their colonisation of streamside habitats. In order to better understand post-establishment, development and extension of these populations, a section of the Ceze River in southern France was studied. This region was chosen because of its active alluviality with frequent and strong floods. A combination of ecological and genetic approaches shows that in time individuals become more vigorous, and that new settlement in these populations occurs each year through the arrival of vine shoots or seeds from elsewhere. These naturalised rootstocks have a large potential for becoming invasive due to their high genetic diversity and initial adaptability to this environment. Vitis rootstocks should be added to the increasing list of exotic invasive species of alluvial habitats that are already weakened through strong human impact on flood regulations, forest fragmentation and eradication of mature forests. The evolution of the interspecific relationships between the exotic species in the European alluvial habitat represents an exciting new field of research.

Competition between two invasive Ponto-Caspian species in Lake Balaton (Hungary)

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The zebra mussel (*Dreissena polymorpha*) and the amphipod *Chelicorophium curvispinum*, originating from the Black and Caspian seas accidentally invaded Lake Balaton in the early 1930s, at almost the same time. After the initial invasion, the two primary competitors spread rapidly, invaded the entire lake and have become dominant macroinvertebrates in the littoral zone of Lake Balaton. In this presentation we summarize our research on the interaction of two species, temporal and spatial patterns of their colonization and the coexistence on different substrata at different conditions.

We studied factors and environmental parameters influencing and determining the recruitment of zebra mussels in field experiments using natural substrata (stones, wood pieces) at different depth and distance from the shore. We monitored zebra mussels and *C. curvispinum* on submerged macrophytes (2001–2002), in the stony littoral zone (2003–2005), and on the reeds (2006) of Lake Balaton.

The colonization study showed that after the initial invasion the relative abundance of zebra mussels was reduced and finally *C. curvispinum* dominated on exposed substrata, in the 8th week of the experiment. We found competition for better conditions between the two species in Lake Balaton. Our quantitative field assessment shows the dominance of zebra mussel on suitable surfaces (reeds and stony littoral zone) of the lake, especially in the spawning period after more than 75 years since initial invasion, in contrast to the observation in Rhine and our short-term experiment. However, on submerged macrophytes, which are a temporary habitat for the animals, zebra mussels dominated only in the spawning period. After the dry period (2003–2004) zebra mussels started successful and rapid colonization; the population regenerated by 2005 and they returned as the dominant macroinvertebrate, in contrast to the results of our short-term experiment.

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Growth dynamics of *Solidago canadensis*

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Solidago canadensis is a (new) dangerous invasive species, which has already established in the local flora. The present study was conducted over five years in the vicinity of Tartu (South-Estonia) and focused on the growth dynamics of *S. canadensis*, with focus on possible growth limitations to the distribution on local scale and trade-offs between reproduction and growth.

Solidago canadensis is a perennial herb which can dominate vegetation and reach a high shoot density. Thirty genets were excavated in order to analyze (i) the age of genets, (ii) genets circumference, (iii) number of shoots and (iv) flower branches, (v) annual growth of rhizomes and (vi) the relations between these parameters. The results showed that taller plants had greater number of flower branches, which indicates their higher contribution to the next generation (Figure 1). No trade-off between the size and number of offsprings was found.

The size of genets was positively correlated with the number of vegetative offsprings. Mean number of offspring per genet was 16. To predict the growth changes of *S. canadensis* during the next twenty years, genets growth dynamics was modelled using two parameters: annual rhizome growth and rate of vegetative reproduction. The results showed that genets increased considerably in size with increasing annual rhizome growth.

Solidago canadensis is a stout herb with very efficient vegetative reproduction and annual rhizome growth. Therefore, there are no growth contraints to the establishment in resident plant communities. The results of the present study suggest that futher spread of *S. canadenis* in Estonia should be followed and eradication, if the negative effect on local biodiversity continues, may be needed.

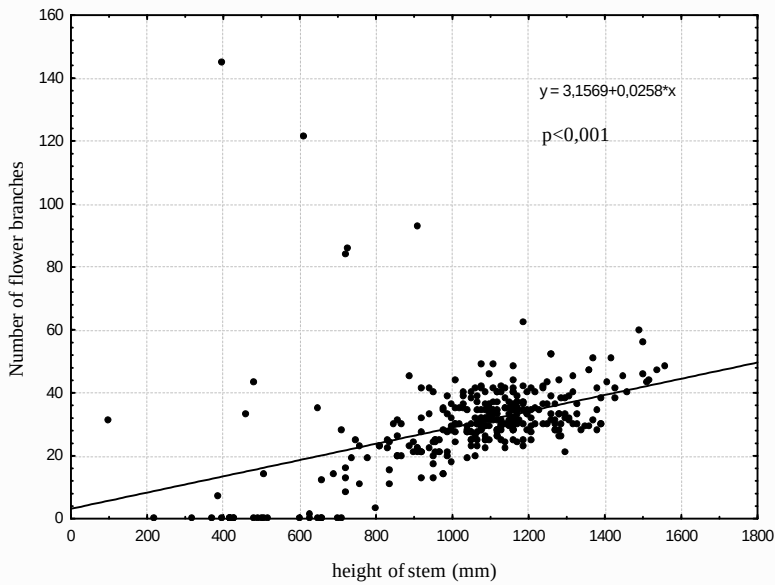

Figure 1. Height of stems and number of flower branches of excavated genets.

Elevated CO_2 and warming interact to influence invasion of a semi-arid grassland

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Although a variety of simulated global changes have been shown to influence plant invasions, interactive effects of different changes have rarely been studied (Vilà et al. 2007). We examined effects of CO_2 enrichment and warming on the ability of the introduced forb *Linaria dalmatica* to invade semi-arid mixed-grass prairie. Twenty 2.5 m^2 plots of undisturbed native prairie were treated with a factorial combination of two CO_2 concentrations (present ambient [380 ppm], and Free Air CO_2 Enriched, or FACE [600 ppm] CO_2), and two temperature regimes (present ambient, and elevated temperature [1.5/3.0 oC warmer day/night]), with five replications each. CO_2 treatments began in May 2006. Seedlings of *L. dalmatica* were transplanted into all plots in June 2006, and watered periodically through August 2006 to increase survival. Warming treatments began in May 2007. By the end of 2007, CO2 enrichment had led to a 7-fold increase in *L. dalmatica* survival and a 31% increase in the average height of surviving plants. Warming in ambient CO_2 plots decreased plant height, apparently due to cessation of growth early in the season. *Linaria dalmatica* height continued to increase in warmed FACE plots throughout the growing season, almost matching the height in non-warmed FACE plots. Although the mechanisms behind these responses remain unclear, CO_2-induced stimulation of plant growth can be driven by increases in water availability in semi-arid ecosystems (Morgan et al. 2004). In this study, soil water availability increased with CO_2 enrichment and decreased with warming. Strong responses of *L. dalmatica* to water addition in this ecosystem (Blumenthal et al. 2008) suggest that differences in water stress may partially explain its responses to both CO_2 enrichment and warming. These results are in accord with previous studies in which invasive species have responded strongly to CO_2 enrichment (Weltzin et al. 2003), but not with previously observed positive correlations between minimum temperatures and C3 forb invasion (Alward et al 1999). They also demonstrate that CO_2 enrichment can have particularly strong effects in conjunction with warming, not only facilitating invasion, but also eliminating negative effects of warming on invasion.

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Biomass and population dynamics in genus *Corbicula* in the Hungarian Danube section

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In the Hungarian Danube section four invasive mussel species can be found: *Corbicula fluminea*, *C. fluminalis*, *Dreissena polymorpha* and *Sinanodonta woodiana*. Both species of *Corbicula* were first detected in the southern part of the Hungarian Danube in June 1999. Nowadays *C. fluminea* spread throughout the main arm of Danube and it has already appeared in the active alluvial floodplain of the Szigetköz area. However, *C. fluminalis* can only be found in the Hungarian Danube section downstream Paks, below the outlet of the cooling water channel of Paks nuclear power plant, which is a verification for its termophil feature.

The taxonomical status of *C. fluminalis* is controversial and we know very little about the life cycle and invasive characteristics of this species. For this reason we studied the density, body length – body mass relationship, biomass and population dynamics of *Corbicula* species living at the outlet of the cooling water channel of Paks nuclear power plant in the littoral zone. Samples were taken 8 times between October 2006 and October 2007, when it was allowed by the water level.

From the altogether determined 17 mussel species the relative abundance of *C. fluminea* was 15% and *C. fluminalis* represented 41% of the total number of individuals. The density varied throughout the year, it was highest in June (16.5 individuals m^{-2}) at *C. fluminea*, while *C. fluminalis* attained a higher density peak (36,5 individuals m^{-2}) in November. The biomass of *C. fluminea* ranged from 0,009 g m^{-2} to 27,669 g m^{-2}, and that of *C. fluminalis* from 2,712 g m^{-2} to 13,835 g m^{-2}. The density and biomass values refer to 1 m^2 surface area of the 5 cm upper depth layer of the sediment.

Corbicula fluminea reached greater body size: maximum height 38.29 mm, length 40.06 mm, width 27.14 mm and body mass 20,539 g. *Corbicula fluminalis* has a higher shell height-length ratio and a more spherical form: maximum body height 23.72 mm, length 23.61 mm, width 21.11 mm and body mass 8.355 g. There was a linear relationship between shell height, length and width, and the body length – body mass relationship was represented by power function at both species.

According to the length-frequency analysis of *C. fluminalis* one reproduction period was identified centered on June. The length-frequency analyses of *C. fluminea* indicated two reproduction periods, first occurring in winter, and the second in June. Comparing with the population of *C. fluminea* situated upstream Budapest, different reproductive strategy was identified. Two well-defined reproduction periods occurred in June and November. Due to the heated water the reproduction period delayed at Paks.

The density was very low compared to published data. Upstream Budapest the density peak of *C. fluminea* was 736 individuals m^{-2}, however its maximum shell length was lower. The influence of warm water at Paks results in the more rapid growth of *C. fluminea*, which may be a different life strategy.

Introduction history and biological species traits as determinants of naturalization success of North American woody plant species in Europe

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One of the major challenges of invasion biology is to unravel the determinants of successful establishment of species. It is widely assumed that propagule pressure and time since introduction are very important for successful naturalization of a species in a new region, and that these components of the introduction history of a species might override the importance of biological characteristics. However, most studies, particularly the ones on plants, do not have information on time since introduction, because it is mostly unknown, and have only indirect estimates of propagule pressure, such as human population density. We compiled a data set on naturalization success, measured as the number of states in Europe in which the species has established, of ca 800 woody species from Northern America and exact information on time of introduction into Europe. Moreover, we included propagule pressure, measured as the number of botanical gardens and city parks where the species has been planted in Europe. We completed the data set with information on the native distribution and biological characteristics of the species. Preliminary results show that time since introduction has a weak but significant positive effect on naturalization success, and that propagule pressure has a strong positive effect on naturalization success. We are currently analyzing the effects of the biological species traits on naturalization success, and we will present these results together with the ones on the introduction history of the species at the conference

Comparative study of capacity of the invasive cordgrass *Spartina densiflora* and the native *Spartina maritima* to phytostabilize heavy metals

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The Tinto-Odiel estuary (SW Spain) is one of the most polluted areas in the world, with extremely high concentrations of trace metals in the sediments. The main sources of contamination of this coast are sewage from the coastal towns, industrial dumps and pollution from the Tinto and Odiel rivers, which are acidic and contain large amounts of metals from erosion and mining. It is well known that the complex system that constitute the estuarine sediments is strongly influenced by plants, which can alter the biochemistry of trace metals in soil. Therefore, they are being increasingly used in phytoremediation processes to reduce contamination.

The aim of this study was to investigate, comparatively, the capability of two estuarine plants, the invasive cordgrass *Spartina densiflora* and the native cordgrass *S. maritima*, to modify their environment in terms of concentration of heavy metals (Al, As, Cd, Cr, Cu, Ni, Pb and Zn) in two localized sites of the Tinto-Odiel estuary (Odiel river and Tinto river). In this way, the contents of these trace elements were determined in sediments and rhizosediments of the two species.

Both species showed a potential for As, Cu, Pb and Zn phytostabilization in Odiel river, especially the invasive cordgrass *S. densiflora*, which acts like a sink for these metals and prevents them from becoming available to other organisms. Although, in Tinto river, the most polluted site of the estuary, neither of the two species showed potential for metals phytostabilization, probably because high concentrations of metals pass over a threshold value altering biological and structural properties of root cells.

Risk assessment of plant invasions: comparing post dispersal seed predation of exotic pine species in Mediterranean ecosystems

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Seed size seems to be an important trait to predict invasiveness by plant species specially so for pine species (Louda 1989, Nepstad et al. 1991). At the same time, the biotic resistance hypothesis predicts that natural enemies such as seed predators are an important component of invasibility (Elton 1958). We compared seed predation by seed addition experiments of 16 *Pinus* spp. with different seed size and different invasiveness sign (Rejmánek & Richardson 1996, Z+: more invasive and Z–: less invasive) in Mediterranean shrubland. We also conducted exclusion experiments to determine potential seed predators and seed's preferences in relation to seed size. Preliminary results reveal that seed predation by rodents (*Apodemus sylvaticus* and *Mus spretus*) was very intense for all species without significant differences among them or between Z-sign. Neither did we find a significant relationship between seed predation and seed size. This study suggests that native seed predators strongly reduce the probability of establishment by *Pinus* spp. and are an important component of biological resistance to plant invasion.

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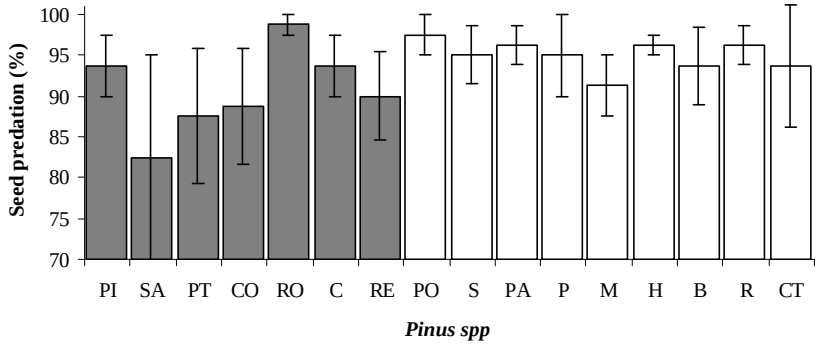

Figure 1. Post-dispersal seed predation in autumn (mean percentage ± SE) of *Pinus* species (n = 80 seeds) from lower to higher invasiveness potential (Z-score) Grey columns represent of Z- score species and white columns Z+ score species. *P. pinea* (PI), *P. sabiniana* (SA), *P. palustris* (PT), *P. coulteri* (CO), *P. roxburghii* (RO), *P. canariensis* (C), *P. resinosa* (RE), *P. ponderosa* (PO), *P. sylvestris* (S), *P. patula* (PA), *P. pinaster* (P), *P. muricata* (M), *P. halepensis* (H), *P. banksiana* (B), *P. radiata* (R) and *P. contorta* (CT).

Experimental plant introduction: disentangling the roles of propagule pressure, soil disturbance and life-history traits: first results

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An important issue in ecology is which factors determine successful population establishment of plant species. Identification of these factors is particularly relevant for biological invasions. It has been hypothesized that the ideal invasive plant should possess life-history characteristics such as fast and profuse germination, rapid growth, self-compatibility, adaptive phenotypic plasticity and high competitive ability. Empirical evidence for the role of species traits in invasiveness, however, is scarce. Moreover, the importance of species traits may depend on environmental factors such as soil disturbance, and might be overwhelmed by the introduction history of the species including time since introduction and propagule pressure.

The importance of intrinsic species characteristics and extrinsic factors on naturalization can be disentangled in experiments that use controlled introduction of species. Because these experiments impose the risk of introducing new invasive species, they have never been done. However, the risks can be reduced by using horticultural and native species that are already available in the target region instead of introducing new species.

To quantify and disentangle the roles of species traits, soil disturbance and propagule pressure, we have experimentally introduced 50 horticultural and 50 native herbaceous species at different propagule pressures in 16 grassland sites with and without soil tilling. Of these species, we will determine the establishment success over the next three years and assess how this relates to propagule pressure and soil disturbance. To determine the roles of species traits in establishment success, we will assess seed and germination characteristics, growth rates, breeding systems, competitive abilities and plastic responses to shading for the 100 study species in other experiments. These characteristics will be related to establishment success in the field experiment. This project will be the first one to experimentally quantify and disentangle the influence of life-history traits, soil disturbance and propagule pressure on establishment success while controlling for time since introduction.

Here we present first results.

Could natural enemies be the answer for Japanese knotweed invasions in the UK and Europe?

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Japanese knotweed (*Fallopia japonica*, also referred to as *Polygonum cuspidatum* and *Reynoutria japonica*) is considered to be among the most serious invasive exotic weeds in Europe. It is a rhizomatous perennial plant native to eastern Asia, which was introduced into Europe in the mid-19th century as ornamental and fodder plant. Today, *F. japonica* is considered to be a pernicious weed of both urban and natural environments especially riparian ones. A recent UK government review estimated the cost of control to be £ 1.56 billion, were it to be attempted nationwide.

Research into the potential for the biological control of these taxa has been on-going since 2003 and in that time numerous surveys and considerable research has taken place both in Japan and in the UK. Worldwide, classical biological control, i.e. the intentional release of coevolved specialist natural enemies from the native range into the invasive range of a weed, is used as an environmentally benign, sustainable method to solve weed problems. Research revealed 186 species of arthropod and over 50 species of fungi associated with *F. japonica* in its native range. Of these, most were rejected but two highly specific organisms, namely a *Mycosphaerella* leafspot and the psyllid *Aphalara itadori*, whose life-cycle and host range have been thoroughly studied. Though some work is still required on this challenging but very promising pathogen, the scientific work on the psyllid is far from complete. Exposure to a test plant list that exceeded 90 species has shown the sap-sucker to be a true knotweed specialist and incapable of damaging and completing development outside the target group of knotweeds. As part of the evolving licensing requirements, pest risk assessments and data sheets for these agents are currently under review by the relevant UK authorities for consideration to release in the UK. This paper summarises the findings and highlights future potential for the agents in other European countries as well as North America.

Do native congeners increase post-dispersal seed predation in exotic species?

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It is hypothesized that the success of exotic species may be due to the loss of natural enemies during colonization of a new range (Enemy Release Hypothesis). On the other hand it is documented that diverse groups of pathogens or predators may switch to newly-arrived species, thus reducing the advantage of lost enemies.

I demonstrate the differences in the rate of post-dispersal seed predation between six exotic plant species and their native congeners. Seeds of each species were left unprotected during the period of 6 months (after release from mother plant until germination) or treated by fungicide or wire net protection. If the Enemy Release Hypothesis holds true, the difference in predation rate of protected and control seeds would be larger in native species. In addition, I compared the predation rate of protected and control seeds of exotics at sites with native congener population with predation rate at sites where native species was missing. It was expected that more seed will be lost at sites with co-occurring congeners as they may host specialist enemies switching to seed of exotic species. Results of both experiments are discussed in the context of the formulated hypotheses.

Does local adaptation to climate play role for the performance of invasive *Buddleja davidii* populations?

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Recent studies have emphasized that rapid evolutionary responses to the new environmental conditions may be a key feature for the success of invasive species. Local adaptation can lead to an increase of plant fitness resulting in higher population density and enhanced spread. In our study, we investigated the importance of adaptation to climatic conditions during plant invasion using the butterfly bush (*Buddleja davidii*) as a model system.

This fast-growing woody perennial originates from China and was introduced to Europe around 1890 for ornamental reasons. Its fragrant and colourful flowers attract butterflies and are favoured by gardeners. Escaping from cultivation, the shrub has spread into disturbed areas like roadsides, railways, river banks and brownfields. *B. davidii* is invasive in most countries of Western Europe, in New Zealand, USA and on islands like Hawaii and Fiji. Within this distributional range, the species apparently has a wide ecological amplitude concerning climatic conditions: from oceanic to sub-continental and from temperate to Mediterranean climates. In order to quantify population × environment interactions, we set up a common garden experiment replicated in three central European regions ranging from an oceanic to a sub-continental climate. Moreover, we integrated a reciprocal transplant experiment where we included the three populations originated from the three regions hosting the common gardens. This experimental design allows to test for (i) genetic differentiation in ecologically relevant traits, and (ii) local adaptation to climate among invasive populations of *B. davidii*. We measured traits in terms of growth and reproduction across all three common gardens, and investigated flowering phenology in the common garden in Halle.

The invasive *B. davidii* populations differed significantly in all growth and reproductive traits among the gardens but not within the gardens. Furthermore, there was no population × garden interaction, indicating that all populations responded similarly to the different environments. We did not find significant correlations between any traits of growth or reproduction, and climatic characteristics of the populations' home sites. Considering just the three populations that were reciprocally transplanted, we found significant differences between the gardens in all measured traits (except for number of stems). While the population originating from Basel outperformed the other two populations in the Basel garden, the other population did not perform best at their respective home sites. Thus, the "local vs. foreign" criterion was only valid for the population from Basel. Surprisingly, 21% of all plants flowered within the first year after germination (2006). This percentage was highest in Halle (52%), where populations differed in their probability of flowering. There was, however, no relationship between the begin or the duration of flowering, and any climatic variables or geographic coordinates. In conclusion, our study revealed no evidence for local adaptation to climatic conditions in invasive European *B. davidii* populations. Nevertheless, we suggest that continuing plant breeding, including hybridization with closely related *Buddleja* species, could lead to increased genetic variation in cultivated butterfly bush stocks, thereby providing the raw material for future evolutionary adjustments.

Competition of introduced *Phragmites australis* with its closest relative and other congeneric pairs of native and introduced plant species

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During the 1990s, the European wetland grass, *Phragmites australis* (common reed) became a lot of attention because of the "reed die back" in many European countries (Van der Putten 1996). Many *P. australis* populations, especially the aquatic ones experienced a decrease in population growth, the causes of which are still not sufficiently explained. *Phragmites australis* also received much attention in North America after a population explosion in the last centuries. The species was introduced to North America some hundred years ago and showed stable populations patterns. However, in the last centuries, *P. australis* populations became more abundant and grew aggressively, forming vast monocultures. This resulted in negative impacts on native fauna and flora (Marks et al. 1994). Especially one taxon, *P. australis* subsp. *americanus*, does suffer most from the introduction of *P. australis*. This subspecie was described in 2004 and is the closest relative to the introduced *P. australis* in North America (Saltonstall et al. 2004). As shown by Saltonstall (2002) the native *P. australis* is not able to compete with the introduced *P. australis*, which results is a complete replacement of the native species by the invader. Figure 1 represents the displacement of the native *P. australis* in Connecticut, Massachusetts, and Rhode Island over a 60 year period starting in 1900. After 1960, no native populations are left and only introduced populations are present. The effects of introduced *P. australis* on other native or introduced flora are still not studied and remain unclear.

The first greenhouse experiment examined the competition intensity between the two closely related species. Both species were grown alone and in pair wise combination with 20 replicates each. Allelopathy was controlled using activated carbon which binds plant secondary compounds released via root exudates. When grown alone both species showed nearly the same above- and below-ground biomass. In some cases the native *P. australis* showed a higher growth than introduced *P. australis*. However, when grown in a pair-wise combination, an asymmetric competition between the two species was observed. The introduced *P. australis* nearly doubled its above- and below-ground biomass while the native decreased it by about 50%. In addition, plant traits such as specific leaf area, relative growth rate, stem density, or stem height showed the same results as the biomass.

The second experiment examined the effects of native and introduced *P. australis* on native and introduced congeneric plant pairs. Only species that were already introduced to North America were chosen to pair with native plant species. The data and results of this experiment are presented.

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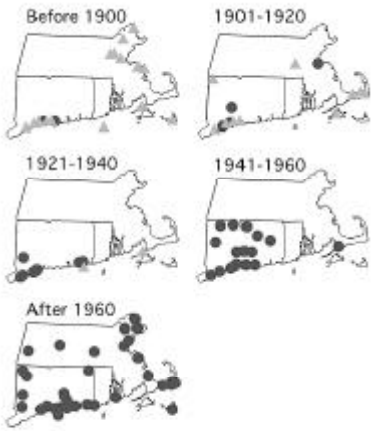

Figure 1. Changes in *P. australis* haplotype distribution patterns over 20-year time interval in Connecticut, Massachusetts, and Rhode Island. Grey triangles represent native *P. australis* poulations; black circles represent the introduced *P. australis* populations.

Can we explain the invasion potential of three introduced *Bromus species* based on their performance in the native range?

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Studying invasive species in comparison to native closely related species is a frequently used method to understand the mechanisms behind exotic invasions. However, the different evolutionary processes behind the native and introduced congeners and the fact that many native species themselves are aggressive colonizers raise fundamental doubts among ecologists about the reliability of these results. Comparing introduced invasive species with introduced non-invasives is more appropriate.

We chose three annual *Bromus* species with Eurasian origin which were introduced to USA and exhibit different invasion success. The downy brome (*Bromus tectorum*) is one of the most widespread and harmful invasive species, currently dominates many semi-arid ecosystems in western USA. It is present in 47 states. The poverty brome (*Bromus sterilis*) is also present in the USA, but with a narrower distribution (27 states) and lower invasion potential, while the corn brome (*Bromus squarrosus*) is present in 19 states only, and is not considered a weed. These three species co-occur on semi-natural plant associations on sandy soils in the Danube-Tisza Interfluve Region in Hungary. We tried to answer the following questions. (i) Which factors determine their success in their native range? (ii) What differences among them can explain the differences between their invasion potential in their introduced range?

First, we made a basic trait-collection of the species studied and scanned it for essential differences that can explain their spread. Second, we studied the habitat preference of each species, their response to different grade of anthropization and the composition of the vegetation in which they occur. The three species differ only in few basic traits. However, some of these differences could predict their success as exotic invaders. The highly invasive *B. tectorum* occupies the highest number of floristic zones within its natural range. This could influence the introduction frequency of the species and its naturalization success. Besides, *B. tectorum* is the only species, which can also be pollinated by wind besides cleistogamy and selfing. Although the three species co-occur in sandy habitats, they prefer different types of patches and tolerate different grade of disturbance: *B. tectorum* occurs in disturbed areas, in the primary phase of the succession, *B. sterilis* prefers the shadow of the black-locust stands, while *B. squarrosus* is present in natural, undisturbed patches.

Invasive fish species *Neogobius melanostomus* (Gobiidae) in the Danube river: parasite fauna and condition status in native and non-native distribution area

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Round goby (*Neogobius melanostomus*) is a fish species native to Ponto-Caspian region. Since the 1980s, it was introduced to the Great Lakes in North America (where it has become especially invasive), Baltic Sea and also upstream the Danube river.

Parasite infection has been recognized as one of important factors affecting the process of invasion. Absence of parasites in introduced hosts may occur because of conditions unfavourable for parasite survival or further development in a new environment. Parasite loss may result in better condition of introduced hosts, which can provide them with an advantage over native species (i.e., Enemy Release Hypothesis). Transmission of parasite species from introduced to native species can also occur and result in a strong pathogenic effects on natives but introduced species may be infected with new parasites as well.

In our study, communities of metazoan parasites and condition status of round goby was investigated in three stretches of the Danube river in Bulgaria (native population of round goby), Slovakia and Austria (introduced populations) during 2005 and 2006. Introduction with round goby of parasite species non-native for the Slovak and Austrian sections of Danube was not observed. Instead, introduced round goby has been infected with several new parasite species that are not known in its native population. The abundance of parasites did not significantly differ between native and introduced goby populations in most of the fish groups tested. The comparison of condition indices revealed better condition status of round goby in the areas of its introduction compared to its native distribution area, but no relationship between the values of condition indices and parasite abundance was observed. Therefore, parasitism is not a significant factor affecting condition status and expansion of round goby in the middle Danube river.

Trophic features of an invasive fish species, tubenose goby *Proterorhinus marmoratus*, in the upper part of Kuibyshev water reservoir (Middle Volga, Russia)

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The main goal of this study was to analyze the diet spectrum, quantitative characteristics of feeding and trophic features of tubenose goby (*Proterorhinus marmoratus*), the new gobiid invader in the upper part of the Kuibyshev water reservoir. Tubenose goby was discovered in the Volzhsky stretch (48°43' E, 55°47' N) of the reservoir in 2004. Food composition of the tubenose goby was studied based on analyses of 104 stomachs. The specimens of the tubenose goby were caught in September 2006 and in July and September 2007; they ranged from 15 to 49 mm in standard length (average 29.2 mm; SD 2.8) and from 0.02 to 12.15 g in weight (average 0.35 g; SD 0.05). Among specimens investigated, individuals of the first, second and few individuals of the third year of life were found. The data on sex ratio indicate some prevalence of males above females in all age groups. Male had greater length/weight characteristics in comparison to females.

A total of 24 food types, representing 11 systematic groups of invertebrates were found in the diet of tubenose goby. Young fishes were feeding on large near-bottom zooplankton, mainly representatives of the family Chydoridae. Benthic, badly floating species, such as *Acroperus harpae* and *Eurycercus lamellatus* prevailed in the contents of intestines. Older fishes fed more on Amphipoda (*Chelichorophium curvispinum*), Copepoda (*Canthocampus staphylinus*), but gut content consisted mainly of small insects, inhabiting zone of macrophytes and Diptera larvae, dwelling soft sediments (Chironomidae). Molluscs (*Dreissena polymorpha*, *Lythoglyphus naticoides*), although very abundant in the investigated part of the Kuibyshev reservoir, were not used for food by tubenose goby. This is connected to length/weight characteristics of tubenose goby and their strict preference of the certain type of microhabitats (coastal macrophytes zone).

To characterize the intensity of nutrition of Gobiidae, gut fullness coefficient (FC) was monitored. Mean indices of stomach fullness were relatively high (112±13‰). This indicates a high intensity of feeding and, consequently, good food provision for tubenose goby in the Kuibyshev water reservoir. The relatively smaller success of invasion of tubenose goby and the uneven distribution in the Kuibyshev reservoir can be explained by specific features of their diet: tubenose goby keeps feeding mainly on benthic zooplankton and small water insects. They compete with juvenile fishes and many other fish species. Another invader from the same family, round goby (*Neogobius melanostomus*), consumes mainly *Dreissena*, which is not so much on demand as a food object.

Ponto-Caspian invertebrate invaders, numerous in the reservoir, were practically absent from the diet of tubenose goby. Our study did not confirmation the “invasional meltdown” concept of Simberloff & Von Holle. The establishment of round goby in the Kuibyshev water reservoir does not appear to be facilitated by other invaders from the same region of origin.

How a high phenotypic plasticity of *Ambrosia artemisiifolia* explains its invasion success in France?

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Common ragweed (*Ambrosia artemisiifolia*) is an annual plant belonging to the Asteraceae family, introduced from North America to Europe one century ago. This plant species is now widespread in numerous countries all over the world, causing damage to agricultural crops and human health. *Ambrosia artemisiifolia* may infest spring crops, but also invades a wide range of habitats such as human-disturbed sites or riverbanks. Furthermore, this species produces abundant pollen inducing strong allergenic reactions in humans (Basset & Crompton 1975).

The success of colonization of some invasive species in different environments may result from their high phenotypic plasticity (Hassel et al. 2005). A considerable variability of life history traits was previously observed among and within the populations of common ragweed (Fumanal et al. 2008). However, some questions remain: (i) Are the invasive common ragweed populations introduced in France locally adapted to their habitats or are they highly plastic in their life history traits? (ii) Do detectable genotype × environment interactions exist? (iii) Can their potential of response to contrasted environments explain their invasive success?

Reciprocal transplants were used in order to test these hypotheses, using three French invasive populations of common ragweed grown in contrasted environments. The same genotypes were transplanted in each original site selected from different habitats (riverbank, wasteland and gravelpit) and along a latitudinal gradient. Several life history traits (plant height, width, number of secondary axes, above-ground dry biomass) were measured during, or at the end of the experiment and analysed using ANOVA and multivariate statistics.

No local adaptations of populations to specific environments were detected. However, we showed that some populations had higher fitness than others in all the environmental conditions tested. A high phenotypic plasticity among and within populations was also detected. The genotypes within populations showed different and complementary plastic responses to their new tested habitat. The amplitude of the plasticity also differed among genotypes. Furthermore, this high plasticity was consistent with the high genetic diversity of French common ragweed populations, showing the highest genetic diversity within the populations (Genton et al. 2005). The high response capacity of genotypes to environmental changes may be an optimal strategy for the populations to optimise their invasion success.

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Identifying determinants of plant invasiveness: a comparative approach using congeneric pairs of invasive and non-invasive naturalized species in their native range

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Predicting characteristics of invasive plants species is a major challenge in invasion ecology. Previous studies attempting to identify determinants of plant invasiveness relied on characteristics measured in the invasive range. Here we aim to test whether invasiveness can be predicted from plant characteristics that are measured in their native range.

We selected 10 congeneric pairs of invasive and non-invasive plants that are naturalized in North America and native to Europe. We sampled on average 3 populations per species, measured several life-history traits and estimated leaf as well as seed herbivory. The poster will outline our field work results and will potentially allow assessing how well they predict plant invasiveness.

Comparison of emergence and survival rates between pairs of coexisting alien and native species under different levels of irradiance and watering

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Human-induced alterations in the availability of light, water or nutrients can create new opportunities for alien species and decrease the adjustment of the native ones to the environment. In this study, we aim to identify the light and water conditions that favour exotic plants to the detriment of co-existing native ones. We selected six alien tree species, two of them widespread in the Northwest of the Iberian Peninsula (*Acacia dealbata* and *Eucalyptus globulus*) and four spreading through the floodplains of the central Iberian Peninsula (*Ailanthus altissima*, *Robinia pseudoacacia*, *Acer negundo* and *Eleagnus angustifolia*). For comparison, we selected two native trees in the first area (*Pinus pinaster* and *Quercus pyrenaica*) and three in the second (*Ulmus minor*, *Fraxinus angustifolia* and *Populus alba*). On 1 May 2008 we sowed pre-treated seeds of all species under two combinations of soil moisture (90–100, 70–80 and 50–60% of the field capacity) and light (100, 70, 40 and 10% of full sunlight) outdoors, in the Botanical Garden of Alcalá University (Central Spain). Four trays per each species and treatment were set in the experimental plots (550 trays in total, 48 per species). For big seeds we used multi-pot trays (24 pots of 330 ml per tray) and for small seeds single trays of 28 × 38 cm. All of them were filled with a 1:2 mixture of sand and substrate (Kekkilä, NPK: 15-10-20). To get the light treatments, we used green nets, to mimic the light gradient spanning from a closed forest to a gap. Water treatments were nested within each shade treatment; they were obtained by weekly weighting four trays per treatment and by manually adding the amount of water to reach the target moisture when required. Emergence and survival rates are measured twice per week.

Preliminary results show that alien species tend to emerge earlier than their native pairs (Figure 1). Among the exotic species, germination rate was accelerated (*Acacia dealbata*, *Ailanthus altissima*) or decelerated (*Eucalyptus globulus*) by high irradiance, or not affected by treatments (*Robinia pseudoacacia*, Figure 1). Among the native species, only *Populus alba* exhibited a high rate of germination three weeks after sowing, which was significantly higher at low irradiance. Watering treatments did not affect the emergence rate because the strong rains in May offset the effects of our treatments. After three weeks from sowing, none of the germinated seedlings exhibited mortality. These preliminary results suggest that seeds of exotic trees germinate earlier than those of natives, and that germination of exotic species is favoured by high or medium light intensity, or is not sensitive to the range of experimental conditions. If this result is confirmed, it would indicate that the spread of exotic trees is favoured by disturbances that increase the amount of light reaching the soil.

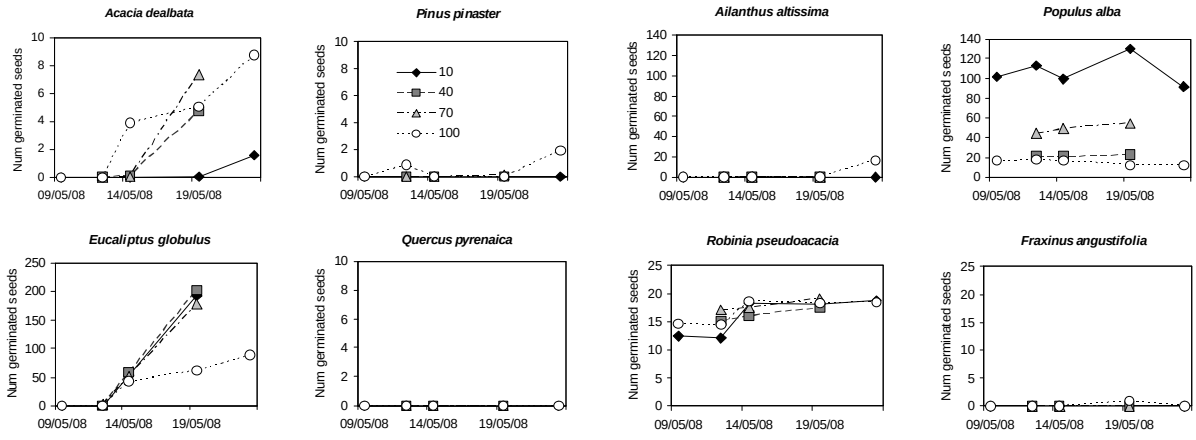

Figure 1. Cumulative number of germinated seeds for exotic invasive trees (left graphs) and coexisting native trees (right graphs) grown under four levels of irradiance (from 10 to 100% of full sunlight). The four left graphs correspond to species from Northwest Spain, the four right graphs to those from central Spain.

Correlates of naturalization and occupancy of introduced ornamentals in Germany

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Invasions are multistage processes. The performance of a species at the different stages depends on socio-economic, biogeographical, ecological and evolutionary factors. Most studies addressing the factors that determine the invasions success focus on one particular stage, usually by examining data on introduced species that succeeded to naturalize, whereas species that failed to naturalize are often not considered.

In this study (Hanspach et al. 2008), we examined success in naturalization and occupancy of 8018 ornamental plant species, all of which were introduced into botanical gardens in Germany. Data on species introductions were extracted from the SYSTAX database (Information System of German Botanical Gardens). The list of successfully naturalized species in Germany was taken from the BiolFlor database. The influence of parameters characterizing propagule pressure, biogeography, winter hardiness, life strategy, morphology and genetic variability on species naturalization and occupancy in Germany was tested using regression models. These parameters were derived from the SYSTAX database and the European Garden Flora. The influence of phylogenetic dependence was considered within simple single variable models as a nested random effect. All traits that appeared significant in these simple models were combined in a multivariable model.

The simplified multivariable model revealed an increasing probability of naturalization of species with higher winter hardiness, a wider native range and a higher planting frequency in botanical gardens (Nagelkerke-R2 0.196). Moreover interactions between growth height and planting frequency and between growth form and winter hardiness influenced the probability of naturalization. The occupancy of naturalized plant species, which is the number of occupied grid cells (6' longitude × 10' latitude), can be explained by the winter hardiness (pseudo-R2 0.61). The stratified pre-selection of ornamental plants by gardeners may hold a key to their successful escape from cultivation and subsequent naturalization.

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Comparing density and fitness in native and invasive populations of *Linaria vulgaris*

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Comparing the native with the invasive range is important for investigating the mechanisms of invasion and to inform control efforts (Hierro et al. 2005, Edwards et al., 1998). In particular, interactions such as pollination and competition occurring at different spatial scales may affect the spatial dynamics of populations, leading to differing density patterns across spatial scales. The study of invasives would benefit from examining these density-fitness relationships at multiple spatial scales (Taylor & Hastings 2005).

Linaria vulgaris is a clonal, perennial herb that is native to Europe and invasive in North America (Pauchard et al. 2003). This study aims to compare density and fitness between UK and North American populations at multiple spatial scales. 0.5 degree grid cells of the UK were climatically matched with cells in North America using an ordination of the CRU Climate Dataset (New et al., 1999). Populations were then identified in Yorkshire, Essex, Alaska, British Columbia and North Washington State. Surveys of the UK populations demonstrate how conspecific density surrounding an individual varies across spatial scales. We also show the relationship between conspecific density and survival, growth and seed production. Future work will examine density and fitness in North American populations.

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

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Fallopia japonica is one of the most aggressive invasive plant species in Europe (Beerling et al. 1994). It was introduced from Asia during the nineteenth century. It can grow up to 3 meters tall and form dense stands displacing native plant species, altering soil properties and pedofauna. All European populations are formed by a single male-sterile clone. Thus they should only be able to reproduce only vegetatively. However, *F. japonica* can be pollinated by *F. sachalinensis*. This cross produces a hybrid, *F. ×bohemica*, which can spread even more rapidly than its parents (Mandák et al. 2004).

The aim of this project is to compare functional traits of these two invasive species and their hybrid in Belgium, to establish which traits have influence invasiveness and compare the competitive ability of the three taxa. Although the physiology of *F. sachalinensis* was studied, comparison of the ecophysiology of the three taxa in their introduction area has never been the object of a study.
Sites where several *Fallopia* taxa grow in sympatry were chosen to avoid environmental effects.

During the whole growth season, data on height, number of leaves, number and length of internodes, N and P content and architecture (number and length of ramifications) are recorded using 10 plants of each taxon. We aim to determine the pattern of growth, biomass allocation between leaves and stems, and dynamics of nitrogen allocation, including resorption from senescing organs. Common garden experiment will follow in 2009 to compare the three taxa under controlled conditions.

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Influence of herbivore insects on population dynamics of *Cirsium arvense* in its native habitat

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Cirsium arvense is one of the 10 most frequently listed weeds in the USA and Canada. The use of biological control might be one option to fight its invasion. There have been many attempts to use biological control to limit the spread of invasive species, however, with a limited success. One of the problems in using biological control is that we still know relatively little about the effect of herbivores on plant performance in natural populations, thus we are not able to decide under which conditions biological control might be effective.

The aim of our project was to investigate the effect of natural enemies on *Cirsium arvense* in its native range. We measured damages by different herbivore insect guilds and rust fungus *Puccinia punctiformis* in *Cirsium arvense* in six different populations in the surroundings of Prague (the Czech Republic). The populations were divided by a humidity gradient. We assessed the spatiotemporal variability in damages by several natural enemies in *Cirsium arvense* between locally distinct populations with different abiotic conditions and seasons. In particular we were interested in identifying damage types that co-occur through space and time. We also wanted to discern whether the most considerable insect species have the greates influence on the population dynamics of *C. arvense* (the most effective herbivore hypothesis) or if a combination of more species has greater effect (complementary herbivore hypothesis).

The damage to plants of *C. arvense* differs through seasons and is more common in wet site conditions. Damages that are co-occurring on the same individuals are necrosis at the top of ramets, eaten flower tops, cocoons in leaves, galls in stem and other stem damages. Other guilds of natural enemies that co-occur in the studied species are rust, holes and mines per leaf, and froghoppers. The most important result is that guilds producing leaf necrosis were causing the same damage separately on *Cirsium arvense* as when combined with folivory guilds or with those which produce stem damage. This suggests that searching for an insect from this guild could lead to better biological control of *C. arvense* than to use a combination of various control insect species; nevertheless, more studies are needed to confirm this fact.

Ecological study of invasive species *Lupinus polyphyllus* in the Bohemian Forest

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Alien species represent an unwelcome component not only in the flora of conservation areas. They can cause considerable problems to management by replacing native flora, reducing species diversity and occasionally also altering site conditions (Vitousek 1990). *Lupinus polyphyllus* is one of the most hazardous invasive species in the Czech Republic (Chytrý et al. 2005) and its increasing occurence represents a threat to native biodiversity not only in the Bohemian Forest. The species spread in the National Park Šumava was recorded in a GIS layer with the record of habitat features (abundance per population and nature of biotope), which was consequently analysed. Data was obtained from recent records. The most frequent occurrences are along the roads, ways and railways. *Lupinus polyphyllus* occurs mostly in populations consisting of 10 to 50 plants. The germination of seeds originating from six localities in different altitudes was measured experimentally. The influence of altitude on seed germination and seedling survival was studied. Seed from individual localities differed significantly in seed germination, but not in seedling survival. Seed germination decreased with increasing altitude.

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Does parasite prevalance and impact vary between native and invasive alien crayfish?

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Parasites that affect native and alien species differently can influence the outcome of invasions. In the UK, the invasive alien signal crayfish, *Pacifastacus leniusculus*, and the native white-clawed crayfish, *Austropotamobius pallipes*, can both be infected by microsporidian parasites. One such species, *Thelohania contejeani*, causes porcelain disease which destroys muscle tissue and causes mortality. It is not known if this parasite affects the crayfish species differently. We are investigating the role of parasitism in the ongoing invasion in the River Wharfe in Yorkshire using a long-term survey of parasite prevalence in native and alien crayfish populations. Behaviour experiments using crayfish of both species show the impact of parasitism on each species' activity, responsiveness, and prey choice. Here we present data on *T. contejeani* prevalence in native and alien crayfish populations, and the impact of parasitism on the behaviour of native crayfish.

Biological invasions, regional identity and biodiversity: the example of *Rosa rugosa*

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Biological invasions represent a major threat for biodiversity. The expansion of non-native plants often resulted in a decline of biodiversity, which concerns diversity of genes, species, communities, ecosystems, as well as of landscape. Especially in coastal dune areas of NW Europe, the expansion of *Rosa rugosa* is problematic, because of strong decline in species diversity. On the other hand, there are some positive aspects of *R. rugosa* such as erosion control, tourism control, and human's recreation-regeneration value. Using *R. rugosa* the project will exemplify, how a differentiate analysis of species invasion potential in relation to various habitats could be used for nature conservation strategies. The project is dealing with following questions: (i) Which genotypes and hybrids of *R. rugosa* were and are planted in German coastal areas? (ii) What differences of invasion potential exist, regarding dispersal, establishment, and spread between *R. rugosa* types in various coastal dune areas? (iii) How do different dune types vary in relation to habitat suitability in relation to *R. rugosa*?

Expected are results about the risk potential of different *R. rugosa* types, management recommendations on priority dune habitats, including shrub removal, and probably recommendations on low-risk *R. rugosa* hybrids to be used for future planting in coastal areas.

Plant traits and functional types of alien and native species on Central Italy coastal dunes

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Humans have extensively altered the biological diversity of the Earth, both locally and globally, inducing major consequences on terrestrial and marine ecosystems. In particular, loss of diversity has concerns coastal dune ecosystems, which are vulnerable and especially rich in rare and threatened species (Acosta et al. 2006, 2008). Direct human activities on beaches and coastal dunes have not only caused the decline and extinction of local species, but also increased rates of species invasion. Therefore, analysing floristic and functional diversity (Garcia-Mora et al. 1999) becomes a priority in order to preserve and manage these ecosystems. In this study, we identified functional groups of native and alien species growing on coastal dunes of Central Italy and compared morphological and functional traits of these species in order to analyse the success of alien plants in relation to natives.

First, we selected native and alien plants whose main morphological and functional traits we analysed. The most common and abundant 41 species were selected (27 native and 14 alien). Then we chose 16 morphological and functional traits that are strong predictors of invasion by aliens (Pyšek & Richardson 2007). Through Multiple Correspondence Analysis (MCA) and Hierarchical Cluster Analysis (HCA) we (i) identified functional groups of native and alien plants in Mediterranean sand dunes; and (ii) analysed the pattern of each trait in the factorial plane and in each functional group. We compared plant traits between native and alien species, using t-tests for continuous (or quantitative) type data, and Mann-Whitney U-tests, for discrete (or categorical) type traits. Analyses were carried out using the statistical package SPSS.

Three main functional groups (PFTs) were identified: (i) annual plants that utilize resources rapidly; (ii) foredune perennial species that store resources; (iii) backdune perennial species that invest in above-ground biomass. All functional groups contain alien species, which therefore share with native species both annual and perennial strategies. No significant differences between native and alien plants were observed for perennial functional groups, but only for the group of annuals, particularly those growing on the transition dune, where alien species flower later and have a more developed growth form.

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Benthic prey selection by racer goby *Neogobius gymnotrachelus* in various habitats of a lowland dam reservoir in the lower Vistula River (Central Poland)

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Racer goby (*Neogobius gymnotrachelus*) is a Ponto-Caspian expansive fish, which spread upstream in large European rivers during last years and colonised the lower Vistula River in Poland. So far, the diet of this non-indigenous species in newly established areas has been studied only in nearshore, shallow waters. Little is known about its food composition as well as feeding preferences in various habitats at a large spatial scale, including offshore, deeper parts of rivers and dam reservoirs, which differ from nearshore areas with respect to bottom substrata and benthic prey availability.

Therefore, in the growing season 2005, we studied taxonomic composition and abundance of benthic macrofauna (potential prey) as well as the diet of gobiids at several sites located along 1.9 km wide cross-section profile of the Wloclawek Reservoir on the lower Vistula. Samples (invertebrates and fish) were taken from depths 0.5–2.5 m (nearshore, sandy or muddy bottom areas with or without macrophytes), 4–5 m (open water areas with muddy bottom) and 10–12 m (the current zone with muddy bottom). Dietary items in the gobiid guts were identified and expressed as the percentage contribution to the total wet weight of prey taken. These values were compared to percentage shares of the same items in the bottom fauna samples taken from the area of fishing to check foraging selectivity.

In general, macrozoobenthos abundance was very high in the reservoir (mean total density was 36,000 ind. m^{-2}, and biomass 142 g fresh weight m^{-2}), which provided suitable feeding conditions for benthivorous gobiids. Molluscs (including small individuals available for fish) predominated in the total biomass of benthic fauna in the nearshore zone (< 2.5 m deep). Oligochaetes were most abundant in open water areas (4–5 m deep), while in the current zone (10–12 m deep), both oligochaetes and chironomids subdominated by weight. Racer goby fed mainly on chironomids, however, small molluscs were also taken in substantial amounts in the off-channel habitats, and sometimes amphipods and leeches were numerous in the diet. Oligochaetes, despite their great abundances in environment, were eaten in much lower numbers. Invertebrates specific for the nearshore zone were not found in the guts of fish sampled at the offshore sites. Thus, fish probably did not explore large areas during foraging.

Our results confirm previous findings that racer goby exhibit wide dietary plasticity, which allow them foraging on site-specific benthic communities. However, the results also suggest that oligochaetes were the least suitable prey, because they were negatively selected in various habitats. Probably, they are an alternative prey for racer goby, eaten in greater amounts only when more attractive prey is scarce.

Intraguild predation between Harlequin ladybird *Harmonia axyridis* and European ladybirds

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Harmonia axyridis is a ladybird of Asian origin that is presently invading Europe. Among other detrimental effects, *H. axyridis* is suspected to affect native ladybird populations through intraguild predation and competition for food. As part of a larger risk assessment study, we are presently investigating the intraguild predation between *H. axyridis* and native ladybirds. Our goal is to screen as many native ladybirds as possible, but aphidophagous species are tested in priority because they share their diet with *H. axyridis* and are thus more likely to encounter the invasive species in the field. Competition tests are carried out in Petri-dishes between eggs and L1, L1 and L1, and L4 and L4. *Harmonia axyridis* and one of the native species are released in Petri dishes for 24 hours, in the following combinations: first instar larvae against eggs, first instars against first instars and last instars against last instars.

Preliminary results with a limited number of species showed that eggs of indigenous species are more palatable for *H. axyridis* larvae than the reverse. Competition tests between larvae showed that *H. axyridis* is an asymmetric predator of indigenous ladybirds, particularly in the last instar. The only exception found so far is *Anatis ocellata*, which often acted as predator of *H. axyridis*. More complete results on intraguild predation will be presented at the conference. In order to link the results obtained with the underlying mechanisms, we will analyse the chemical compounds of any eggs or larvae that are not accepted or suitable for *H. axyridis* development.

Hybrid species of the invasive *Fallopia* complex and their resistance to herbivores

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Hybridization can play an important role for the success of invasive plants and herbivore resistance of hybrids may be an important component of hybrid-plant fitness. In Europe, *Fallopia* taxa are among the most aggressive invasive plants, capable of altering the character of ecosystems. Several species were introduced from eastern Asia and are able to hybridize in Europe. The hybrid between *F. japonica* and *F. sachalinensis*, *F.* ×*bohemica*, seems to spread more aggressively than the parental species. We studied the palatability and suitability as food of several *Fallopia* species and their hybrids for native European herbivores. Three *Fallopia* species (*F. japonica*, *F. sachalinensis* and *F. baldschuanica*) and two hybrids (*F.* ×*bohemica* and *F.* ×*conollyana*), all with known genotypes, were offered to three herbivores. As a control, plants of *Taraxacum officinale* and *Rumex obtusifolius*, which is in the same family as *Fallopia* (Polygonaceae), were also offered. No-choice tests were carried out with the generalists herbivores *Arion lusitanicus* (common garden slug) and *Noctua pronuba* (Lepidoptera, Noctuidae), as well as with the specialist *Gastrophysa viridula* (Coleoptera, Chrysomelidae).

Leaf area consumed by all three herbivores differed strongly among the taxa. Consumption on leaves of *Fallopia* was much lower than on leaves of the native species. Leaves of *F. japonica* consistently suffered the lowest leaf damage. The hybrid plants showed either intermediate levels of resistance, or similar levels of resistance as one of the parental species, depending on the hybrid taxon and the herbivore used. These findings indicate that hybridization influences resistance of the *Fallopia* complex to herbivores, which in turn may influence hybrid fitness. In general, the herbivores performed better on the two European control plants than on leaves of the *Fallopia* taxa. These results are consistent with observations in nature. In Europe, plants of the *Fallopia* complex are hardly attacked by any herbivores, which could be one reason for their invasion success.

Germination and seedling establishment of exotic *Fallopia* taxa along a climate gradient

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Exotic knotweeds of the genus *Fallopia* (syn. *Reynoutria*), *F. japonica* (also referred to as *Polygonum cuspidatum*), *F. sachalinensis* as well as their hybrid *F. ×bohemica*, are considered to be among the most serious invasive exotic weeds in Europe. These taxa are thought to reproduce mainly asexually in Europe. There is a growing evidence that sexual reproduction also occurs in the introduced range. In addition, the different *Fallopia* taxa are able to hybridize. Viable seeds have been recorded from various taxa of *Fallopia*, although seedlings are rarely observed in the field. Lack of observed seedlings may be due to lack of pollen and low rates of seedling establishment. Seedlings of *Fallopia* may be sensitive to frost and will not survive the winter. Increasing temperatures may lead to greater rates of seedling establishment. Frequent sexual events and hybridization could increase the genetic variability and this could lead to an increase of the invasiveness of the *Fallopia* taxa.

A germination experiment was set up along a climatic gradient to test the impact of climatic factors on germination and seedling establishment of exotic *Fallopia* taxa in Europe. Seeds of *F. japonica*, *F. sachalinensis* and the hybrid *F. ×bohemica* were collected in several regions in Germany, Switzerland and Belgium. In November 2006, seeds were placed in pots in common gardens at six different locations along a gradient from northern Germany to southern Switzerland. The climatic conditions at the southern most location are similar to the future climate predicted for large parts of Germany, i.e. with higher temperatures and annual rainfall.

Preliminary analyses indicate that germination differed significantly between locations and was lowest at the northernmost and at the most elevated location. Height, leaf length and leaf width of seedlings differed significantly between taxa and locations. Smallest values of morphological parameters were recorded for plants growing at the most elevated site, and highest values for plants growing at the most southern site. The results also indicate that *Fallopia* seedlings are able to survive the winter.

Seed ecology of the invasive alien species *Acacia longifolia*

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In the Portuguese dunes, exotic species such as *Acacia longifolia* (Andrews) Willd were introduced to curb sand erosion and after that became invasive, representing nowadays an environmental problem of increasing proportions. *Acacia longifolia* success is partially due to the abundant seed production, with high longevity in the soil, which are crucial to the ability of plants to (re)invade new areas. Consequently, successful control of this species depends not only on the efficiency of the method applied, but also on its availability in the seed bank. In order to assess the role of this species seed bank on the invasion process, three experiments were conducted aiming to: (1) evaluate the effect of depth and duration of burial on the viability of seeds; (2) quantify the accumulated seed bank; (3) quantify the seed rain and primary dispersal.

In experiment 1 ripened seeds were collected from dehiscent pods and sub-samples were sown inside bags at different depths and collected after 4, 10, 18, 31 and 55 months to evaluate germination and viability. Results showed that a relatively high number of seed did not recover, reaching 80% of seeds lost in the most superficial depth (1–2 cm), after 55 months of burial. Seed germinability (germination without stimulation) was very low (less than 20%). Nevertheless, after stimulation, a high percentage of seed (almost 100%) were viable. The effect of the time of burial was only evident on the amount of seed recovered.

In experiment 2, seed traps were installed during seed rain season along transects established perpendicularly to the invasive stand margins to quantify seed rain and evaluate primary dispersal. Results showed that seed rain is concentrated very close to the stand margin (no seeds were found on traps distant more than 1 m from the margin), indicating that gravity rather than wind is responsible for *A. longifolia* seed dispersal. Number of seeds reached 16,000/m^2 in areas under the trees.

In experiment 3 transects were established perpendicularly to the stand margin and soil cores were collected at each meter. Soil was then explored to detect and quantify *A. longifolia* seeds. The soil seed bank (0 to 10 cm depth) reached 4000 seeds/m^2, in areas under the trees or very close to the stand margin. Sporadic seeds were found until 7 m from the stand margin, indicating that possibly some other agent may be implicated on seed dispersal. Periodic strong winds may also be responsible for the scattered seeds found apart from the invasive trees. Comparing the 4000 seeds/m^2 recovered from the seed bank with the 16,000 seeds/m^2 collected on the seed rain traps, it is obvious that enormous amount of seed germinate or are destroyed before entering the seed bank.

The experiments showed that despite a high percentage of ripened seeds lost (both in the seed bank and before entering it) the surviving seeds are highly viable and numerous enough to quickly (re)invade the area. Experiments are being conducted to explore the agents of dispersal to more distant locations.

Secondary succession after the removal of *Reynoutria* taxa

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In the Czech Republic, the *Reynoutria* taxa rank among highly invasive with negative impact on biodiversity of invaded communities. Many current projects therefore attempt to eradicate these taxa. This is usually accomplished by spraying of inflicted area with non-selective herbicides. The process is very time and money demanding. It is thus desirable to ensure that the system will recover quickly after the treatment. Due to its weakened stability, the system is vulnerable to invasion by other invasive species and its recovery is uncertain. One possible approach to achieve full recovery of the system is to support secondary succession at the site. In order to direct the secondary succession to demanded results, it is necessary to know its detailed progression. It is also useful to know if the direction and speed of succession is affected mainly by habitat conditions or by the availability of seed. The limitation by habitat conditions might be important since *Reynoutria* taxa may modify the conditions of the stands. To describe the course of succession, we monitor the sucession on sites after spraying with herbicides and compare it with sites at which the target species were sown. Results after two field seasons are presented.

Dynamics of soil seed bank of *Robinia pseudoacacia*, a tall leguminous tree species invasive in Japan

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Robinia pseudoacacia is a tall leguminous tree species native to North America. It is well-known as a worldwide invasive plant species. The seed of *R. pseudoacacia* show physical dormancy due to the impermeable seed coat, and forms soil seed bank. However, little is known about the soil seed bank of *R. pseudoacacia*. In our previous study, we found that some trees produce dormant seeds, whereas other trees non-dormant. In addition, the life span of *R. pseudoacacia* seems to be shorter than the other tall tree species (< 100 years), and old-aged stands tend to decline abruptly even though there are no natural enemies in Japan. This suggests that at the stand level the amount of seed of *R. pseudoacacia* in the soil should be proportional to basal area (BA) rather than stand age. To verify this hypothesis, we investigated the amount of seed in the soil in artificial stands in Hokkaido, northern Japan, with respect to the stand dynamics.

We selected eight artificial stands, planted in 1930s to 1990s, in central Hokkaido, northern Japan. We set up a 20 × 20 m plot in the stand in May–June, 2007, in which we recorded all tree species taller than 1.3 m and measured DBH (diameter at 1.3 m height above ground) to estimate BA at stand level (m^2/ha). Hereafter, we will define BATotal and BARp as BA of all trees and BA of *R. pseudoacacia* in each plot, respectively. In each plot, we also took 20 soil samples (10 cm in radius × 10 cm in depth) from the forest floor. The soil samples were screened in the laboratory for seed of *R. pseudoacacia*.

In the present study, the relationship between BATotal and stand age exhibited sigmoidal curve; with increasing stand age, however, BARp–stand-age exhibited upward convex curve. This implies that the biomass of *R. pseudoacacia* stand increased for 50–60 yrs, and after the peak, the stand declined gradually. The remaining space would then be occupied by other, native tall tree species. The amount of seed of *R. pseudoacacia* (hereafter NSeeds) varied widely among stands, and the maximum number was 13,757 seeds/m^2 in 55 yrs-old stand. The relationship between NSeeds and stand age also exhibited sigmoidal curve with increasing stand age. NSeeds was significantly proportional to BARp ($r = 0.948$, $P < 0.001$; Figure 1) implying that soil seed bank of *R. pseudoacacia* in the present study is strongly related with stand biomass.

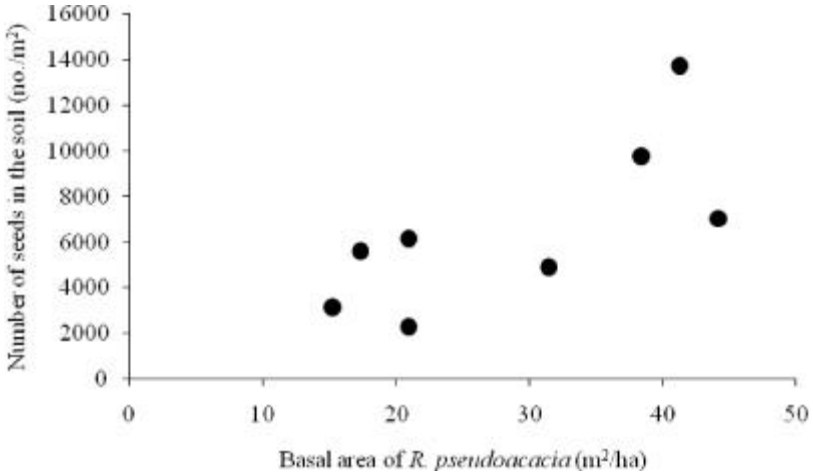

Figure 1. The relationship between the amount of seeds in the soil and BA of *R. pseudoacacia* in central Hokkaido, Japan.

Comparative study of the capacity to accumulate arsenic and lead in tissues of the invasive cordgrass *Spartina densiflora* and native *Spartina maritima*

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Different studies show that the uptake, retention and excretion of heavy metal by plants in estuarine environments, as well as metal distribution through different plant tissues, differ among plant species. The aim of this works was to compare the capacity of two species, the invasive cordgrass *Spartina densiflora* and native *S. maritima* to accumulate arsenic and lead in different tissues.

Spartina maritima usually grows in regularly flooded low marshes, while *S. densiflora* in middle/high marshes. Plants of both *Spartina* species were collected from Odiel and Tinto salt marshes (n = 5), and separated in four different fractions: roots, tillers and old and young leaves. Then the different tissues were dried at 80 °C for 48 h, and As and Pb concentrations were analysed using an atomic absorption spectrophotometer.

The concentrations of As and Pb in different tissues dcreases as follow: roots > tillers > leaves, for *S. maritima*; and roots > leaves > tillers for *S. densiflora*. *Spartina densiflora* accumulated higher concentration of both metals in leaves than *S. maritima*. On the contrary, this content was higher in roots of the native *S. maritima*. The concentrations of As (ca 40 mg kg^{-1} dry weight) and Pb (ca 70 mg kg^{-1}) measured in leaves of both species is are considered excessive or toxic for plants by other authors. Levels of Pb ca 20 mg kg^{-1} dry weight has been reported to completely stop plant root growth and cause plant death in a few weeks. *Spartina* species have mechanisms to avoid the translocation of As and Pb to aerial tissues, since the higher concentration of these metals were found in the roots. The capacity of both *Spartina* species to live in sites with such a high concentration of metal could be used for phytoextraction of As and Pb in polluted salt marshes as Odiel and Tinto.

Growth and photosynthetic responses to copper stress of an invasive cordgrass *Spartina densiflora*

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Spartina densiflora Brongn., is found in coastal marshes of south-west Spain, growing over sediments containing 300–3000 ppm Cu. A glasshouse experiment was designed to investigate the effect of copper from 0 to 64 mmol l^{-1} on the growth and the photosynthetic apparatus of *S. densiflora* by measuring relative growth rate, leaf elongation rate, number of tillers, height of tillers, chlorophyll fluorescence parameters, gas exchange and photosynthetic pigment concentrations. We also determined total ash, copper, calcium, magnesium and phosphorous concentrations, and C/N ratio. At 47 and 64 mmol l^{-1} Cu *S. densiflora* showed 50% biomass reduction after a month of treatment.

Long-term effects of copper on the growth of *S. densiflora* were mainly determined by variations in net photosynthetic rate. The reduction in PSII efficiency, measured by the Fv/Fm ratio, suggested that the decrease in net photosynthetic rate was a result of the structural and functional degradation of the photosystems and of the negative effect on the synthesis of photosynthetic pigments. In addition the greatest impact of Cu on photosynthesis appears to be via the regulation of stomatal conductance, due to an alteration in the K/Ca ratio in the guard cells.

However, the results indicate that *S. densiflora* is capable of tolerating a very high and continued exposure to copper, since this species prevents the translocation of copper from nutrient solution to roots and controls the ion transport into leaves. Therefore, *S. densiflora* could be useful in the phytostabilization of soils.

Phenological patterns of two *Acacia longifolia* communities in central Portugal

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Acacia longifolia (Andrews) Willd, commonly named Sydney golden wattle, is considered to be one of the most important invasive species in Portuguese dune ecosystems. In Portugal, there is a lack of information on the phenology and relationships between phenological pattern and abiotic factors. Thus, a study was initiated to provide descriptive information on the phenology of *Acacia longifolia* and investigate the relationships between climatic factors and some phenological events.

The study was conducted in two areas of central Portugal, Natural Reserve of S. Jacinto Dunes (RNDSJ, 40°39' N, 8°44' W) and Coimbra (40°12' N, 8°24' W), from December 2005 to November 2007. During this period, flower bud formation, flowering, fruiting and vegetative growth were observed monthly in 36 plants in RNDSJ and 6 plants in Coimbra. To detect climatic predictors of phenological events, we related the intensity of each event in a given month to climatic variables (average, maximum and minimum temperature, day length, relative humidity and rainfall). Climatic data were obtained from Maceda for RNDSJ and from Escola Agrária of Coimbra for Coimbra, which are the nearest weather station to the two study areas. The data were analysed statistically to compare phenological events between study areas and months and test for the relationships between phenological event and climatic factors.

The phenological patterns of *Acacia longifolia* for both areas are shown in Figure 1. Plants in both areas had comparable seasonal phenology that differed principally in the timing of certain phenological events. Flower bud formation exhibited a maximum in August in the first year. In the second year there was a small maximum in October in RNDSJ and between August and November in Coimbra. The distribution of flowering was highly variable. In both areas, the flowering occurred in two February and March in 2006. In the second year, the flowering period was longer in RNDSJ and another flowering period began in October of the same year. Fruiting commonly occurred one month after the peak of flowering, from spring to summer. In RNDSJ, fruiting occurred from March to July in both years, reaching a peak in May/June. In Coimbra, the fruiting period started in March and finished in May with a maximum in April/May. Vegetative growth was observed throughout the year in both study areas and was higher between the two major flowering periods.

Although there were apparent differences in the relative proportions of the phenological events between the first and second year, the timing of phenology was fairly consistent. Because of this, the variation in flowering bud formation, flowering and fruiting did not differ significantky between the two areas. However, there was a marked variation in the proportion of plants that exhibited vegetative growth. The phenological events was not correlated with the majority of climatic factors. Flowering and fruiting were negatively correlated with daily air temperatures but the relationship was not significant. Day length and the maximum and minimum temperature were the most important factors for vegetative growth and explained about 50% of variation in the data. These results show that climatic factors influence phenology of *Acacia longifolia*, hence the predictable climate change may alter phenological patterns.

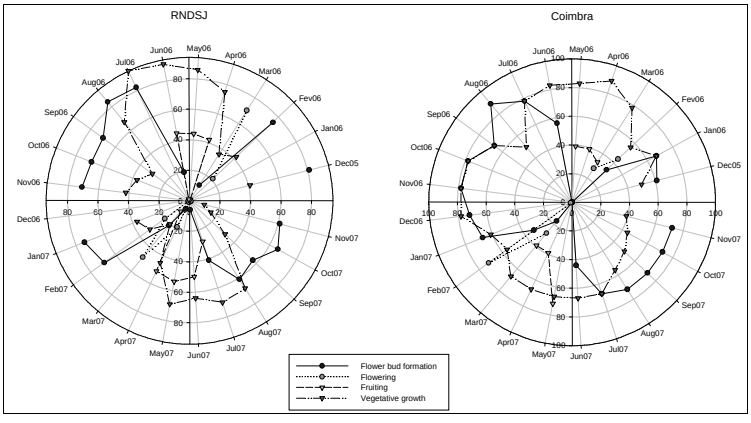

Figure 1. Phenological diagrams of *Acacia longifolia* in RNDSJ and Coimbra.

Comparative ecology of reproductive characteristics of naturalized plants as a tool for prediction of invasiveness

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Attempts to predict which species will become invasive are an important part of research in plant invasions. Our ability to predict, with reasonable precision, the outcome of invasion by a particular species depends on the knowledge of its invasiveness in a given geographical area and habitats it invades. Traditional approaches searching for species attributes as determinants of invasiveness have been based so far on only vague estimates of these characteristics that are difficult to obtain for a large numbers of species. Nevertheless, there is an agreement that reproductive characteristics are crucial for the outcome of invasion.

Therefore we aimed at obtaining quantitative information on reproductive characteristics of a representative sample of alien species (neophytes, introduced since 1500 AD) of the Czech flora, which served as a basis for robust analysis of reproductive determinants of species invasiveness. Species were selected in order to include both widely naturalized and invasive aliens and those with limited distribution, in order to cover various types of invasive behaviour. In 2005–2007, we collected the diaspores of 92 neophytes with different invasion status from 231 localities, and measured following reproductive characteristics: diaspore germination under different temperature regimes, diaspore size, shape and weight, diaspore production, genom size, RGR and seedling establishment, diaspore buoynancy and epichory. We created a database of reproductive characteristics. Regression trees were used to analyse the data, with invasion success expressed as the number of occupied grid cells in Czech Republic being the dependent variable and reproductive characteristics explanatory variables.

We found that the invasion success of neophytes of Czech Republic is affected by interactions of the following reproductive characteristics: diaspore germinability, shape and weight; genom size; good dispersal by epichory; and seedling RGR. These results represent the first complex analysis of a large number of reproductive characteristics and have potential to improve our understanding of traits contributing to species invasiveness, as well as the ability to predict invasions by plant species.

Population growth rate of *Pinus strobus*, an invasive tree in Central European sandstone areas

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Most studies attempting to understand causes of species invasibility deal with single species traits. However, to show that these traits are really those that make a species a good invader, we need to link all traits in a common framework and show how particular traits contribute to overall population growth rate. This can be done by means of population growth models that describe the complete life cycle of a species.

In our study we focused on local population dynamics of *Pinus strobus*, a tree invasive in sandstone areas of Central Europe (the Czech Republic). We studied its growth in three main types of habitats with the aim to identify the most important transitions in the life cycle in each of these habitats and determine potential rate of spread. We also evaluated the effects of spatial and temporal variation in the data on the predictions of future spread. Population growth was modelled using population transition matrices based on the stage-classified population data. The data were collected along a typical environmental gradient of the sandstones that included (i) humid and shaded lower slopes and ravine bottoms, (ii) dry, windy insulated rock tops and (iii) average environment along the slopes. The individuals of *P. strobus* were classified into nine stages and followed over time.

The results indicate that *P. strobus* has a high local population growth rate in all environments, which supports its high ability to spread. Population growth rate of the mean matrices for each position on the slope ranged between 1.109 (with 95% bootstrap confidence interval 1.087–1.134) on the upper slope, 1.112 (1.078–1.142) along the middle slope and 1.185 (1.158–1.216) at the lower slope and ravine bottom. The higher population growth rate of plants at the bottom was mainly because of significantly higher reproduction in this position. On the other hand the survival and growth of trees up to 8 m was significantly reduced in this position compared to the other two.

The elasticity analysis revealed the survival of the oldest trees as the most important element in all positions. The second highest transition was survival of the trees up to 0.15 m in the upper slope. In the middle slope and the bottom, all growth related transitions have the second highest elasticity.
Overall, spatial variation in local population dynamics is higher than the temporal variation. The results thus suggest that it is important to understand the distribution of different habitat types in the landscape to properly predict the rate of spread of the species.

Introduction of weedy forms of genus *Beta* on arable land: potential danger for sugar beet growing and biosafety

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In many countries worldwide where sugar beet is grown, the weed beet has occurred more frequently since the end of the 1980s when the beet seed started to be produced and imported from south-eastern European countries (France and Italy). In this region, wild sea beet (*Beta vulgaris* subsp. *maritima* Arcang.) is native and can pollinate some maternal plants of sugar beet (*Beta vulgaris* subsp. *vulgaris* var. *altissima* Doll.) in seed multiplication fields. The resulting seed is distributed as an impurity in beet seed into sugar beet production areas worldwide. Sugar beet is normally biennial and does not flower in the first year when it is cultivated for bulb production, but the crossbreds with wild sea beet are annual due to expression of a dominant "bolting gene" introduced from wild sea beet (Boudry et al. 1993). These plants emerge and create the seeds in the first year after sowing and later establish persistent soil seed bank and primary populations. The weed beet is hard to control especially in sugar beet fields and can cause serious problems due to competition, hosting of pathogens and complications during the harvest. So called Beta-complex of crop-, wild-, and weedy-forms has also become a recognised case study of gene flow, introgression, and conservation of wild plant genetic resources in relation to the introduction of genetically modified cultivars of sugar beet (Soukup et al. 2007).

The aim of the study was to describe the invasion process of weed beet and find the main reasons for its spread. The invasion of weed beet in the Czech Republic was analysed using observation and experimental methods. The modes and frequency of introduction were examined, farming practices influencing the population dynamic of weed beet were evaluated, and biology and ecology of weed beet were studied. Weed beet seeds were detected in about 20 % of imported beet seed batches. In 1–5 % of seed batches, the contamination limit of 0.05 % was exceeded. Therefore, the seed is the main and regular source of weed beet introduction. At the contamination limit 0.05 %, 50 weed beets can be introduced per 1 ha. The conditions of intensive sugar beet crop production favour the introduction and spread of weed beet. Weed control is carried out using herbicides, which are not able to affect selectively the weed beet in sugar beet field. Inter-row hoeing, which can cut the emerging weed beet plants, is no longer used in current sugar beet growing technology. Hand selection of bolters and weed beet is nowadays impossible at bigger farms. Sugar beet leaves are not harvested; they are cut and spread over the soil surface after the harvest together with weed beet seeds. A high production of weed beet seed glomerules noticed in our observations (1560 per plant in average, each with 2–3 seeds) is the main reason of quick enrichment of the soil seed bank if the bolting weed beets are not removed before flowering. Although the decline of soil seed bank was rapid in our experiments (92.6 % buried seeds died after two, and 98.7% after three years), it is not enough to avoid fully its emergence in subsequent sugar beet in crop rotation. Therefore, weed beet became a serious problem for sugar beet growers. In the future, the populations of weed beet could also become a very persistent reservoir of various transgenes and important element of gene flow inside and outside the agro-ecosystem (Bartsch et al. 2003).

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Preference and performance of *Cameraria ohridella* on *Acer pseudoplatanus*

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The horse-chestnut leaf miner, *Cameraria ohridella* (Lep.: Gracillariidae), is a moth of unknown origin that was first observed in Macedonia in 1984 and has now invaded most of Europe. It is mainly a pest of the white flowering horse-chestnut, *Aesculus hippocastanum* (Sapindaceae), a tree native to the Balkans and introduced into Central Europe as an ornamental urban tree, in the sixteenth century.

Field observations and screening test showed that the moth can also oviposit and develop on other *Aesculus* and *Acer* species. High infestations of *C. ohridella* can be found on *Acer pseudoplatanus* trees situated close to infested horse-chestnut. However, there are important variations in the oviposition rates and development success of *C. ohridella* on *A. pseudoplatanus*. These variations could be due to differences in the ability of *A. pseudoplatanus* varieties to attract the moth and develop resistance reactions, or to *C. ohridella* populations that have become adapted to maple. The main objective of this study is to understand the mechanisms of the association *Acer–Cameraria* and determine whether *C. ohridella* may shift to a native maple, *A. pseudoplatanus*.

The first experiments, carried out in the field in Switzerland showed that females oviposit on different deciduous species. However, *A. hippocastanum* remains the preferred host-plant. Among the other potential host-plants, *A. pseudoplatanus* is clearly preferred for oviposition, but more than 80% of the larvae die in the first two instars. Ongoing experiments show that the oviposition preference and larval performance of *C. ohridella* on *A. pseudoplatanus* vary significantly between sites and individual maple trees.

Journey through the secret life of giant hogweed (*Heracleum mantegazzianum*)

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One of the most aggressive invasive plant species in Europe and North America, and one which receives a high level of publicity, is giant hogweed (*Heracleum mantegazzianum*). Public awareness of this species is due to its exotic appearance, enormous size and risk to human health. The flowering individuals can reach up to 5 m height, leaves are up to 2.5 m long, terminal flowering umbels are up to 80 cm in diameter and the whole plant contains phytotoxic sap, which causes burning and blistering on contact with human skin. *Heracleum mantegazzianum* was introduced from its native range in high altitude mountain meadows in Caucasus to European gardens as an ornamental species during the 19th century. Then it started its successful tour through Europe and nowadays is considered invasive in many European countries. What makes it so successful and is there a way to control its distribution? These two questions summarize the key issues of an EU funded international project "Giant Hogweed (*Heracleum mantegazzianum*) a pernicious invasive weed: developing a sustainable strategy for alien invasive plant management in Europe" (Pyšek et al. 2007).

Here we present the highlights and important aspects of the ecology of this species. Our research covered topics from its basic biology such as reproductive characteristics, floral biology, seed ecology, seed bank dynamics and population ecology to more specific areas of research on the patterns of distribution at small (landscape) and large (country) scales, studies on range expansion, distribution limits and the regeneration ability of the species. During the research several popular myths about this species' biology were refuted.

The key for the invasion success of *H. mantegazzianum* is the synergistic effect of several characteristics: (i) early spring germination; (ii) fast growth of seedlings and rapid formation of dense cover; (iii) no principle constraints to flowering in the massively invaded area in the Czech Republic; (iv) high fecundity (although not as high as often indicated and cited in literature!); (v) ability for self-pollination resulting in viable offspring; (vi) high germination rates; (vii) a large, short-term persistent seed bank; and (viii) high regeneration ability. Nevertheless, the species does not seem to possess any special characteristic/mechanism; extremely high fecundity, rapid growth, capability of self-pollination, extended germination period by means of short-term persistent seed bank, high germination, negligible impact of natural enemies – all these characteristics can be found in other plant invaders. Therefore, it is a combination of superior traits associated with a single species, and acting at different stages of the life cycle, what provides *H. mantegazzianum* with remarkable invasion potential and makes it a 'master-of-all-traits' of plant invasions. This has practical implications, as the species does not seem to have a weak link in its life cycle, on which the control measures could be most efficiently targeted.

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Comparative study of closely related Asteraceae species with different invasion status

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A complex of three closely related alien species of Asteraceae with different invasion status (casual *Coreopis tinctoria* and *Cosmos bipinnatus*, and invasive *Bidens frondosa*) along with native *Bidens tripartita* were studied. The main aim of this study was to clarification the invasion success of *B. frondosa* and assess the invasion potential of both unsuccessful aliens.

Among studied characteristics were reproductive traits (germination under different light and storing regimes, seed viability and seed production), growth characteristics (relative growth rate, biomass production and height of adult plants), tolerance to drought and competitive ability. The impact of *B. frondosa* on invaded communities was also studied.

No crucial characteristic explaining the invasion success of *B. frondosa* was revealed. This species seems to follow the "Jack of all trades" rather than "Master of some" strategy (Richards et al. 2006). Its invasive behavior can be interpreted as a mozaic of many supporting traits, especially high seed production and seed viability, reasonably high percentage of germinated seeds in almost all tested regimes, high relative growth rate and height of adult plant together with considerable biomass production. The unsuccessful aliens *Coreopis tinctoria* and *Cosmos bipinnatus* showed good potential for naturalization and further spread.

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Invasion without sex in *Veronica filiformis*

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Mankind is changing its environment in a hitherto unprecedented way. One aspect of this change is the introduction of organisms to a new environment, creating hundreds of evolutionary experiments. While most of these "experiments" fail, those that succeed are important to understand evolution. One exceptional case is the introduction of *Veronica filiformis* from the Caucasus to Europe (Lehmann 1942). *Veronica filiformis* does not reproduce sexually but exclusively by vegetative means within the introduced area (Harris & Lovell 1980). This is caused by the self-incompatibility of the species combined with spatially very limited dispersal by vegetative means.

By analyzing patterns of gene flow and dispersal routes in the native and introduced areas, we aim at understanding the importance of vegetative and sexual reproduction in the whole distribution area. For this it is necessary to know the origin of introduced plants, the dispersal of potential clones on different scales (transcontinental to local) and the potential of adjacent clones to produce seeds with each other. Molecular markers (AFLP fingerprints) and crossing studies are being conducted to answer the above-mentioned questions regarding the dispersal ability of *V. filiformis* in its native and introduced area with two different strategies. Initial crossing studies (done between March and May 2007) with plants from 26 populations collected on a transsect between Tübingen and Münich (190 km) demonstrate that multiple clones are present, sometimes separated by at most 23 km. Some preliminary AFLP-results showed differences in the intra-population diversity.

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Seed germination, seedling appearance and frost resistance as determinants of invasion success: comaprision of invasive and native impatiens species

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Traits associated with early ontogenetic stages, i.e. seed germination, seedling appearance and seedling survival, are among the key factors determining the spread of alien plants in their secondary distribution areas. For annual plants these traits are extremely important. Their role was addressed by comparing three *Impatiens* species (Balsaminaceae) alien to the Czech Republic, and a native, usually co-occurring congener: *I. glandulifera* (native to Asia), widely distributed invasive species rapidly spreading mainly in the last two decades; *I. parviflora* (native to Asia), widely distributed invasive species with less dynamic current spread; *I. capensis* (native to US), which is not present in the Czech Republic yet but invasive in western Europe; *I. noli-tangere*, native to Europe. To compare the basic characteristics of seed germination and seedling establishment we investigated (i) germination under cold-wet stratification, (ii) seedling appearance and survival in an experimental garden, (iii) frost resistance of the seedlings and (iv) depletion of soil seed bank.

The results showed some differences between native and invasive species. The native *I. noli-tangere* required the longest time for stratification and had the lowest germination and seedling appearance. On the other hand, it was less sensitive to frost. The highly invasive species *I. glandulifera* required the shortest time for stratification, and its seedlings appear very early in warm seasons. *Impatiens glandulifera* was moderately sensitive to frost, while *I. parviflora* was the most sensitive. It seems that invasive *I. glandulifera* and *I. parviflora* do not form seed banks, while *I. noli-tangere* and *I. capensis* have a potential for to form them. The results of all experiments indicate that the invasion of *I. capensis* to the Czech Republic is possible.

Trait groups of alien plants and their abundance in the Netherlands

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Invasive plant species can have major effects on the biodiversity and ecosystem functioning. Preventing their introduction would be the most cost-efficient solution. The majority of alien plants are introduced intentionally, for example by ornamental plant trade. If we knew which of these plants are likely to become noxious invaders, their introduction can be easily prohibited.

Many studies addressed plant traits that predict invasiveness. Finding one trait or a group of traits that predict invasiveness among all plant species is unrealistic. But, at the level of genera or ecosystems, success has been achieved. Therefore, when examining the patterns among invasive plant species in the Netherlands we followed a multi-trait-group approach, linked to the species habitats. We aim to identify groups with a high and a low invasion potential. An advantage of doing this study in the Netherlands is the availability of extensive information on plant presences and abundances at the national and local scales. Defining which species are invasive and which are not is a difficult aspect of invasion ecology, many different definitions have been used. The Dutch databases are very helpful in this. Instead of using expert judgement for defining invasive and non-invasive alien species, we use local and national plant abundances to indicate the impact on the communities.

Structure of fish foraging assemblages in the pelagial of the Rybinsk reservoir prior to and after invasion by the Ponto-Caspian kilka *Clupeonella cultriventris*

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A comparative analysis of the species composition and age structure of fish foraging assemblages in the pelagial of the Rybinsk reservoir was performed in 1977–2007. The first kilka specimens were found in 1994 and in 2000 constituted 80.7% of the total catch in the pelagic trawl. Previously, smelt *Osmerus eperlanus* (L.) constituted up to 90% of the foraging assemblages. Advancement of the southern species (kilka) northwards and rapid decrease of the northern invader (smelt) abundance is probably due to climate warming noted in the last 10–15 years. The process of kilka's invasion into the Rybinsk reservoir was preceded by and accompanied with a significant decrease of smelt reproduction noted in the last 10–15 years. Analysis of the age structure of its catches in this period showed the decrease of the underyearlings' share. Thus, in 1991 0+ smelt constituted 67.3% (adults 32.7%). In 1992 the ratio was 11.4 and 88.6%; in 1993 6 and 94%; and in 1994 1.8 and 98.2%.

Adults of blue bream *Abramis ballerus* (Linne), vendace *Coregonus albula* (L.), bleak *Alburnus alburnus* (L.) and sablefish *Pelecus cultratus* (L.) previously foraged together with smelt and now with kilka in the same assemblages. Underyearlings of sablefish, blue bream, roach and especially bream have significantly increased their relative abundance in fish pelagic assemblages (on average in the water reservoir: 0.04, 0.46, 0.3, 0.1% in 1977 and 0.9, 3.7, 4.8, 4.9% in 2006, respectively). This is probably a result of the fact that previously middle link of the food chain zooplankton–smelt–pelagic predator (pikeperch) was represented by a planktofage facultative predator. With kilka's invasion and decrease in smelt number, the predation press of 3–4 year old smelt, that fed mostly on the percid and cyprinid fry (up to 60% of the ration) decreased (Ivanova 1982).

In the period of smelt's reproduction decrease (1992–1994) the predator (pikeperch fry)–prey (smelt fry) ratio in pelagic fish assemblages was on average 80.5–6.4% in the water reservoir. This led to a rapid decrease of pikeperch fry abundance in the pelagial of the reservoir already in 1995. Only in the central part of the main stretch, where smelt is still abundant, on average 0.2 underyearlings of pikeperch were caught during 5 min. trawling with Corey net. According to the data of the fry survey from 2006, denoted predator–prey (0+ kilka) ratio has restored being 6.9–83.1%, correspondingly.
Analysis of stomach contents of the mature pikeperch found in the pelagic trawl catches in 2004–2007 has shown that this pelagic predator has successfully switched over to feeding upon the southern invader which substituted smelt. It should be noted, that it took a few years for the pikeperch to get "accustomed" to the new food object.

The results show that kilka has completely occupied the smelt's ecologic niche in the Rybinsk reservoir. Nevertheless, the character of present trophic links did not change: one zooplankton consumer and food object of the pelagic predator has changed to another. It seems that naturalization of kilka in the water reservoir coupled with simultaneous and almost complete disappearance of a previously abundant planktofage (smelt) is one of a few lucky examples when the invader has not caused negative consequences but reestablished the trophic structure of pelagic fish community of the water reservoir.

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A comparison among five *Impatiens* species with different invasive capacity

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Phenotypic plasticity is believed to play an important role within exotic species, as it may increase their invasiveness. If plasticity is adaptive, plastic responses to environmental factors may allow individuals to express advantageous phenotypes in a broader range of environments. Consequently, phenotypic plasticity enhances the probability of persistence of an introduced alien organism in its new habitat.

To test this hypothesis we germinated seeds of five plant species of the genus *Impatiens* that are both invasive and native to Europe. *Impatiens noli-tangere* is native to continental Europe and Britain. *Impatiens glandulifera* is currently one of the dominant invasive plant species in Europe. In addition, we selected three other exotic *Impatiens* species that are naturalized in Europe that vary in their invasive capacity (*I. balfourii*, *I. parviflora* and *I. capensis*). Here we present some preliminary findings of an experiment carried out in 2008. *I. glandulifera* showed the highest germination rate. No germination occurred in *I. noli-tangere* seeds. In order to quantify the growth rate of the four germinated species (*I. glandulifera*, *I. balfourii*, *I. parviflora* and *I. capensis*), we planted seedlings in thirty-litre pots in the Botanic Gardens of Trinity College Dublin in 2008. The photosynthetic capacity of 10 individual plants per species was assessed using an infra-red gas-exchange analyzer. Light response curves for each individual of each species were obtained weekly for 5 weeks, which followed the entire life cycle of the leaf of each species. CO_2 response curves also were obtained for 10 individuals per species. In addition, measurements of growth were taken weekly (e.g. height, no. of flowers). In further work, plants will be harvested and other parameters of growth will be determined (e.g. dry weight above and below ground, total leaf area, specific leaf area).These results will be combined with the results of a further experiment where individuals of the five *Impatiens* species will be grown in the same location with different treatments of water and/or nutrients.

Is *Prunus serotina* an aggressive invader in areas with a low propagule pressure?

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Prunus serotina Ehrh., a tree species native to North America, has been planted massively in Western Europe for various purposes, mainly in the understory of pine plantations on sandy soils. During the second half of the 20th century, the species became known as a forest pest and much money was invested in the control of the species. Only recently, ecological research tried to figure out why *P. serotina* is such a successful invader. However, this research focused mostly on heavily invaded areas, where the presence and abundance of *P. serotina* still reflect its introduction history (Verheyen et al. 2007). As propagule pressure is an important driver of invasion processes (Kriványek et al. 2006), we investigated whether *P. serotina* could still be labelled an aggressive invader in an area with a far lower propagule pressure, in which the species had not been favoured through deliberate human introduction.

The study area, located in central Belgium (50°52' N, 04°7' E), was a mixed deciduous forest, spontaneously developed after a clear cut during WWII. Aerial photographs (1944–1986), forest inventory data (for 1986, 1996, and 2006), and tree ring data were used to reconstruct the invasion of *P. serotina*, infer the underlying mechanisms, and predict the future role of *P. serotina* in the forest reserve.

Connectivity to seed sources and light availability were the major determinants of the *P. serotina* presence. Its occurrence was more likely in plots close to seed trees and in plots with a high share of shade-casting tree species. Plots with a canopy of light-demanding species were characterized by a dense *Rubus* layer in the understory and a low *P. serotina* presence. At present, *P. serotina* cannot not be considered an aggressive invader in the studied forest. The rate of spread slowed down rather quickly and the establishment of native (semi-)shade-tolerant shrub and tree species, e.g., *Sorbus aucuparia* L. and *Corylus avellana* L., seems not to be hampered by the *P. serotina* presence. Furthermore, *P. serotina* showed low growth and seed production in understory, while its further germination and establishment were probably hampered by the high *Rubus* cover. Nonetheless, calamities opening up the canopy layer in the few areas with a high *P. serotina* sapling density might alter the course of the invasion process.

Our results show that 'windows of opportunity' (DeGasperis & Motzkin 2007), i.e. spots with a high light availability, are an important driver for *P. serotina* colonization. When these 'windows' close, it is difficult for *P. serotina* to thrive and the invasion process slows down. Closing the windows of opportunity for invasive species might be an effective measure to mitigate their aggressive behaviour.

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POSTERS

Section 3

Evolution of species invasiveness

The role of hybridization in the evolution of invasive *Fallopia* species

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Recent biological invasions provide opportunities to investigate microevolution in contemporary scales and the role of evolutionary events during postinvasion evolution. There are three invasive taxa of the genus *Fallopia* in Central Europe, two parental species and their hybrid. We determined the cytological and genotypic variation in all taxa, as well as the population genetic structure of the hybrid *F.* ×*bohemica* in two selected localities. These two localities differed in the presence of parental species, ploidy level and hybrid genetic diversity. The main outcomes of this study are: (i) in addition to vigorous vegetative spread, some *Fallopia* taxa can also spread effectively by generative reproduction; (ii) the cytological and genetical make-up of hybrid populations strongly depends on the parental species composition of the locality; (iii) in some localities *F.* ×*bohemica* can behave as hybridogenous taxon, i.e. can mate with itself and spread independently of the parental species; (iv) in spite of irregularities in hexaploid hybrid meiosis, the hexaploid *F.* ×*bohemica* can bring into being hexaploid progeny, but at very low frequency; (v) in the hybrid a comparison of potential and actual cytological variability indicated that the rare hexaploid progeny may be strongly favoured by natural selection, since most of the genetically diverse hybrid populations comprise only of hexaploid hybrids. The role of successful generative reproduction, which is a rare event, is important for further spread because each established offspring can be maintained by vegetative reproduction. High variability of hybrids brings opportunities in adaptation processes in new environments. Knowledge of the likelihood and speed at which such adaptation evolves in invasive plants is important for management practices when evolutionary changes enhance ecological abilities to spread.

Hybridization between the invasive garden escape *Lamium argentatum* and native *Lamium* taxa in northwestern Germany

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Hybridization between alien and native plant species can have important consequences. It may lead to changes in the invasion potential of the alien species and also alter the locally adapted gene pool of the native species. We are studying the consequences and extent of the hybridization between the invasive garden escape *Lamium argentatum* (Smejkal) Henker ex. G. H. Loos and two native congeners, *L. galeobdolon* L. and *L. montanum* (Pers.) Rchb.

Lamium argentatum is commonly grown as an ornamental groundcover and has been introduced into forests with illegally disposed garden rubbish. During the last few years, *L. argentatum* has spread dramatically in a number of beech forests in northwestern Germany and invaded the populations of the two native species. We have localized several contact zones and are analysing putative hybridization using morphology, ploidy level variation, and molecular markers (AFLP, chloroplast DNA). Controlled hand crossings are used to verify the cross compatibility of the taxa.

Hybridization between two of North America's worst invasive plants (*Centaurea stoebe* and *C. diffusa*): geographic patterns and implications for invasion

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Hybridization is hypothesized to enhance the ability of non-native species to invade (Ellstrand & Schierenbeck 2000). Although a number of invasive taxa are of hybrid origin, relatively few studies have compared the frequency of hybridization between the introduced and native ranges, or examined the performance of the hybrids relative to the parental species. Spotted (*Centaurea stoebe*) and diffuse knapweed (*C. diffusa*) are two of the most ecologically and economically devastating invasive plants in western North America. The diploid variants of these species are known to hybridize in their native range in Europe (Gáyer 1909, Ochsmann 1998). Based on floral morphology, hybrids were reported in North America (Ochsmann 2001). As a first step towards understanding if hybridization has altered the invasion of these two species, we conducted extensive field surveys in the native (Eurasian) and introduced (North America) ranges in 2005 and 2006. Additionally, molecular data (Amplified Fragment Length Polymorphisms) were collected to gain a more in-depth understanding of hybridization at the genetic level. In the introduced range plants with hybrid morphology are present in most diffuse knapweed sites (97%, n=39), but not in spotted knapweed sites (n=22). Several lines of evidence suggest that individuals of hybrid origin were introduced with diffuse knapweed, and hybrids were not created post-introduction. For example, the spotted knapweed here is likely all tetraploid and the diffuse knapweed is diploid and crossing these cytotypes produces no viable seed. Additionally, the plants with intermediate floral morphology in North America are no more likely to demonstrate admixture from spotted knapweed than those that appear as typical diffuse knapweed; this supports the idea that hybrids have experienced many generations of back-crossing, and the relationship between morphology and hybridization has likely been decoupled. Interestingly though, plants with hybrid morphology within diffuse knapweed sites were taller and more frequently exhibited polycarpy than plants that appeared as typical diffuse knapweed. Biological control agents, both seedhead feeders and root miners, do not discriminate between hybrid-type and diffuse-type plants within diffuse knapweed sites. Because hybridization between spotted and diffuse knapweed occurred prior to introduction approximately 100 years ago, and because biological control agents do not avoid hybrids, it seems unlikely that hybridization is currently altering diffuse knapweed's invasion. It is, however, plausible that the inclusion of hybrids with the introduction of diffuse knapweed contributed to the success of this species in North America. A large greenhouse common garden is examining this possibility.

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AFLP analysis of genetic diversity within and between the population of *Fallopia* taxa in southern Poland

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The knotweed (*Fallopia*) taxa are recognized as the most troublesome alien invasive species in Europe and North America (Tiébré et al. 2007). In recent decades, much attention has been paid to the genetic aspects of the invasive success of these taxa. Attempts to evaluate genotypic diversity in *Fallopia* complex were made with use of molecular markers, including RAPDs, ISSRs (Hollingsworth et al. 1998), SNPs, SSRs (Gammon et al. 2007) as well as isoenzyme analysis (Mandák et al. 2005).

We investigated local populations of *F. japonica*, *F. sachalinensis* and their hybrid *F. ×bohemica*. Amplified fragment length polymorphism (AFLP) analysis has been used to measure polymorphism among 150 individuals from four selected populations. The populations consisted of one taxon (later called 'homogenous') or were composed of two or three taxa cohabiting in the same area. An analysis using 16 pairs of selective primers was made. Analysis of genetic diversity within and between populations was performed in two parts. The first part was aimed at the polymorphism between taxa, based on data collected from homogenous populations composed of particular *Fallopia* taxa, while the second part investigated populations consisted of three taxa growing together. DNA polymorphism between particular *Fallopia* taxa ranged from the lowest, 7% for *F. japonica* and *F. ×bohemica*, to relatively high, 29% and 33% for the pair of *F. sachalinensis* and *F. ×bohemica* and the pair of parental species, respectively. Analysis of polymorphism amongst individuals from each taxa revealed that there were no significant differences in their AFLP band pattern.

Cluster analysis was performed on AFLP data coming from population consisting of three taxa and selected individuals from homogenous populations. The resulting dendrogram showed that the relationships between each taxon growing together were consistent with the previous result for homogenous populations. Two clusters with a high genetic similarity were distinguished: cluster A which includes six individuals of *F. sachalinensis*, and cluster B, which groups five individuals of *F. ×bohemica* and three individuals of *F. japonica*.

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Persistence and genetic variation of feral oilseed rape (*Brassica napus*)

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Plants escaping cultivation are one source of neophytes. Oilseed rape is capable establishing feral populations on roadsides and other semi-natural habitats. We analysed the origin, persistence, and genetic variation of feral oilseed rape populations in northwest Germany based on a field survey (2004 –2007) and microsatellite markers. A maximum likelihood approach was used to allocate individuals of feral populations to their source varieties and to hybrids between these varieties. The majority of the analysed sites was inhabited by oilseed rape for at least two of the four years. The proportion of feral populations setting seeds was higher than in comparable studies. Within population genetic diversity of feral oilseed rape populations had increased in comparison to the common varieties. Multiple introductions of different varieties and hybridisation between these varieties were identified as the most important sources of genetic variation in feral oilseed rape populations. The detection of hybrids between different varieties indicates that feral oilseed rape populations may persist via self-recruitment. Therefore, feral populations may serve as stepping stones for intraspecific and interspecific gene flow. In the case of cultivating genetically modified oilseed rape feral populations might contribute to the uncertainty regarding the potential risk of transgene escape to wild or weedy populations. Knowledge about the underlying mechanism of establishment and persistence, and the evolutionary potential of feral populations is a prerequisite for a successful risk assessment of GM plants and of high policy relevance.

Genetic variability and spread of the giant hogweed (*Heracleum mantegazzianum*) at a local scale: Lee river catchment in southeast England

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Heracleum mantegazzianum Sommier & Levier (giant hogweed) is one of three invasive alien *Heracleum* species in Europe (Jahodová et al. 2007a). It was introduced as a garden ornamental at the beginning of the 19th century and its seeds were exchanged among botanical gardens and estate gardeners. The first known escaped population was reported in 1828 from Cambridgeshire and since then the plant begun to spread rapidly across Europe. To date, *H. mantegazzianum* has been documented in 21 European countries and is considered as one of the most notorious weeds in Europe (Pyšek et al. 2008). It is invasive also in Canada and the USA and was introduced to Australia and New Zealand. The biology and ecology of *Heracleum* species is relatively well known. However, there are few genetic studies of giant hogweed and related species (Walker et al. 2003, Jahodová et al. 2007a, b). These are limited to the regional or continental/species scale.

In this study genetic variation of giant hogweed was examined at a local scale. Amplified fragment length polymorphism (AFLP) was used to investigate genetic diversity of plants growing along the river Lee and its tributaries in Hertfordshire, UK. We analysed 20 samples from the river Lee and 100 samples from its tributaries Beane, Mimram and Rib. The genetic similarity between plants sampled in these catchments was calculated. Implications of the results with regard to possible origins and spread of *H. mantegazzianum* at this local scale is discussed.

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Testing prediction of evolution of increased competitive ability hypothesis between native and invasive *Lythrum salicaria*

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The evolution of increased competitive ability (EICA) hypothesis predicts that when an organism escapes its natural enemies it may shift allocation from defense to growth. Therefore, such plants may have superior competitive ability than their native progenitors. Unfortunately, competitive abilities, i.e. competitive effect (ability to suppress neighbours) and competitive response (ability to tolerate the inhibitory effects of neighbors) of invasive and native populations have rarely been compared in a common competitive environment.

We conducted a common garden experiment to test the prediction of the EICA hypothesis by comparing the competitive ability of *Lythrum salicaria*, which is an invasive species of North America and a native to the European range. Plants from four US and four European populations were raised in competitive environments in all possible pairwise mixtures and in a control environment. Competitive effect and response were evaluated by using the relative interaction index. We predicted that, if invasive species are better competitors than the native they should outcompete native species when grown together, i.e. competitive effect ability should be higher for introduced populations than for natives. Competitive response ability should not necessarily differ among origins.

There was a significant difference in height and leaf size between native and invasive populations but no difference in biomass, capsule number and seed production. Invasive species were shown to reduce the biomass of native species more than native species biomass reduced when grown with native neighbours. However, there was no significant difference in competitive response between native and introduced population for biomass. On the contrary, native plants significantly reduced the fitness with respect to capsule number and seed production of invasive plant when grown together and showed less response in presence of neighbours. Our results contradict the EICA hypothesis and suggest that more comparative experiments of invasive and native plant with naturally co-occuring neighbours are urgently needed.

Clinal differentiation during invasion: *Senecio inaequidens* along altitudinal gradients in western Europe

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Plant population differentiation may play a role in decreasing the ability to predict whether, where, and when an introduced species will invade. However, few studies have addressed the level of genetic change an alien species may undergo during range expansion, e.g. in response to climatic variation with altitude.

In the present study, we tested the hypothesis that invasive populations of *Senecio inaequidens* (Asteraceae) differentiated during migration from two independent introduction sites into divergent altitudinal and climatic zones. We carried out two years of common garden experiments with eight populations from a Belgian altitudinal transect and ten populations from similar French transect. Climatic analysis revealed that the Belgian transect followed a temperature and precipitation gradient. A temperature and summer drought gradient characterized the French study site. We evaluated differentiation and clinal variation in the following characters: days to germination, days to flowering, height at maturity, final plant height and aboveground biomass.

Results showed that *S. inaequidens* populations differentiated in growth traits during invasion. First year of experiment, regressing population growth trait means against source population altitude indicated the presence of clinal variation along both transects. Second year, similar results were found along the French transect, i.e. a reduction in height at maturity, plant height and aboveground biomass with increasing altitude. Including seed mass as a covariate did not change the outcome of the analysis. The possible evolutionary causes for the differentiation observed are discussed.

Breeding programmes making new invasive species: an early warning case of oriental goats' rue (*Galega orientalis*) in Estonia

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Bioenergy and fodder plants are selected, bred, and engineered from alien taxa to have few resident pests, tolerate poor growing conditions and produce highly competitive monospecific stands (Barney & DiTomaso 2008). Thus, the aim of the breeding is in many cases to combine plant traits, which are making certain species highly invasive. The perennial leguminous oriental goat's rue (*Galega orientalis* Lam.) is starting to invade potential in temperate region. The species is indigenous to Caucasus, and was introduced to north-western Russia as a honey source ca 80 years ago. In Estonia, intensive and nowadays in this area leading agricultural studies appear since the 1970s (e.g., Nommsalu et al. 1996). Oriental goats' rue has been fed to livestock as greenfed or conserved as silage or hay. The species has been increasingly promoted as bioenergy species and also as appropriate species for organic farming and also for recultivation oil-shale open pits. The sown area is growing year by year.

The poster shows rapidly changed wild distribution of the species in Estonia, and describes distribution pattern in randomly used pilot areas. In Estonia we consider the oriental goat's rue already not only ecologically invasive (Ööpik et al. 2008) but transformer species, and our country is unfortunately an important source of the species seed worldwide. A widely used commercial cultivar is Gale, released jointly by Estonian and Russian plant breeders in 1987. Oriental goats' rue has already been introduced to Baltic countries, Scandinavia, Japan (Iwabuchi et al. 2005), USA, Canada and other countries. The priority actions should be to increase awareness among agricultural sector, and impose restrictions on cultivation of the species, e.g. by cleaning the area after harvesting. It is advisable to restrict or prohibit the cultivation of oriental goats rue at least in protected areas. This note is especially important as an early warning for all countries, in which the species is under evaluation as a suitable biomass crop. Prevention is the most cost-effective way to avoid enormous expenses associated with plant invasions afterwards.

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POSTERS

Section 4

Impact of invasions

Evaluation of invasive species threat to rare species and biodiversity on landscape level

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Nowadays, in the period of habitat quality deterioration and species diversity loss, biodiversity conservation and localization of biodiversity hot spots are recognized as an issue of major importance. Biodiversity of native species is commonly accepted as a measure of habitat value, but the importance of particular habitats as places of endangered species survival should not be omitted. Additionally, species invasions are generally considered to be a major threat to biodiversity. As a habitat with overall lower biodiversity can still harbour a significant proportion of endangered species we find habitat evaluation using species endangerment status to be an important approach complementary to evaluation of habitats using general biodiversity measures. Apart from biodiversity of native species, the proportion of invasive species is also an important characteristic of habitats quality and signals their possible further development. We compared habitat according to these three components of their overall biodiversity (e.g., endangered, not endangered and alien species)

The Red List of IUCN is a widely recognized system for classifying species by the risk of their extinction, and the Red List Index (RLI) illustrates the relative rate at which a particular set of species changes overall threat status; RLI was applied especially for evaluation of the changes of extinction risk in time for birds and amphibians of different biogeographic realms, birds living in different ecosystems or amphibians of different families. RLI seems to be a useful tool for trend illustration of deterioration or improvement in status.

We used CORINE land cover and Natura 2000 mapping systems to obtain basic information on habitat distribution and quality in the Czech Republic. The two systems distinguish altogether 171 habitat types that were grouped into 14 units in order to obtain a manageable number of categories. For each habitat we recognized five degradation stages partially based on Natura 2000 mapping system. Species lists of groups widely accepted as important indicators (vascular plants, molluscs, butterflies, ground beetles, amphibians, reptiles and birds) were compiled using expert statements and literature for each habitat. In particular, alien plant species were classified according to Pyšek et al. (2002) and the endangerment status of all organisms followed the current Red List of the Czech Republic. To calculate a value of Red List Index, at least two Red Lists from two different periods are usually needed in order to assess the deterioration or improvement of the status over time. We were not interested in the endangerment status changes over time, but in conservation importance of habitats expressed as the occurrence of species with a high extinction probability in the habitat. Our RLI was calculated as the difference between the current Red List and a hypothetical one, where all the species were classified as “least concern”. The result is a habitats comparison not only from the view of biodiversity but also from a perspective of their importance as a sanctuary of endangered species. In addition, we discuss values of habitats as provided by the RLI in the light of intrusion of invasive species.

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Impact of *Fallopia ×bohemica* and *Helianthus tuberosus* on the richness and composition of plant communities in western Hungary

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Fallopia ×bohemica and *Helianthus tuberosus* belong to the most dangerous alien environmental weeds in western Hungary. They are generally considered by plant ecologists and nature conservationists as a threat to biodiversity, but until now there were no quantitative data about their effect on the vegetation of invaded areas in this region.

In this study a comparative approach was used to estimate the impact of these two invasive species on the (semi)natural plant communities. The impact of *Fallopia* and *Helianthus* was studied in 41 and 23 sites, respectively. Three plots were sampled in each site: one in the dense stand of the invading species, one in the uninvaded plant community and one in the transition zone between them. The percentage cover of plant species was visually estimated and the following characteristics were calculated: species richness, Shannon diversity, proportion of shade tolerant plants and proportion of Grime's life strategies. These characteristics of the three phases of invasion (i.e. uninvaded area, transition zone and invaded stand) were compared by Friedman's non-parametric ANOVA.

Species richness and diversity decreased due to the invasion by both species. These charcteristics were significantly lower even in the transition zone than in the original vegetation. The proportion of shade tolerant species did not change, which indicates that decreasing species richness is caused not only by shading from invasive species. The proportion of specialists decreased during invasion in both cases. *Helianthus* invasion did not influence significantly the proportion of competitor and ruderal species, while in the case of *Fallopia*, the proportion of ruderals slightly decreased and that of competitors slightly increased during invasion.

This so-called comparative approach supposes that before invasion there were no differences between the plots of a site, therefore the data are not considered to be a rigorous proof of the causal relationship between the invasion and differences between invaded and uninvaded plots. However, this comparative approach, often used in studies on vegetation succession and termed a "space for time substitution", allows to account for a wide range of invaded communities and regions, and may yield general conclusions.

Life history characteristics and predation impact of the amphipod *Pontogammarus robustoides*, introduced in the Neva estuary (Baltic Sea)

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Pontogammarus robustoides (Sars) is a pontogammarid species that rapidly has extended its range in Europe starting from the Ponto-Caspian basin. It was found in the Neva estuary in 1990s, by present it has reached high abundance (1500 ind.m^{-2}) and biomasses (43 gWWm^{-2}). The amphipod belongs to predaceous omnivorous species; at high abundance they may influence on structure and density of invertebrate communities (especially, chironomids, oligochaetes, isopods, trichopterans, other amphipods).

From May to October of 2002–2003, populations of *P. robustoides* were studied in southern and northern parts of the Neva estuary in order to understand life cycle of this species. Furthermore, the structure of benthic communities in ice-free period of 2005–2007 was studied to assess its predation pressure on invertebrate communities. The samples were taken using cylindrical corer with sampling area 0.03 m^2 in shallow-water areas. The Predation Impact Index (IP) was elaborated and applied for assessment of amphipod impact on invertebrate community (Berezina 2007). The IP is the ratio between the consumption rate (Cpop) of the amphipod population and total production of their prey for a given period (IP = Cpop/Pprey). The predation impact of amphipods on the community was ranked as high (IP > 1), middle (0.5 < IP < 1) and low (0 < IP < 0.5).

The results showed that *P. robustoides* has one year life cycle with three generations per year in the Neva estuary. In 2002, the first females with clutches (ovigerous females) appeared in the end of May at water temperature 10–15 °C. Number of the ovigerous females varied considerably during season and reached maximally 47% in late May and 38% in late July. Sex ratio in both species was skewed in favor of females. Female/male ratio averaged 0.52±0.05, ranging from 0.31 in the end of May to 0.82 in the middle of August. Size-dependent fecundity varied seasonally reaching maximum in May (78 eggs per female). By the end of June the females released juveniles of first generation (June cohort). The density of juveniles (75%) peaked in August after a release of next brood by the females. The June cohort reached the reproductive size (9–10 mm) by late August-September and started to reproduce. The last ovigerous females of June cohort and partially of August cohort were noted at the end of September. In October reproduction of *P. robustoides* terminated due to reproductive resting period. The similar results were recorded in 2003. In laboratory at temperature 20 °C, *P. robustoides* juveniles require approximately 60–70 days or 1200–1400 degree-days from birth to initiating oogenesis (Berezina et al. 2005). The IP index varied between dates, reaching a maximum in the beginning of summer (IP = 2.8–7.6) and in autumn (1.2–4.7). IP < 1 was recorded in August, when juveniles were abundant in *P. robustoides* populations. In freshwater Neva Bay (easternmost part of the estuary), where the amphipod reached high densities, its predation impact was higher than in brackish waters of the estuary. The results show a strong predation impact of *P. robustoides* on invertebrate community.

Mustelids on islands: is it always as bad as we think?

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Introduced mammalian predators frequently have major impacts on biodiversity. This issue is clearly seen on islands where, for example, introduced mustelids can have devastating effects on ground-nesting bird populations. However, eradication of problem species is not always an immediately feasible option because of logistical, financial and social constraints. Thus, in many cases, lethal control of is carried out only around key sites, often with little prior study of the ecosystem dynamics, even though problems associated with removal of individual species are now well recognised.

We studied the impact of introduced feral ferrets (*Mustela furo*) on a ground-nesting wader, the northern lapwing (*Vanellus vanellus*), on Rathlin Island, UK. Lapwing have experienced severe population declines over much of the UK, at least in part because of habitat loss. However there has been little alteration of habitat on Rathlin, and declines in ground-nesting birds appeared to occur after the introduction of ferrets. Ferret population dynamics and behavioural ecology were examined in the winter prior to their removal using mark-recapture and radio telemetry, to allow comparison of pre- and post control regimes. Pre-control, ferrets had large overlaps in ranges and very close associations among individuals, both atypical of small mustelids. Removal trapping and exclusion from control plots was highly effective. However the population had significantly increased and remained high in the following winter, clearly facilitated by the lack of territoriality. Despite this increase in predator density, ferrets were not found to have a significant impact on nests in either year, and lapwing breeding success was sufficient to maintain their population.

Thus, contrary to the familiar problems seen with introduced mustelids, we found feral ferrets, although exhibiting behaviour which may have been expected to increase their threat, did not have the anticipated impacts. Importantly though, this study highlights the potential for apparently effective control to exacerbate the situation for species of concern in subsequent seasons. It serves as a valuable reminder that, whilst broad generalities are useful, they should not be used to the exclusion of examination of the system in question, particularly prior to the greater expenditure of eradication and/or ongoing control programmes.

ISEIA, a simplified protocol for assessing the environmental impact of invasive species in Belgium

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Harmonia is a new information system on non-native invasive species in Belgium, which is developed at the initiative of scientists gathered within the Belgian Forum on Invasive Species (http://ias.biodiversity.be). This system aims at collecting standardised information on the impacts of non-native species which are assumed to be detrimental to native biodiversity in Western Europe. It includes a high diversity of taxonomic groups from terrestrial, freshwater and marine environments. Species included in the system are allocated to different list categories (black and watch lists) based a two dimension ordination, i.e. environmental impact and geographic distribution in Belgium (Figure 1). Such categorisation offers a scientific background to prioritise actions to prevent introduction and mitigate the impact of invasive species (restriction to importation, trade regulation, local control actions, etc.).

The environmental impact of non-native species is assessed in a standard, objective and transparent way through a simplified protocol developed by the Forum, the Invasive Species Environmental Impact Assessment (ISEIA) protocol. It consists of four sections matching the last steps of the invasion process, i.e. the potential for spreading and colonising natural habitats as well as the adverse impacts on non-native species (competition, predation, hybridisation and disease transmission) and ecosystems (modification of nutrient cycling, food web alteration, etc.). Scores for each section are assessed based on organism's history of impact in neighbour areas together with their ecological profiles.

Based on that protocol, assessments were performed for non-native vascular plants and vertebrates established in Belgium. Data were easily collected from the literature for most of those organisms. Repeatability was quite good, providing that criteria were thoroughly discussed among the expert groups. Evidence for detrimental impact on biodiversity by non-native vascular plants and vertebrates will be discussed on the basis of assessment results.

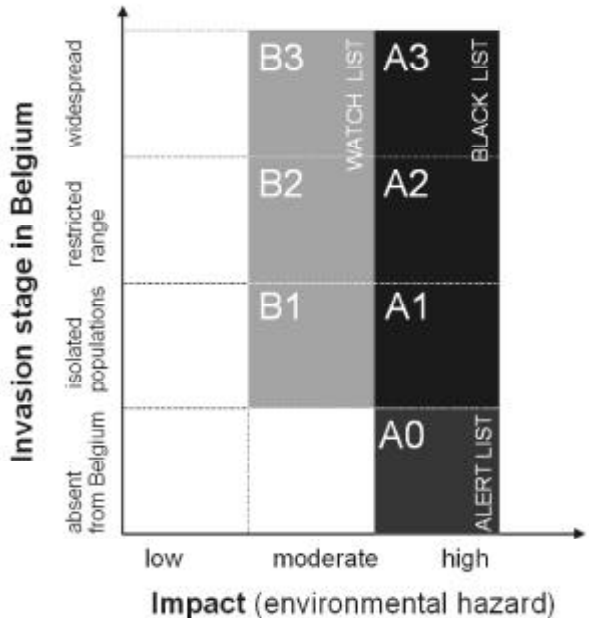

Figure 1. - List system used to identify non-native species of most concern for preventive and mitigation actions.

Effects of the exotic plant *Echium vulgare* on the pollination of native herbs in Andean prairies

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Few studies have evaluated the indirect effects of exotic introductions on local floras. In relation to pollination, exotic plants may increase flower visitors at an area or alternatively reduce pollination on native plants when monopolizes visits. Changes in pollination activity may have strong demographic effects by influencing flower fecundity.

We conducted a removal experiment of the exotic herb *Echium vulgare* (Boraginaceae) in three sites and evaluated changes in richness and diversity of flower visitors on the native plants *Alstroemeria ligtu* (Alstroemeriaceae), *Phacelia secunda* (Hydrophilaceae), *Schizanthus hookeri* (Solanaceae) and *Stachys albicaulis* (Lamiaceae) in prairies near to a temperate forest (Termas de Chillan; 36°54'34" S 71°24'46" W, 1834 m a.s.l.). The study was conducted in the austral summer season of 2008. In each site we established 1 × 2 m quadrants on 10 m transects and quantified the number of flowers, number of flowers visited and visitor identity by quadrant in 5-min observation intervals. With these variables we estimated the visitor diversity and visitation rate, using an ANOVA test we compared for each plant specie changes in these estimators before and after *E. vulgare* removal. Additionally, we collected flower stigmas (before and after removal) to assess the number and identity of pollen received by flowers. We detected two taxa as principal visitors: *Bombus dahlbomi* (native bumblebee) and *B. terrestris* (exotic bumblebee). Our results indicate that the impact of *E. vulgare* on native plants is contingent to the pollinator descriptor that is used. On the one hand, exotic plant increased the species richness of flower visitors on native plants and by other hand, *E. vulgare* reduced the number of visits per flower. We are currently evaluating the effects on pollen identity and deposition on stigmas.

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Impact of exotic invasive plants on soil fauna

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It has been shown that invasive plant species can modify soil properties such as nutrient content but little is known about impact of such modifications on soil animal communities. We wanted to test if exotic invasive plant species modify soil fauna community in terms of density and diversity. We investigated the impact of two troublesome exotic invasive plant species, *Fallopia japonica* and *Solidago gigantea*. For each species, four locations were selected in Belgium with contrasting native vegetation (grassland, woodland). Pitfall traps and soil cores were used to assess the meso and macrofauna in invaded area compared to the indigenous vegetation. Earthworm extractions were also made. We started in 2006 with two sampling dates, in spring and autumn, for each species in each site. All individuals were identified at the family level. The number of individuals in each taxonomic group was counted.

Data collection 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 values in the non invaded adjacent vegetation. We also found that some groups were more abundant under *Fallopia* such as isopods or millipeds, which have affinity for shaded and humid environment. Multivariate analysis revealed that the total faunal assemblage was more homogenous in invaded plots. This is mainly due to the monospecific vegetation formed by *F. japonica* as opposed to the multispecific resident vegetation. Another interesting result concerned the differences in earthworms species between invaded and uninvaded plots. Earthworms species associated with a moist environment were only present under *F. japonica* while grassland species were only present under the uninvaded vegetation. Differences of soil fauna assemblage between *Fallopia* plots and the resident vegetation seem to be principally due to microclimatic modifications after invasion. In the future, a more extensive sampling will be made to confirm these trends. In addition, for the major groups of soil fauna, the determination at the species level will allow us to predict the functional consequences of this change on the ecosystem.

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Effect of natural infection with aphid-borne onion yellow dwarf virus (OYDV) on yield of onion and garlic crops in Egypt

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The natural infection of onion with onion yellow dwarf virus (OYDV) resulted in a significant crop reduction of 27.4 cm in pseudostem length of the plant, 29.1 in the number of leaves, 31.9 g in weight of plants and 41.8 g. in weight of bulbs. The reduction in Chinese garlic crop due to infection with OYDV was about 47.6 cm in pseudostem length, 27.8 in the number of leaves, 56.2 g in weight of plant, 58.8 g inweight of bulb, 47.4 in the number of cloves and 71.9 g in the weight of cloves, while these respective figures were 16.8 cm, 20.1, 47.1 g, 46.6, 20.0, and 44.9 g in local (Baladi) garlic.

Increase in species richness caused by tree invasion in managed forests in Hawai'i

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It was our aim (i) to test the hypothesis that species that are regarded as noxious invasives may exert different biodiversity impacts on altered forest plantations compared to near natural ecosystems, and (ii) to analyse how non-indigenous tree species (*Cinchona pubescens* Vahl, *C. calisaya* Wedd.) at increasing levels of abundance affect biodiversity patterns in tropical forests and tree plantations. The location of our study site was the Makawao Forest Reserve on the island of Maui in Hawai'i (USA) where introduced *Cinchona* species were mapped within various forest types. *Cinchona* species have naturalized mainly in *Eucalyptus* and *Pinus* plantations and in *Acacia koa* forests. In these forest types, we analysed species composition of invaded and noninvaded plots. Data were then compared based on different levels of *Cinchona* cover and forest types (one-way, two-way ANOVA).

In contrast to its effects on other tropical Pacific islands, *Cinchona* facilitated the establishment of native species, leading to higher species richness and a higher proportion of endemic species, including tree ferns. Species richness was about 20% higher in invaded plots, both in plantations and in near-natural forests. The proportion of endemic species increased with increasing cover of the invader, and invaded plots showed a nearly 50% higher proportion of endemic species compared to noninvaded plots.

We conclude that by modifying habitat through the addition of a vegetation layer, a particular invasive species may exert divergent effects on endemic species across different ecosystem types. Our study demonstrated facilitative impacts in structurally simplified tropical forests which are in contrast to the findings of comparable studies on naturally treeless vegetation on Galápagos, where the same structural change by the same introduced tree led to a sharp decline in species numbers. Positive cascade effects are expected when tree ferns which are facilitated by *Cinchona* function as nurse plants for other species. Site differences and vegetation composition of invaded habitats may therefore strongly influence the performance of the invader. In terms of application, the results of this study indicate that risk assessments and management approaches need to consider habitat heterogeneity.

Effects of native and invasive plants on the development of a specialist herbivore and its gregarious parasitoids

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Current climate warming results into range shifts of plants, their natural enemies, such as insect herbivores, and of their enemies, including parasitoid wasps. Many invasive plants are known to be released from their native pathogens and herbivores enabling them to establish in their new range. However, the mechanisms facilitating these processes are poorly understood. Furthermore, interactions between invasive plants, their herbivores and higher trophic levels, such as parasitoids, have been little studied. Instead, the current focus has been more on population ecology-oriented research aimed primarily at finding ways to eliminate or control invasive plants in their exotic ranges. Because of this, important information on ecophysiological aspects of multitrophic interactions involving invasive plants and associated consumers is lacking. Studies on multitrophic interactions with both invasive and native plants will provide important information of the degree of adaptation amongst local herbivore and parasitoid assemblages and may prove important in understanding (i) how these insects respond to novel plants both developmentally and behaviourally, and (ii) if natural enemies of important herbivores may prove an impediment in the control of the invasive plant. For that reason, studies are required exploring interactions between invasive plants and their associated consumers over three (or more) trophic levels.

The present project aims at studying the interactions between an invasive plant, *Bunias orientalis*, that originates from south-western Asia, but which has spread over much of central and western Europe in the past 20–30 years (Steinlein et al. 1996, Dietz & Ullmann 1997). This range shift is strongly correlated with recent climate warming in the region. The current study examines interactions between the exotic plant, *B. orientalis*, a native plant, *Brassica nigra*, a specialist insect herbivore, *Pieris brassicae*, and two its parasitoids, *Cotesia glomerata* and *Pteromalus puparum*. *C. glomerata* is a gregarious koinobiont endoparasitoid that attacks young larvae of *P. brassicae*, which continue feeding, molting and growing until the final instar when the parasitoid larvae egress from them and pupate (Harvey 2000). By contrast, *P. puparum* is an ectoparasitic idiobiont of *P. brassicae* pupae and related species (Harvey et al. 2007). Both parasitoids are known to lay primary broods of 30–40 eggs into pierid hosts (Harvey 2000).

Two hypotheses are tested here: (i) The native plant is of higher quality for the development of the herbivore, *P. brassicae*, than the invasive plant; (2) The koinobiont parasitoid will suffer larger costs in fitness than the idiobiont because host quality is not predictable for *C. glomerata* but is highly predictable for *P. puparum*. This is because *C. glomerata* attacks hosts whose future quality will determine parasitoid fitness, whereas *P. puparum* attacks hosts whose quality is pre-determined at the time of oviposition. The results will hopefully shed light on constraints imposed by differing plant quality on herbivores and their natural enemies, and may also help to elucidate which types of natural enemies will be most negatively affected by invasive plants containing novel compounds to which they are not adapted.

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Impacts of invertebrate invaders on the ecosystem of Kuibyshev water reservoir with emphasis on food web structure

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Hydroconstruction on the majority of the large plane rivers became a reason for serious transformations of ecosystems of the initial water bodies. As a result of intensive hydroconstruction taking place during the second half of the 20th century in the Volga basin a cascade of the water reservoirs interconnected by system of channels was created. Like the majority of water reservoirs, Kuibyshev water reservoir (Middle Volga, Russia) is characterized by instability of hydrobiological conditions and dynamical development of its ecosystem. Construction of water reservoirs led to creation of corridors for invasions and became a precondition for spontaneous acclimatization of alien-species.

Hydroconstruction in the Middle Volga region during the last 50 years (earlier the river Volga, now Kuibyshev water reservoir) resulted in significant changes in structure of benthic communities including shifts in dominant groups. Especially significant changes have happened among crustaceans that are well represented among alien-species of Kuibyshev water reservoir. After formation of the water reservoir, acclimatization of invertebrates, in particular misids (*Paramysis intermedia* and *P. ullskyi*) took place during the period of 1957–1966 in order to create a favourable feeding conditions for trade species of fishes. Cumacean and amphipoda crustaceans also of Ponto-Caspian origin, appeared in Kuibyshev water reservoir as a result of self-spreading. By 2000 invasive mysids and amphipods have completely naturalized, created steady populations, widely spread in water basin, and occupied the majority of suitable biotopes. Nowadays crustacean species invaders play a significant and in most of cases even dominant role in benthic communities of Middle Volga, in middle and lower Kama (*Dikerogammarus haemobaphes*, *Chelicorophium curvispinum*, *Pterocuma sowinskyi*). Before the invasion of crustaceans, oligochaets and chironomids were the dominant groups in benthic communities of the river Volga. Apart from crustaceans the most successful and numerous benthic invaders in the Middle Volga region are *Dreissena polymorpha*, *D. bugensis* and *Hypania invalida*.

Benthic invasive species contribute significantly to energy and biogens flows of the reservoir. They are also actively used as food by many fishes living in Kuibyshev water reservoir (carp bream *Abramis brama*, roach *Rutilus rutilus*). Our own investigation showed that alien crustacean species constitute the main part of a diet of individuals of sterlet *Acipenser ruthenus*, round goby *Neogobius melanostomus* and starry goby *Benthophilus stellatus*.

Characterizing the effects of invasive species on soil seed bank communities: univariate and multivariate techniques

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Characterization of the effects of invasive species on the structure of invaded communities is important for a predictive understanding of the mechanisms underlying invasion processes. Making rigorous probability statements about such alterations is, however, complicated by the innate spatial and temporal variability of ecological data. Mitigation of the confounding effect of biotic and abiotic variability requires the use of statistical procedures that are effective in (i) identifying and quantifying significant changes in invaded communities, (ii) relating such changes to the presence of invasive species, and (iii) assessing the scale at which processes operate. In this study we used a number of multivariate and univariate techniques to comprehensively assess the ecological effects of three invasive herbaceous species, *Fallopia japonica*, *Gunnera tinctoria* and *Heracleum mantegazzianum*, on the structure of soil seed bank communities, including two recently-developed multivariate procedures: permutational multivariate analysis of variance (PERMANOVA) and permutational analysis of dispersion (PERMDISP). A complex nested hierarchical design was used to test the effects of the three invaders at the scales of site (S), plot (P), and depth (D). Factors site and plot were used to reduce spatial variability and to provide information on the sampling effort required to detect and quantify the effects of invasive species. Factor depth was used to infer seed bank persistence, therefore providing some information on the long-term effects of plant invasions. The differences in the effects of the three invaders (Sp) on seed bank communities were also tested. A sequence of data transformations (no transformation, square root, fourth root and presence/absence) and three resemblance measures (Bray-Curtis, zero-adjusted Bray-Curtis, and a modified version of the Gower distance) were used prior to the analysis of seed bank data. Soil samples were collected in May and October over a one-year period from three sites per each invader. Within each site, four plots were randomly identified and five samples were collected from each plot and then subdivided into three depth categories. The results of this study showed that the differences between invaded and uninvaded seed bank communities were significant at each spatial scale. The use of PERMANOVA and PERMDISP, in combination with traditional univariate and multivariate techniques, was effective in quantifying the effects of the study invaders at different scales, providing a statistically-robust analysis of alterations in the seed bank flora associated with plant invasions.

Land snail assemblages of natural and plant-invaded alluvial ecosystems in the Czech Republic

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The main project objective is a comparison of the snails assamblages of the natural alluvial ecosystems and river floodplains invaded by plants in the area of the Labe river lower course tributaries. In this area, the research in mollusc fauna is of great conservation value and the results will make it possible to evaluate snail assamblages endangered by the projected Labe sluice construction. It will allow to assess the impact of alluvial plant invasions on the diversity of snail assemblages. Regarding a very close relationship of the snail assamblages and the soil they live in or their food differences we expect to obtain a much better model of the impact of invasive vegetation on invertebrates than was the case for groups of arthropods studied so far. The results should be also useful for the management of these biotopes.

Population biology of *Impatiens parviflora* and its impact on species diversity in nature reserves of north-eastern Slovakia

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The research on population-biological characteristics of *Impatiens parviflora* DC. was carried out in two nature reserves in the Prešov district: Šarišský hradný vrch and Fintické svahy, during two vegetation seasons of 2007–2008 in monthly intervals (May–September). Some population biological characteristics of *I. parviflora*, one of the most invasive plant species in Slovakia and Central Europe, were studied.

The aim of the second part of research is to verify a hypothesis on the relationship between the floristic and structural degradation of the herbaceous or ground layer and its resistance to the invasion of *I. parviflora*. This was investigated in the same nature reserves by using transects perpendicular to footpaths. The aim of the study is to find out if (i) there is a negative correlation between species richness and cover of the ground layer and the frequency, cover and density of the *I. parviflora* population, and (ii) if *I. parviflora* easily penetrates into degraded and floristically impoverished communities.

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Soil recovery after removal of the N_2-fixing invasive *Acacia longifolia*: consequences for ecosystem restoration

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Invasion by *Acacia longifolia* alters soil characteristics and processes. The present study was conducted to determine if the changes in soil C and N pools and processes induced by *A. longifolia* persist after its removal, at the Sao Jacinto Dunes Nature Reserve (Portugal). Some areas had been invaded for a long time (> 20 years) and others more recently (< 10 years). In each of these areas, two treatments were used: (i) plots where *A. longifolia* was removed; and (ii) plots where both *A. longifolia* and litter layer were removed; and additionally (iii) a control plot where *A. longifolia* was left intact. Soil samples were collected once a year for four and half years and analysed for chemical and microbial properties.

In general, microbial processes responded faster than C and N pools. In long-invaded areas, two and half years after removal of plants and litter, soil respiration and microbial biomass had already decreased >30%, β-glucosaminidase activity (N mineralization index) >60% and potential nitrification >95%. Removal of plants and litter resulted in a >35% decrease in C and N content after four and half years. In recently invaded areas, β-glucosaminidase activity and potential nitrification showed a marked decrease (> 54% and > 95%, respectively) after removal of both *A. longifolia* and litter. Our results show that after removal of an N_2-fixing invasive tree that changes ecosystem-level processes, it takes several years before soil nutrients and processes return to pre-invasion levels, but this legacy slowly diminish, and we suggest that the susceptibility of native areas to (re)invasion is a function of the time elapsed since removal. Removal of the N-rich litter layer facilitates ecosystem recovery.

Changes of ecosystem functioning in estuaries as a consequence of non-indigenous invasive species introductions

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The global decrease of biodiversity is mostly connected with anthropogenic activities, which, in a broad sense, impair the ecosystem functioning. In addition, anthropogenic activities and/or extreme natural disturbances may facilitate the introduction and possible dispersion of non-indigenous invasive species (NIS). Consequently, biodiversity will decrease in a global scale due to species extinctions but may increase at a local scale due to NIS introductions. In the last years, the biodiversity-ecosystem functioning discussion has been focused almost exclusively in what will happen to ecosystem processes and functions as species richness declines due to extinctions. However, the opposite situation has also significant importance and it is fundamental that this discussion include the cases of biological invasions that resulted in a net increase in diversity at a smaller scale. The number of studies addressing this last issue has disproportional minor attention, although it is clear that invasive species can affect the processes inside ecosystems. In this work we will focus our attention in estuarine areas. These ecosystems are well recognised by their ecological importance but are also frequently subjected to different pressures, being the introduction of NIS one of the most important. Our main objective is to review the introduction history of some of the most emblematic NIS present in estuarine areas and discriminate the past and current ecological status of these ecosystems. Then, we will analyse how ecosystem function is altered due to estuarine NIS introductions, try to find common patterns and assess if these changes are positive or negative in an anthropogenic point of view. There are many examples of estuarine NIS, both plants and animals, which lead to biodiversity changes and ecosystem impairing. Examples of NIS that will be in focus of our study are *Spartina alterniflora* (Plantae: Liliopsida), *Mnemiopsis leidyi* (Ctenophora: Tentaculata), *Eriocheir sinensis* (Arthropoda: Decapoda), *Corbula amurenis* (Mollusca: Bivalvia), *Corbicula fluminea* (Mollusca: Bivalvia), *Dreissena polymorpha* (Mollusca: Bivalvia) and *Cyprinus carpio* (Chordata: Osteichthyes).

Limited impact of *Reynoutria japonica* on urban plant biodiversity

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Invasive plants are recognized as a major threat to biodiversity over the world. While well-researched in natural areas, their supposed negative impacts upon resident ecosystems have been poorly investigated in urban areas so far. Here, we explore the impact of the invasive Japanese knotweed (*Reynoutria japonica* Houtt) in urban wastelands at two different scales. At the site scale, we studied 98 sites and compared the plant diversity of 'invaded' sites to that of 'virgin' sites. We found that floristic composition did not differ significantly between invaded and uninvaded sites and the diversity in itself is not threatened by the presence of the Japanese knotweed. Inversely, mean species rarity was higher in invaded sites.

At the patch of invasion scale, we considered eight urban wastelands, all invaded by Japanese knotweed. On each site, we analysed soil and vegetation jointly along four transects running from the center of the Japanese knotweed stand towards the uninvaded periphery. We showed that this invasive species enhances the incorporation of organic matter and the soil biological activity, and thus creates a positive feedback. However we also showed that Japanese knotweed excludes almost all other competitors. We clarified the local impacts of this species on soil and flora, but we also stressed the importance of scale and dynamics issues, especially in urban areas, to conclude about the harmfulness of this invasive species.

Nectar robbing in an invasive species of the Galapagos Islands

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Biologic invasions are one of the main threats to natural ecosystems. However, not all foreign species arriving to a new ecosystem turn into invasive species. In this study we analyse the effect of nectar robbing (measured like intensity and frequency of robbing) interactions between native floral visitors and a widely invasive species, *Kalanchoë pinnata* in the Galapagos Islands. The results show that two generalist native species rob the nectar in *K. pinnata* and by doing that, they affect the fruit production dramatically. Moreover, our results suggest that nectar robbers could counteract the possible effect of legitimate pollinators on selection on flower size or on floral display because the intensity of robbing is higher in longer flowers and more-flowered inflorescences. We discuss for the first time the effect of this interaction between native antagonist and exotic species in relation to the biotic resistance hypothesis.

Introduced bumblebee induce negative effects in native plants of *Lathyrus multiceps* in the Chilean Andes

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During the past decades there has been much interest on introducing the European bumblebee *Bombus terrestris* L. to pollinate commercial crops in many countries out of its natural area of distribution. Defenders of importation of *Bombus terrestris* for that use argue that this species will have little impact on foreign ecosystems because it prefers to forage on flowers of introduced species of plants rather than on native plants. However, in the Chilean Andes, the introduced *Bombus terrestris* forages on flowers of the native herb *Lathyrus multiceps*. In this study we analyse the effect of the interaction between the introduced bumblebee *B. terrestris* and the native herb *Lathyrus multiceps* on the female fitness of the native plant. The foraging behaviour of *Bombus terrestris* affects negatively to the female fitness of *Lathyrus multiceps*. The bumblebee access to the floral nectar by robbing it and doing that, it decreases significantly the production of seeds. We also analyse the functional relationship between flower morphology and nectar robbing. The chance of flowers being robbed increased with flower length.

Thermophilous plant communities dominated by *Pteridium aquilinum*, an expanding fern in the Capatanii Mountains (Romanian Carpathians)

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The Capatanii Mountains are part of the Parang Mountains. The researched area was located between the Oltet rivulet to the east, the Olt river to the west, the subCarpathian area of Oltenia to the south, the Latoritei mountains, the Valley of Lotru and the Depression of Loviste to the north. In the southern part, at the borderline with the subCarpathian area, there is a stretch of mesosoic limestones which form wild gorges (Oltet, Galbena, Costesti, Cheia, Bistrita). The southern orientation of the slopes and the presence of the limestone layer allow for the occurrence of a great diversity of plants.

The fern *Pteridium aquilinum* (L.) Kuhn (wolf`s clothes, field fern) is a colonizing plant in agroecosystems and natural, degraded ecosystems, being almost impossible to combat. Although it is a native plant in Romania, present over large areas, particularly in the hilly and lower mountain areas, due to the inefficient methods of combat, it should be paid special attention. The extension of invaded areas is underlied by three main causes: agricultural desertion, the reduction of pasturing and deforesting. The effects are economic, ecological (the reduction of biodiversity) and the health of both the animals and man is also affected. Its spread in Romania arouse interest, which lead to the limitation of its expansion. In Romania, even a vegetal association Clinopodio vulgaris-Pteridietum aquilinii Dihoru 1975 was described. The poster focuses on the distribution, ecology and the floristic composition of this association in the Capatanii Mountains. The association is widely spread in the hilly area, at the edge of the woods, on sites of former potatoe cultures, on S, SW and SE-oriented slopes. In the Capatanii Mountains this association is spread over hundreds of acres, giving rise to a serious problem for the local people in terms of control and return of the fields to the agricultural circuit. Up to now, this association was not reported from Oltenia.

Can species traits predict hazard levels of plant pests?

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In the present study I look for the first time at species traits for predicting hazard levels. I focus on organisms of phytosanitary concern and collect data of established plant pests belonging to different taxonomic groups (weeds, insects and micro-organisms). The level of impact these pests have on environment, economy and society is quantified. Species traits are then used as explanatory variables to predict impact levels. I thus expect to identify common species traits responsible for high impact levels. The findings will be validated and are to be integrated in PRA schemes currently being developed in the EU project PRATIQUE. The final aim is to provide Pest Risk Analysts with scientifically funded tools and thus enabling them to collect the relevant data on species in the course of a Pest Risk Analysis.

Climate change enhances the impact of Japanese knotweed (*Fallopia japonica*) on mycorrhizal inoculum potential

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Japanese knotweed, *Fallopia japonica* (Houtt.) Ronse Decraene, an invasive plant in Ireland, grows in large stands that impede the regeneration of native vegetation and modify succession patterns and nutrient cycling (Beerling et al. 1994). These impacts are expected to be enhanced by climate change, as there is evidence that it will favour invasive species (Dukes & Mooney, 1999). Invasive plants may also alter the soil biota and reduce the abundance of arbuscular mycorrhizal (AM) fungi (Reinhart & Callaway 2006). We examined the impacts of both *F. japonica* and climate change simulations on mycorrhizal inoculum potential (MIP; AM propagule number together and infective vigour). The study was undertaken in an area where Japanese knotweed invades semi-improved grasslands. Climate change was simulated using passive polythene enclosures and the environmental conditions were periodically monitored. MIP was assessed in bioassays with white clover (*Trifolium repens*) and estimated using the gridline intersection method (Brundett et al. 1996). Japanese knotweed reduced the number and colonization ability of AM propagules. Possible reasons for this include a direct effect on MIP, a reduction in plant species richness or both of these factors. The effect of *F. japonica* on MIP was also greater when coupled with climate change. These results support the ideas that invasive species alter soil biota and that their effects can be enhanced by climate change.

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How different are native and invasive plant species in their impact on ecosystem processes in Switzerland?

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Invasive plant species may promote their persistence and spread in native plant communities through positive feedback loops. Amongst others, alterations in nutrient cycling (Ehrenfeld 2003) and allelopathic effects (Callaway 2000) can contribute to these self-promoting feedbacks. Do these mechanisms also contribute to the invasiveness of major invasive forbs in Switzerland? And are they more pronounced in invasive than in native species? To answer these questions, we compared leaf traits, litter decomposition and allelopathic properties among three plant groups: invasive forbs, native forbs and native grasses.

Six species per group (18 in total) were grown for two seasons in 3-l pots with sand in a common garden experiment. Their leaf traits were measured in the second growing season and dead leaves were collected for a subsequent decomposition study (mass loss during ten-week incubation in a growth chamber). Allelopathic properties were determined by cultivating seedlings of the grass species *Dactylis glomerata* on substrate taken from the pots in which the 18 test species had grown before. Activated charcoal was added to half of the replicates to absorb possible allelopathic substances, and the difference in growth of the phytometer *D. glomerata* between treatments with and without activated charcoal was taken as a measure of allelopathic effects.

There were more differences between grasses and forbs than between native and invasive forbs. Grasses had higher leaf tissue density, and their litter decomposed slower than the forb litter (on average 26% versus 37% mass loss), whereas native and invasive forbs were equal in these traits. Specific leaf area and nutrient concentrations did not differ between the three groups. Allelopathic effects were detected with most of the species: the phytometer produced significantly less biomass when no activated charcoal was added to the substrate. Invasive forbs and the native grasses exerted similar allelopathic effects (33% and 30% mean growth reduction), whereas native forbs tended to exert lower allelopathic effects (21% mean growth reduction), yet the difference was not significant.

Our study indicates that invasive forbs do not necessarily have a stronger impact than native forbs on ecosystem processes through the studied feedback mechanisms when grown under the same conditions. General differences in traits between grasses and forbs have, however, to be considered in comparative studies. Invasive forbs may have a greater effect on ecosystem processes when they replace native grass species than when they replace native forb species.

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Rigorous impact assessment of invasive plant species: theoretical considerations and practical applications

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According to Parker et al. (1999), the impact of an invasive species can roughly be quantified as I = R × A × E, where R is the area of the invaded range, A is the invader's average abundance, and E is the invader's effect per individual or biomass unit. We argue that this basic formula has got some shortcomings in not accounting for non-linearity of the abundance–effect size relationship and neglecting variability in habitat quality and availability throughout the invaded range. Further, effects of invasive species may not be unique but can be similar to those of native species.

The per capita effect of an invasive plant species is likely to be correlated with its abundance. For instance, single individuals of an invader might have virtually no effect on community structure, composition or function, whereas a dense stand of the same number of individuals might have a strong effect. If this relationship is non-linear, then the product of average abundance and per capita effect gives a wrong estimate of impact. We suggest that measurement of effects on a 'per unit area' basis might be better suited for invasive plant species. In practical applications, non-linearity of the effect–abundance relationship could be accounted for by calculating proportional impacts for different abundance classes of the invader, e.g. open and dominant stands.

Empirical studies show that effects of invasive species can vary substantially between different invaded habitat types. For the invasive plant *Heracleum mantegazzianum* it was shown that it had only moderate effects in tall-herb stands, whereas it completely altered community composition and structure of ruderal vegetation and grasslands (Thiele & Otte 2007). Hence, the measurement of both effects and invaded range should be habitat-specific.

In the course of vegetation dynamics, particularly succession, native species as well as invasive species can alter community composition and structure. For instance, tall herbs may shade out smaller herbs reducing species richness of successional grasslands. If the effects of invasive and native species are redundant, the estimation of effect size based on before-after comparisons may overestimate invader impact. Instead, a comparison of invasive vs. native effect would give a more realistic impact assessment. Hence, we suggest using differential effect estimates (invader effect–native effect). For practical application, we advocate a combined approach of habitat-specific field surveys and remote sensing for area-corrected quantification of the invaded range.

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The impact of an invasive plant on visitation patterns and seed set of a native co-flowering species

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Around the world the number of alien plant species invading native habitats is growing, and understanding the impacts these invasives have on the pollination of the native flora has important implications for biodiversity conservation (Pimentel et al. 2001, Traveset & Richardson 2006). We examined the effects of the invasive *Solanum elaeagnifolium* (Solanaceae) on flower visitation patterns and seed set of a co-flowering native plant *Glaucium flavum* (Papaveraceae) on the island of Lesvos, Greece. We observed flowering *G. flavum* plants in sites with *S. elaeagnifolium* (invaded) and without *S. elaeagnifolium* (uninvaded). *Glaucium flavum* flowers in uninvaded sites received significantly more total bee visits than in invaded sites. The uninvaded sites had larger proportions of *Amegilla* bees and honeybees visiting, but smaller proportions of *Xylocopa* and *Megachile* bees, than the invaded sites. In addition, we hand-pollinated flowers on plants of *G. flavum* with pure conspecific pollen, pure *S. elaeagnifolium* (invasive) pollen, and three different proportions of the two types of pollen (invasive: native 75%: 25%, 50%: 50% and 25%: 75%). As a control some flowers were left unmanipulated for open (natural) pollination and some were permanently covered to obtain the rate of spontaneous self-pollination in the absence of flower visitors. Flowers pollinated with mixtures of conspecific and invasive pollen did not differ significantly in seed set from flowers pollinated with pure conspecific pollen. Seed set in the free pollination treatment was significantly lower than in the 100% conspecific pollen treatment, which suggests that *G. flavum* is pollen-limited. Pollination with invasive pollen resulted in very low seed set similar to that of spontaneous selfing. *Glaucium flavum* was generally robust to the deposition of *S. elaeagnifolium* pollen. Lower seed set resulting from processes of heterospecific pollen deposition (stigma clogging, stigma closing, pollen allelopathy, stylar clogging and stylar inhibition) did not have major effects for the percentages of invasive pollen used.

Our results indicate that the presence of *S. elaeagnifolium* significantly lowers the visitation of pollinating insects to *G. flavum*, which might lead to a reduction in seed set. The deposition of *S. elaeagnifolium* pollen alone, however, did not significantly impact the sexual reproduction of the native *G. flavum* even at the relatively high percentages of invasive pollen applied.

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POSTERS

Section 5

Prediction, risk assessment, management & policy

Managing the invasive crayfish *Procambarus clarkii*: the Mediterranean eel (*Anguilla anguilla*) as an indigenous predator

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The red swamp crayfish, *Procambarus clarkii*, is a paradigmatic invader of freshwater systems in southern Europe (Gherardi 2006). Several attempts have been made to mitigate the multilevel impact of this species but none was successful (Gherardi 2007). Among the different methods proposed, the use of the European eel (*Anguilla anguilla*) as an indigenous predator is promising. Eels are in fact good candidates to control crayfish because of their nocturnal feeding habits and benthonic behaviour, which both match crayfish life-style. However, information about this species' predatory ability on crayfish is still scanty (but see Frutiger & Müller 2002).

A field experiment was conducted in May–August 2007 to investigate the effects exerted by *A. anguilla* on an invasive population of *P. clarkii* in the Tuscan wetland "Padule di Fucecchio". A total of 23 cages (50 × 50 × 200 cm), each containing 15 crayfish of three size classes (large, medium, and small) and enriched with shelters and hydrophytes, was placed for 20 days in a channel. An adult eel (body length: 46.0±1.8 cm) was inserted into each of 11 treatment cages. Each cage was inspected every week and the number of dead/missing crayfish and their size were noted. Dead/missing crayfish were replaced with live individuals of the same size class. At the end of the experiment, the surviving crayfish were collected, sacrificed, and their gut content was analyzed.

Our results show that eels are able to prey on *P. clarkii*; they also reduce the trophic activity of crayfish, thus increasing their mortality due to starvation (guts were in fact significantly emptier in crayfish from the treatment cages). The use of eels is complementary to the traditional trapping because of their habit to prey on the trap-shy small individuals, as a confirmation that invasive crayfish might be more successfully managed by the adoption of a combination of techniques (see also Hein et al. 2007).

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A global information database designed to facilitate research

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Plants have long been introduced from one part of the world to another. Occasionally, non-native plants become invasive in their new range, changing ecosystems, leading to loss of biodiversity, and producing severe economic damage. Plant invasions are expected to increase as the global economy grows. A number of invasive species that have caused serious problems belong to the grass family (Poaceae). Researchers have long searched for ways to predict which species are likely to become invasive in areas outside of their native range. We propose to select a subset of invasive grasses and create a database of information about them that can be used by researchers and managers to investigate their characteristics and interactions with their environments. We will use data from published literature and other public sources to provide in-depth information on factors such as level of invasion in various parts of the world, pests in native and introduced ranges, symbiotic interactions, soil and nutrient requirements and tolerances, and genetic characteristics such as variability, genome size, and plasticity. Here we present our conception and initial format of this invasive grass database. Such a database will allow researchers to compare and contrast traits of grasses and their interactions with the biotic and abiotic features of their native and non-native ranges. This type of research can reveal patterns that can lead to deeper understanding, better control, and improved prevention of grass invasions.

PRATIQUE: an EU 7th Framework Project designed to enhance techniques for assessing plant pest risks and to analyse the options for managing pest invasions

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Growing global trade, environmental change and EU expansion is increasing the risks posed by the continuing entry and establishment of new plant pests and invasive alien species in Europe. Pest risk analyses (PRA) assess the risks and identify appropriate options for their management. The European Union Seventh Research Framework Programme (FP7) project Enhancements of Pest Risk Analysis Techniques (PRATIQUE) was launched in March 2008 to address three major challenges for PRA: (i) predicting the potential for entry and establishment of plant pests and invasive alien species new to Europe, (ii) estimating potential economic, environmental and social impacts, and (iii) designing measures to prevent, eradicate, contain or control invasions.

Three principal objectives are addressed (i) to assemble the datasets required for effective PRAs valid throughout Europe, (ii) to conduct multi-disciplinary research that enhances bio-economic techniques in PRA, and (iii) to develop an improved web-based, user-friendly decision support scheme. The PRA scheme will be hosted by the European and Mediterranean Plant Protection Organization (EPPO).

The project includes 15 Partners. It brings together pest risk analysts, phytosanitary experts, invasive alien species specialists, ecologists, economists and risk modellers from eleven research institutes across the EU, two international organisations, and two institutes from Australia and New Zealand. Sub-contractors in China and Russia are also involved. This consortium will create the first structured inventory of PRA datasets for Europe and undertake targeted research to improve existing procedures and develop new methods for: (i) producing consistent summaries of risk that clearly take account of uncertainty, (ii) assessing economic, environmental and social impacts of plant pests, (iii) mapping endangered areas, (iv) preventing invasions through improved pathway risk analysis procedures, and (v) guiding actions during emergencies caused by outbreaks of harmful pests.

Results will be tested with a representative range of major pests and invasive alien species affecting cultivated and uncultivated habitats of Europe and will be independently validated by phytosanitary experts. Deliverables will be provided as protocols, decision support systems and computer programs with examples of best practice made available to pest risk analysts through modules and direct links to the enhanced EPPO PRA scheme. Further information on PRATIQUE can be obtained from the PRATIQUE Project website (www.pratiqueproject.eu).

Management of invasive plant species in the Oslo area, Norway

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During the last four years, measures have been taken in order to reduce both occurrences and spread of invasive plant species on islands in the inner Oslo fjord. The biodiversity of the area surrounding the capital of Norway is one of the highest in the country, due to the favourable climate and calcareous ground. The area is already threatened by urbanisation, and large efforts are made to save the remaning natural habitats. The invasive species suppress native plants, and are classified as a threat to unique habitats and the indigenous vegetation. The species are: *Vincetoxicum rossicum*, *Bunias orientalis*, *Solidago canadensis*, *Phedimus spurius* (*Sedum spurium*) are *Syringa vulgaris*.
Several different methods are used and tested and the work is evaluated every autumn. For the most part, the methods used are quite time-consuming, e.g. mowing, or removal of seed-bearing plants. Experimental tests with light-impermeable soil covers, herbicides, burning and manual picking are made this season on *Phedimus spurius*. The project is financed by the Municipality of Oslo and the County Governor's Office.

Development of costs effectiveness model phytosanitary measures

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Phytosanitary measures to facilitate international trade are increasingly important. Policymakers of the Dutch Ministry of Agriculture, Nature and Food Quality and the Plant Protection Service asked for a model that contributes to the structure and consistency of the decision making process underpinning the choices of phytosanitary measures.

The research is focused on the development and implementation of a framework for determine the costs and benefits of phytosanitary measures,,in order to support decision-making. The framework (Figure 1) is based on the Multi Attribute Utility Theory, a multi criteria decision making method (Romero & Rehman, 2003). With this method it is possible to calculate and weigh dissimilar quantities (e.g., economic consequences and consequences for nature and landscape). The model has been described theoretically and implemented in a Microsoft Excel spreadsheet

The result of the project is a functional model (in Dutch), in which policy makers and researchers can calculate the impacts of measures. The possibility to weigh impacts is implemented only at a technical level. By means of weighting factors, stakeholders can indicate how dissimilar effects are evaluated. The model is provided with an explanation of its background and an instruction manual. The model is ready to use in the daily practice of policy makers, although it is still in an experimental state. The first experiences of the policy makers with the model can be summarized as follows: (i) It contributes to the consistency and completeness of the decision; (ii) It takes time to use the model, because most impacts have to be calculated separately. This can be overcome in future by developing modules to calculate effects; (iii) It is difficult to distinguish between scoring and weighting impacts. This is the consequence of the fact that weighting factors have only been implemented at a technical level; (iv) The structure lacks flexibility. Research officers have to go through the whole model even if they need only part of it. These experiences will be used in future developments of impact assessment modules in the FP7-project ‘PRATIQUE’.

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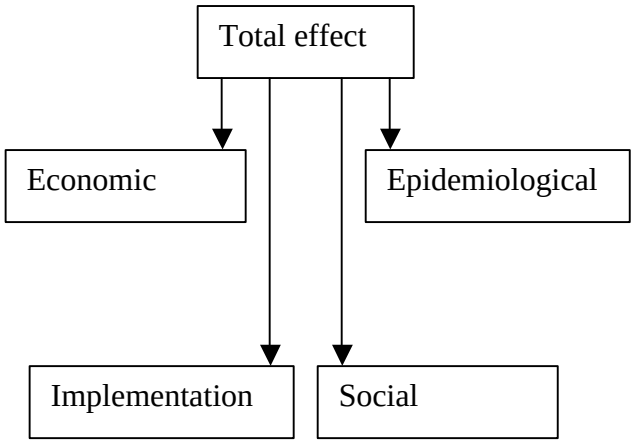

Figure 1. Framework of Cost Effectiveness Model.

Eradication of boil smut (*Ustilago maydis*) from a field in New Zealand

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This paper discusses eradication options and results relating to the Ministry of Agriculture and Foresty, Biosecurity New Zealand (MAFBNZ) response to boil smut (*Ustilago maydis*) from New Zealand. On Friday 13 January 2006 a crop scout in Gisborne, contacted MAFBNZ to report a suspect new to New Zealand corn disease in a 1.9 ha sweet corn seed crop. Seeds were imported from Idaho (USA) as hybrid seed for sweet corn production and planted on 10 November 2005.

A number of eradication options were considered, including hand pulling symptomatic plants, cutting the corn and placing in silage, soil solarisation, deep burial, soil fumigation, deep ploughing, field resting, planting the field with treated corn seed and top soil removal and replacement. Initial containment involved the inspection of the crop and collection and destruction of *Ustilago maydis* infected plants on 16 January 2006. Ninety-three infected plants were collected (including roots), doubled bagged and incinerated during the initial survey. It is estimated that a total of 2–3 plants had mature galls that had erupted teliospores, plus approximately 18 medium sized galls with minor breaks. Movement control restrictions were placed on the infected paddock on 18 February 2006.

After scientific analysis of eradication options, silage of the green crops and stubble followed by deep burial, and soil solarisation of the infected area and a planting restriction on susceptible hosts was undertaken. The crop was destroyed by mechanically cutting each plant into 2–3 pieces and placing into a silage heap between two large sheets of black polythene. Due to timing of the incursion, soil solarisation could not be commenced until the following summer 2006/2007. Between harvest of the corn and soil solarisation the field was planted in ryegrass to mitigate wind dispersal of any remaining fungal spores.

Field temperature results from 2007 / 2008 indicate that temperatures within 0–15 cm of the polythene would have received enough degree hours to eradicate *U. maydis* from that zone. Two scenarios are provided based on the depth of likely spore deposition within the soil column. It is predicted that if a standing population of 202 billion spores was present before solarisation, then remaining spores are likely to range from between 45 thousand to 480 thousand spores.

The number of spores released into the soil, estimated at ca. 202 billion spores, may be under or over-estimated. It is estimated that eradication actions have potentially eradicated over 99% of the spores, and any remaining spores are most likely to be present at depths over 15 cm within the known risk area where *U. maydis* infected plants were found. It is concluded that at least two further years of freedom from Zea mays host plants are required to increase the probability that any remaining spores are eradicated from the field. While *U. maydis* has been recorded germinating after 8 years indoors in cool dry conditions (Christensen 1963), it is considered likely that spore mortality will be higher under field conditions where environmental conditions such as moisture, temperature and pH, and microbial processes such as antibiosis, lysis, parasitism, or competition will contribute to disease control (Katan 1981). While no guarantees of success can be made, MAFBNZ is confident that the process undertaken provide the best chance for eradication of this disease from New Zealand.

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* MAFBNZ appreciates the assistance of the property owners and the response contractors AsureQuality Ltd, Peter Wilkens and Roger Midgely during the response. In addition the awareness and quick reporting of the disease by the crop scout has increased the chances of a successful eradication. MAFBNZ.

Naturally talented? How the BTCV Natural Talent Apprenticeship scheme is helping to bridge the skills gap: Northern Ireland's Invasive Species Apprentice

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The BTCV Natural Talent Apprenticeship Scheme is aimed at training the next generation of naturalists through a unique training scheme. For a number of years it has been of concern that we are losing specialist skills from the conservation sector and it is hoped that this apprenticeship scheme will go someway to helping fill this skills gap.

The Invasive Species Apprentice has been employed to help combat the problem of invasive species within Northern Ireland. The aim of the apprenticeship is to learn about invasive species and receive training in their management through workshops, residential opportunities and on site training; whilst also applying this knowledge to design and instigate projects to help manage invasive species in different environments within Northern Ireland. These projects include the Rams Island rat eradication, the Ballinderry river invasive plant control programme and an awareness raising project to highlight the invasive species issue to the general public, schools and businesses to help raise the profile of invasive species management within Northern Ireland and to also highlight the role that people play in the global invasive species issue. Within the placement appointed mentors are available to offer advice and guidance throughout the apprenticeship.

The implications the apprenticeship has in Northern Ireland are vast. After the completion of the apprenticeship it is hoped that the knowledge will be used to help train and inform others on how to practically manage invasive species and to work towards tackling the invasive species issue within this often-overlooked part of the UK. The Natural Talent Apprenticeship scheme is funded through the Heritage Lottery Training Bursary scheme and is currently one of nine Natural Talent apprentices currently being run in the UK.

The invasion of *Rumex alpinus* in the Giant Mountain (Czech Republic)

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The invasion of an alien plant species *Rumex alpinus* (alpine dock) is a serious problem in the Giant Mountains National Park, Czech Republic. In the last 50 years, this vigorous perennial plant has threatened the biodiversity and economic use of the species-rich mountain meadows. Current attempts to eradicate the invasion are only local and do not take into account that the invasion is a problem at a landscape scale. To design a functional eradication strategy, we thus need information about the spread of the species at the landscape scale. In this way, it should be possible to identify the potentially dangerous source populations, as well as identify the areas that are most susceptible to invasion.
The model integrates data on landscape structure, local population dynamics of the species and on spatial spread of the species. Based on available data on distribution of *Rumex alpinus* in the whole area of Giant Mountains, we identified habitat characteristics of the invaded sites. Based on this knowledge, distribution of all habitats potentially susceptible to invasion can be created in GIS. These data were combined with detailed data on population dynamics collected in three grassland populations and three populations growing along streams. In the first version of the model, long-distance dispersal was simulated using a simple exponential function. The parameters of the exponential function are based on knowledge of seed terminal velocity, plant height and wind speed. We performed a series of simulations of the invasion from the past to the present to calibrate the model. The results of the historical simulations, based on distribution of *Rumex* in 1980 and 1997, were compared with the recent distribution. This comparison helped to choose the set of parameters that best describe the historical spread and on this basis the scenario of the future rate of the invasion was created.

The data used to model the long distance dispersal are very simple. In the current study, we thus attempt to obtain more accurate data based on combination of field studies and analysis of isozymes. Specifically, we will study dispersal by wind at mountain grasslands and by water in mountain streams using seed traps at several different localities. Simultaneously, we will study genetic relationships between plants within single populations as well as between populations.

The results of the study indicate that the population growth rate of *Rumex alpinus* is rather high, which is caused mainly by massive clonal reproduction and persistence. Generative reproduction probably plays an important role in long-distance dispersal. The risk of future spread is high because there are still unoccupied habitats susceptible to the invasion in 70% of the area of the Giant Mts. According to the recent model, if the future trend of the spread is the same as in the past, there could be about 3–4× more occupied habitats 20 years later, still not reaching its potential distribution.

Mitigation practices to reduce biofuel crop invasiveness and biodiversity loss in Italian agroecosystems

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In the recent past many government reports, including CBD, and scientific literature have highlighted the potential impact that biofuel crops may have on natural, semi-natural and agriculture ecosystems (Raghu et al. 2006, Low & Booth 2007). The characteristics of biofuel species, their habitats, cropping systems and farm subsidies are a "weedy merging combination" (sensu Richardson & Pyšek 2006) that may transform farmland into a source of new invasive species that can spread and ultimately harm native biodiversity within agroecosystems.

In fact, (i) The ecological traits of biofuel crops, such as: water efficiency, seed production, scarceness of pest and disease, and fast growth are commonly found among invasive plant species; (ii) In farmland, habitat degradation, fragmentation, abandonment of arable lands, altered water and nutrient cycle and fire regime, presence of river channels are all factors contributing to the creation of new temporary free niches, increasing the invasibility of the land; (iii) Planting large quantities of vigorous plant varieties on a large scale by repeated introductions in different climate and soil condition increases the chance of "crop escape"; (iv) Annual payment schemes, under the EU Common Agriculture Policy, for biofuel crops may be a further cause for potential escape when subsidies are not directly linked to harvesting or processing and leave crops in the field or stocked in farmlands.

A Weed Risk Assessment, adapted and validated for Mediterranean central Italy, screened 14 proposed biofuel species showing that at least nine have the potential to become invasive species; of these some are already recognised as weeds both in Italy and/or elsewhere in Mediterranean-type regions and others never had a cropping system in Italy. APAT, the Italian Government Environment Agency, is at present working on "good practices " to mitigate the potential invasiveness of biofuel crops. A list of "Good management procedures" includes measures such as: use of a pre-cultivation weed risk assessment screening tool for biofuel crops for explicit climates and soil types; reduce propagule dispersion during transportation, as well as severe phytosanitary; specific cultivation practices; subsidy schemes connected to crop processing and not based on historical entitlements (decoupling); dedicated studies on the auto-ecology; assessment of land use; monitoring/surveillance sites located in the surroundings of the biofuel fields; specific biological and chemical control techniques; identification local and regional stakeholders capable of rapidly detecting, eradicating or controlling invasive biofuel crops.

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Table 1. WRA score and a priori invasiveness of proposed biofuel species (source APAT 2007)

Species	WRA score	Invasiveness
Acacia saligna	12	major
Ailanthus altissima	16	major
Crambe abyssinica	0	unknown
Helianthus tuberosus	12	major
Hibiscus cannabinus	5	unknown
Jatropha curcus	15	unknown
Kochia scoparia	11	unknown
Melia azedarach	12	minor
Miscanthus sinensis	11	unknown
Panicum virgatum	4	non
Paulownia tomentosa	4	non
Robinia pseudoacacia	15	major
Sorghum bicolor	6	unknown
Zea mays	1	non

Modelling species distributions: *Otiorhynchus* species

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Pest risk assessment often requires the knowledge of where in a newly invaded area a potentially harmful species may survive. In the past, best judgment and comparison of biotic zones had to suffice, but now computer models are commonly used for this purpose. Two modelling systems, Maxent and Climex, employ fundamentally different methods and are recognised as providing credible results in most cases. In preparation for testing the potential North American range of *Otiorhynchus corruptor* (a European root-feeding weevil and grape pest), attempts were made to test the usefulness of these two systems using other species within the same genus that have already invaded North America and may be presumed to have extended across a good part of their potential range (*Otiorhynchus sulcatus, O. ovatus, O. raucus* and *O. rugosostriatus*).

Maxent produced predicted distributions that corresponded very well with the native range of all species, but rather poorly with the introduced ranges (when assessed using various threshold methods outlined in Liu et al. 2005); only the introduced range of *O. sulcatus* was reasonably well predicted, even though most species' ranges were predicted better than under a random model (Table 1). Climex models were built using the native range of the species, and then projected onto North America. These models predicted a much larger suitable area in North America overall (using the criterion that suitable range is where the ecoclimatic index > 0), which included nearly every N.A. occurrence locality (Table 1). If the guidelines in Liu et al. (2005) were set aside and the predicted potential range under Maxent were chosen as that area that reduces training omission to 0 (minimum training presence), then the Maxent prediction was much closer to the Climex prediction.

The poster also presents how this information aided in the prediction of the potential distribution of *O. corruptor* in North America.

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Table 1. Test omission rate (percentage of positive sampling locations in North America not predicted to be within predicted range) for four *Otiorhynchus* species under Maxent and Climex predictions. Bold values indicate predictions that are better than under a random model (Maxent only). Loc. no. – number of localities in North America.

Species	Loc. no.	Test omission rate (criterion for potential introduced range)	
		Maxent (sum of sensitivity and specificity maximised / minimum training presence)	Climex (Ecoclimatic Index >0)
O. sulcatus 178	178	**0.647 / 0.000**	0.022
O. ovatus 336	336	**0.818 / 0.089**	0.000
O. raucus 27	27	1.000 / **0.259**	0.000
O. rugosostriatus	2	**0.931 / 0.639**	0.153

Invasive plant pathogens: are they more successfully managed than invasive plants?

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Invasive plant pathogens have long been the subject of much research due to their often considerable economic and social impact that results from losses they cause in host crops. However, amongst invasion ecologists plant pathogens have received considerably less attention. Similarly for decades, and in some cases for centuries, invasive plant pathogens have been the subject of what have now become known as biosecurity policies at a national and international scale. Such policies in the field of invasive plants have only relatively recently started to be developed. Comparing the long history of policies used in countries such as the UK to manage exotic invasive plant pathogens with policies devised against other invasive species offers the opportunity to learn from examining policy successes and different policy approaches in these two complementary fields.

We use the example of plant diseases affecting potatoes in Britain to illustrate impacts, research and policies over the last century. We show how, since the introduction of the potato into Britain at the end of the 16th century, the subsequent arrival of plant diseases has resulted in a variety of different policy responses, and we draw comparisons to the situation for invasive plants.

Conserving biodiversity from biological invasions: a two-stage triage system

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Whilst biological invasions are acknowledged as the greatest threat to biodiversity after land clearing/habitat loss (Coutts-Smith & Downey 2006), information on the biodiversity at risk from such invasions or strategies to ensure the survival of these threaten species have not been forthcoming. Contributing to this problem is the widely held assumption that control alone will lead to a biodiversity benefit. There is growing evidence to debunk this assumption, as in many instances control of alien species is insufficient to save threaten biodiversity, or the control actions themselves have adverse impacts on them (Downey 2008). A two-stage triage system has been developed to resolve the problem.

The first stage involves the identification and prioritisation of the biodiversity at risk from the biological invasion, and the second assesses specific sites or locations of such biodiversity to ensure that control is directed at achieving the greatest conservation outcome, independent of land tenure. Identification of the biodiversity at risk uses four steps (i) literature review, (ii) consultation with experts working with either the invasive species or the biodiversity at risk, (iii) peer review of an interim list of species at risk, and (iv) modelling the revised list to determine priorities based on their probability of extinction. The model priorities native species that have a high distribution overlap with the invasive species posing the threat (e.g. > 90%), which are also listed under the threatened species legislation or have the potential to become so. The selection of sites is equally as complex especially at a landscape scale. The site model examines the (i) ability to achieve effective control, (ii) degree of impact at the site – as not all species at risk are equally at risk in all locations, (iii) presence of other threats, and (iv) condition of the species at risk relative to the species overall survival. This triage approach uses a two-way matrix of high, medium and low priority biodiversity and sites for control, in which nine alien plant management priorities for biodiversity conservation are identified, ranging from (i) immediate, targeted action to (ii) broader control to (iii) no or limited action once other priorities have been addressed.

The triage systems has been used to develop management strategies for *Chrysanthemoides monilifera* and *Lantana camara* which also include additional measures to ensure control delivers on-ground conservation outcomes. Specifically control actions that are tailored to the native species at risk and site-specific management plans which account for the individual site variables not addressed in the site model, which include a staggered control approach to limit off target damage (DEC 2006). Despite the difficulty of co-ordinating this program across many different land managers and a variety of land tenures, the above approach has been widely acknowledged by stakeholders as a suitable model for protecting native species from alien plant invasions.

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The role of native birds in native plant species decline, revegetation and alien plant reinvasion: consequences for management and biodiversity conservation

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Whilst it is acknowledged that alien plants contribute to native species declines, little information is available on the mechanisms by which such declines occur. Thus management strategies tend to focus on one aspect of the interaction between alien plants and the invaded native ecosystem – mainly associated with removal of the alien species. However, such approaches may not address the cause (past, present and future) in a long-term sustainable manner.

Here we piece together various ecological interactions associated with *Lantana camara* (lantana) and its avian dispersal vectors to illustrate how we might need to re-examine alien plant management strategies. The first piece of the puzzle involved a recent assessment of the threat of lantana to native species in Australia. This assessment identified 113 native bird species associated with lantana, with 24 directly threatened; 68 positively influenced (or benefited) by lantana invasions; and another 21 species threatened but also partially benefiting from lantana invasions. Of these, 28 species consume the fruits/seeds produced by lantana as well as the fruits and seeds of many native plants. While such information has been previously used to determine revegetation strategies, it can also be used to determine species declines and reinvasion patterns (the second and third pieces). For example 202 native plant species, that produce fruits or seeds that these birds also consume, are being negatively impacted by lantana. Indirectly, through the dispersal of lantana, these birds have contributed to the loss of the native plants that provided them with food resources in the past. This process hampers revegetation and the long-term control of lantana, as it is difficult to stop further dispersal of lantana into managed sites. As well as helping the reinvasion of lantana, these 28 bird species also consume fruits and seeds of 36 alien plant species, which have been known to invade following lantana control. These include *Phytolacca octandra* (ink weed), *Solanum mauritianum* (wild tobacco) and privets, *Ligustrum* spp. Such information is critical for understanding the long-term implications of managing lantana for biodiversity conservation. As native birds play a role in dispersing both native and alien plants, it is important to encourage native plant recovery (which may involve additional restoration), while controlling alien plants that will reinvade over the long-term. In addition the implications of this research show the value of understanding the native species at risk and their ecology/biology and that management needs to be more holistic. While this information was collated for lantana there are broader implications for the management of all alien plants species – not just those that have bird dispersed fruits.

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Pest risk analysis for *Solanum carolinense* in Austria

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The invasive plant species *Solanum carolinense* was recorded for the first time in a maize field in 2004 near Pischeldorf in Carinthia, Austria (Eberwein & Litscher 2007). Since then a small-scale but continuing dissemination of the plant occurred at this site. *Solanum carolinense* is native to the Gulf States of the United States but has spread throughout the eastern United States to southern Ontario and in the west to California. By now the plant has already been reported in several countries in Europe, e.g. in the Netherlands, Norway, Germany and the Czech Republic.

Solanum carolinense, a member of the Solanaceae family, is a broadleaf perennial weed with an extensive and deeply penetrating root system. Reproduction of *S. carolinense* is accomplished through adventitious buds on creeping horizontal roots as well as seeds. The plant is considered to be highly competitive, causing important yield losses in nearly all crops. However, because of its extensive root system, effective control is difficult and only a few herbicides control this plant and have crop selectivity.

Thus, a Pest Risk Analysis (PRA) was conducted according to the EPPO decision support scheme, PM 5/3 (3) (2007) (http://archives.eppo.org/ EPPOStandards/PM5_PRA/PRA_scheme_ 2007.doc) in order to assess the relevance of *S. carolinense* for the agricultural production in Austria. Two relevant pathways for introduction of *S. carolinense* were analysed. *S. carolinense* seeds may be present as a contaminant in seeds for planting as well as in grain and oil seeds either for feeding stuff or oil products. The computer programme Climex® was used to generate maps of the potential occurrence of *S. carolinense* in Austria under present climatic and climate change conditions. Field work and the relevant literature were used to discuss the probability of establishment, spread and the economic damage.

In conclusion, the probability of an introduction of *S. carolinense* to agricultural areas by these two pathways is considered to be not very likely due to low import rates of consignments of seeds from countries where *S. carolinense* occurs. Therefore, the current introduction in Carinthia is supposed to be an isolated case. Nevertheless, establishment and further spread of *S. carolinense* is likely, taking into account its biology and ecology as well as the climatic conditions in Austria. Considering its potential economic damage to field crops, risk management options, i.e. containment and eradication programs, are required to avoid further spread of *S. carolinense* to other agricultural areas at risk.

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Testing the efficacy of non-chemical control methods against invasive knotweeds (*Fallopia* spp.)

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Exotic knotweeds, *Fallopia* (syn. *Reynoutria*) *japonica*, *F. sachalinensis* and the hybrid between the two species, *F.* ×*bohemica*, are considered to be among the most serious invasive exotic weeds in Europe, causing significant damage to native ecosystems. Several methods are currently used to manage *Fallopia* invasions in natural areas, however, their effects on exotic knotweeds and on biodiversity are poorly supported by experimental studies.

In May 2005, we started a replicated long-term experiment comparing three widely applied non-chemical control methods at a field site in Belfort, France. The methods selected included two different cutting regimes (1 cut or 6 monthly cuts during knotweed growing season) and a combination of cutting in the first year followed by covering ground with geotextile, a vegetable fibber matting. Within each surface, a 2 × 2 m permanent plot was established and knotweed density and biomass, as well as species richness and cover of native vegetation were recorded each year. In addition, invertebrates were collected using pitfall traps to investigate the response of invertebrate assemblages to control methods. After three seasons, *Fallopia* above-ground biomass on plots with 'monthly cutting' and 'geotextile' were reduced by 94% and 90%, respectively, compared to control plots. Cutting *Fallopia* once a year also led to a reduction in above-ground biomass at the end of the second season, but not to differences in the following spring. *Fallopia* shoot density was reduced by 'monthly cutting' and 'geotextile' and all three control treatments reduced percentage of flowering *Fallopia* shoots at the end of the second season.

Native vegetation (so far only recorded in the two cutting treatments and control) responded positively to decreased *Fallopia* above-ground biomass and the cover of native plant species was highest in plots where *Fallopia* was regularly cut. However, cutting once a year also resulted in increased cover of native species. In addition, species richness in spring 2007 was significantly increased in patches where *Fallopia* was cut regularly. The effect of control methods on invertebrate assemblages is still under investigation and will also be presented.

Mapping and analysing spatial and temporal distributions of invasive weeds and herbicide-resistant weed populations using GIS

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Several new weed species including *Abutilon theophrasti* Med. and new populations of herbicide-resistant weed species were observed in European agricultural fields in the past few years. Those weeds are difficult to control and cause higher production costs once they have spread over many fields and established a persistent seed bank. Therefore, it is necessary to locate and monitor new findings of these weeds, identify reason for introduction to prevent invasions and work out effective methods to eliminate those weeds.

An internet based geographic information system (GIS) was set up to monitor, analyse and map findings of *Apera spica-venti* (L.) P. B. populations resistant to ALS-inhibitors in Europe. Geodata were correlated to data on soil characteristics, tillage, crop rotation, weed control methods and weed density. The GIS is used to direct weed sampling and to plan field studies to work on the population genetics of these biotypes and weeds.

Two-year field studies near Prague and near Cologne were conducted in sugar beet to investigate the biology, population dynamics, competition and control of *Abutilon theophrasti*. It was found that *A. theophrasti* was more abundant and competitive in the field studies near Prague than in the experiments near Cologne. The populations of *A. theophrasti* expressed a high morphological and phenotypic plasticity and genetic variability (GSDice = 0.71 – 0.75). Time of emergence, biomass, plant height, number of seeds per plant, sensitivity to chemical and mechanical control methods and genetic similarity varied significantly between and within populations. This indicates that *A. theophrasti* is capable to adapt to different environments and management practices and thus can become a potential invasive weed species in Europe. *Abutilon theophrasti* was tolerant to all conventional chemical weed control strategies in sugar-beet (Phenmedipham, Desmedipham, Ethofumesat, Metamitron and Choridazon). Only Triflusulfuron and Clopyralid applications reduced biomass by 20 – 80 %. Sugar beet yield was reduced by 50% in plots with 20 individuals of *A. theophrasti* per m^2 and up to 1699 capsules per m^2 with viable and persistent seeds were produced in the treatment with standard herbicides. This indicates that it is not possible to control this weed in fields where sugar beet is included in the rotation once it has established. It is therefore necessary to prevent new invasions.

Conservation of native white-clawed crayfish (*Austropotamobius pallipes*) under threat from signal crayfish (*Pacifastacus leniusculus*) invading British waters

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The white-clawed crayfish, *Austropotamobius pallipes*, is the only crayfish native to the UK. Its distribution has been reduced by competition from introduced crayfish; most importantly the North American signal crayfish, *Pacifastacus leniusculus*. Signal crayfish, introduced to the UK in the 1970s, produce dense populations that can significantly damage habitats and out-compete white-clawed crayfish for shelter and food. Furthermore, signal crayfish are vectors for crayfish plague (*Aphanomyces astaci*), a fungal infection that decimates highly susceptible white-clawed crayfish populations. Yorkshire holds a number of dense populations of white-clawed crayfish but signal crayfish populations are spreading rapidly. One popular method of conservation of white-clawed crayfish is to transplant healthy populations at risk from invasion by signal crayfish into ponds and lakes currently lacking crayfish. These 'Ark' sites aim to preserve viable populations in areas with minimal risk of invasion by signal crayfish. My research will use field manipulations to examine the impact of the native versus invasive species on freshwater biodiversity and abundance. I will use laboratory experiments to investigate prey choice and consumption of the competing species. I will assess the effectiveness of Ark sites by comparing survival and growth of white clawed crayfish in native habitats versus Ark sites. Research outcomes will be used to advise the Environment Agency and the wider scientific community on the efficacy of 'Ark' site conservation and best practices for the management of remaining white-clawed crayfish populations.

Conservation of *Carassius auratus* against hybridization with *C. cuvieri* in Korea

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Gold fish (*Carassius auratus*) is native in freshwaters of Korea. There was no species that could hybridize with *C. auratus* in Korea until *C. cuvieri* was introduced for inland fishery in 1972 from Japan. Massive release of fry of *C. cuvieri* in large dams of the Han, Nakdong and Keum rivers resulted in its wide distribution across the country. *Carassius cuvieri* has become a dominant species in dams and slow flowing rivers in a decade or so after the massive release. *Carassius auratus* has lost rapidly its dominance in competition with *C. cuvieri* for habitat and food. Possible hybrids between *C. auratus* and *C. cuvieri* are nowadays quite common in the waters of Korea, which is another threat to *C. auratus*. There remained a limited number of reservoirs and slow-flowing waters with *C. auratus*, which are free from *C. cuvieiri*.

Because it is beyond control to eradicate *C. cuvieri* in the infested waters, we took the way to protect waters with *C. auratus* and still lacking *C. cuvieiri* in the long-term. A number of reservoirs of agricultural use without detectable size of *C. cuvieri* population were selected. In the season of high water demand, these reservoirs can be emptied as they used to be in the past. Water flow is unidirectional from the reservoir to the stream or agricultural field, which substantially prevents natural introduction of *C. cuvieri* from the infested downstream. With the prohibition of fishing or behaviour yielding the spread of *C. cuvieri* beyond watershed, *C. auratus* is expected to be well protected from possible hybridization with *C. cuvieri*. This is a passive way but will be practically the only mean to conserve *C. auratus* against *C. cuvieri* spread in Korea.

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A rationale for an improvement of the ranking system of alien plant species in Korea

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Each of 81 alien plant species was assigned into one of the three management classes according to the total score as to the risk and management needs in Korea. Total scores for the class I, II and III are above 50, 50–40 and below 40, respectively, in a scoring system of 100 points. A number of alien plant species were overestimated or underestimated. For example, a burcucumber (*Sicyos angulata*) requires urgent response although it was assigned to the class III with the score 25. The rate of spread of *S. angulata* was comparable to the two most notorious invasive alien plants species, great ragweed (*Ambrosia trifida*) and common ragweed (*Ambrosia artemisiaefolia* var. *elatior*). On the contrary to this, Carolina horsenetlle (*Solanum carolinense*) of the class I showed limited spread beyond pastures. This type of discrepancy between management class and management needs can be resolved by prior independent classification of the species of high concern over the present assignment based on total score. A subcommittee composed from the pool of experts, administrators and stakeholders from private sector is recommended to decide the management class of a certain alien species that behaves unexpectedly in Korea. Another possible mission of the subcommittee is to make an inventory of alert species requiring early detection and early response. Risk assessment on some alien species including the above-mentioned ones strongly supports that we have to find ecological properties of decisive importance in invasiveness and harm of an alien species prior to normal processing for risk classification.

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Preventive measure of high potential against the spread of an alien muskrat, *Ondatra zibethicus*, in Korea

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Muskrat (*Ondatra zibethicus*) is raised on commercial base in Korea since the early 2000s. A small company has sold muskrat to a number of farmers who want to breed it for profit. In 2007, the number of muskrats raised in Korea was over 1,500. It strikingly resembles nutria in terms of habitat, meals and reproduction. Nutria has rapidly spread in Korea during the last decade due to the lack of responsibility to keep it contained in the raising facilities. Wupo wetland, the largest freshwater wetland in Korea, was under visible attack by nutria. Muskrat will be the next to nutria unless no action is taken immediately. We propose a new scheme to share responsibility among stakeholders for any release or escape of muskrat into the wild. Because the supplier of muskrat promised profit from its raising to farmers and sold raising facilities to them, the supplier is partly responsible for any failure in the containment of it in the course of raising and handling of musk rat. The ratio of the numbers of muskrat sold to a specific farmer to the numbers of increased muskrat by the farmer will be used to determine the degree of responsibility in the case of no intentional release of muskrat from the relevant raising facilities. In the case of intentional release, the supplier will take partial responsibility proportional to the total number of released muskrats. The remaining responsibility should be directed to the farmer who caused spread of muskrat in the wild. The use of this scheme might have resulted in little spread of nutria in the wild including Wupo wetland and riparian zone of the Nakdong river at the downstream.

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Public awareness as a tool for prevention and mitigation of invasive plants species

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Even though biological invasions are considered one of the main threat to biodiversity worldwide and the problem is already recognised by the Portuguese law (Decreto-Lei no 565/99), this problem is still unfamiliar to the Portuguese population in general. At the same time public is one vector of introduction and spread of invasive alien species (IAS) and, on the other hand, can play a major role in helping to control invasive species. Therefore, public education is critical when aiming to prevent introduction of IAS and mitigate problems caused by these species. To achieve the sustainable management of IAS, promoting awareness and understanding of this environmental issue is not only important for present day scientists and other professionals dealing with exotic species, but for decision-makers and general public as well. Several initiatives have been developed with the aim to contribute to public awareness about IAS:

(i) Scientific work fields, to control invasive species and learn about IAS. Since 2003, seven editions of scientific work fields were promoted, taking place in three Natural Reserves in Portugal, involving more than 120 volunteers. This kind of actions has proved very effective, both training people and increasing awareness, with huge success among university students and professionals that deal with IAS

(ii) Training courses about identification and control of invasive plants for professionals dealing with exotic plants. Three editions of the course were developed from 2005 to 2007 with more than 30 participants, including technicians from municipalities, workers from industries of vegetation control, conservation, and forestry experts, researchers', among others.

(iii) Web page (www.ci.uc.pt/invasoras) about invasive plant species, the first of its kind including information about invasive plants in Portugal. Since 2004, there were approximately 30,000 visits to the site. Numerous people write to this page e-mail asking for information, technical assistance and requesting our participation in awareness/environmental education sessions.

(iv) Inquiries targeting public authorities, conservation experts, forestry associations, and researchers' community, aiming not only to evaluate the situation in Portugal but also to increase public awareness about IAS. Until now, more than 200 institutions answered the inquiries. Results show that unawareness about IAS remains a reality.

(v) "Invasive plants in Portugal", which is a technical document, available both in paper and in the web, about identification and control of exotic plant species considered invasive by the Portuguese Law. It has been distributed among professionals working with exotic plants and entities that manage areas invaded by IAS.

(vi) Diverse materials, including leaflets, postcards, posters, field guides, targeting different publics (general public; young school children and teenagers) aiming not only to create awareness about the problem but also to help to identify the most common and problematic species in Portugal

Overall, the challenge to increase public awareness is worthwhile. We will keep this commitment together with our research activities, diversifying the field actions, establishing protocols with local and regional administrative entities, promoting advisory actions oriented to specific publics, and improving implementing interactive maps on the web page.

The monitoring of exotic invasive species in Fuerteventura (Canary Islands) through Geobotanical Information Systems (GIS)

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In this paper we present an actualized catalogue of exotic invasive species and transformer species (Richardson et al. 2000) for the island of Fuerteventura (Canary Islands). The ca 100 km between La Entallada lighthouse at the south-eastern coast of Fuerteventura and Cap Juby represent the shortest distance between the Canaries and the African mainland. This implies an increased risk of natural or artificially induced colonization by exotic (non-native) species, especially after the establishment of a new maritime route between Puerto del Rosario (Fuerteventura) and Tarfaya (Morocco). Our results are presented with the aid of a Geobotanical Information System (Martín Osorio et al. 2005), which correlates data of the physical environment (geology, geomorphology, bioclimatology, pedology, etc.) with biological data, especially those concerning the chorology of invasive exotic plant species. We present a 1000 × 1000 m grid network of the distribution and approximate number of individuals of each species.

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Effect of glyphosate and imazamox on growth and photosynthetic apparatus of *Spartina densiflora*

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The South American cordgrass, *Spartina densiflora*, has become the dominant plant species on recent tidal marsh restorations in the Doñana National Park (SW Spain). We examined the effect of different doses of glyphosate (720–7200 g a.i. ha^{-1}) and imazamox (20–68 g a.i. ha^{-1}) on growth and photosynthetic apparatus of S. densiflora.

Imazamox had no effect neither on growth nor photosynthetic apparatus of *S. densiflora*. On the contrary, glyphosate inhibited photochemical efficiency of photosynthesis from day one. Net photosynthetic rate, stomatal conductance and photosynthetic pigments and the number of new tillers were reduced. Glyphosate at high doses (ca 7200 g a.i. ha^{-1}) could be an appropriate method of control, since it has a negative effect on the photosynthetic apparatus and growth of *S. densiflora*. The amount of glyphosate retained by the soil (unavailable for plant, leaching and runoff) indicates that the herbicide and its main metabolites are strongly retained by the marshy soil, suggesting that this chemical control method is also environmentally safe.

The problems of alien species invasion in terrestrial and water ecosystems of the South of Russia

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The Southern Scientific Centre of the Russian Academy of Sciences (SSC RAS) carries out research on the assessment and conservation of biodiversity of terrestrial and water ecosystems, entry of alien species and development of the control of invasive processes and forecast measures in the South of Russia. Among the main forms of alien species impact on indigenous species and natural communities are: (i) change of the habitat of indigenous species; (ii) rapid habitat extension and fast replacement of indigenous organisms; (iii) transport of diseases affecting both indigenous species and human beings.

It is ascertained that invasive processes in water ecosystems develop so fast (e.g., introduction in 2001–2002 and mass development of *Mnemiopsis leidyi* in the Caspian Sea, dominance of the acclimatized Far East species *Mugil soiuy* in the Sea of Azov catches in 2002–2007) that permanent regular monitoring of ecosystems biodiversity is required. In 2004 the first specialized Marine Biology Laboratory controlling water ballast of trading vessels was established in the Russian seaport of Novorossyisk by SSC RAS. Control methods, including the study of vessels' water ballast and ecosystem monitoring of port water area (plankton, benthos, ichthyofauna etc.) were developed on the basis of Laboratory, with further risk assessment of invasive species' introduction and spread/distribution.

It is worth mentioning that invasions of alien plant species into vegetation communities are the constituent element of the synanthropisation process in steppe ecosystems. The problem of widespread distribution and harmfulness of *Ambrosia* species has become a global one. An important research direction is the development of biological control of *Ambrosia artemisiifolia* L.. When conducting field experiments in 2005–2007, it was established that introduction of brown mustard (*Brassica juncea*) into crop rotation in agrocenoses (with a sowing norm of 6 kg/ha) suppressed the growth and development of *Ambrosia*. In 2007 long-term experiments with insects-phytophages, *Zygogramma suturalis* (F.) and *Tarachidia candefacta* Hubn., based on their seasonal colonization, were started to control the invasion of *Ambrosia*.

It is ascertained that the Karakurt spider (*Latrodectus tredecimguttatus*) extends the range of invaded habitats in terrestrial ecosystems in the Rostov region, and the density of its populations increases; coleopterous unusual expansion on the plain steppe territories has also been registered. The entry of alien species from the Caucasus foothills became possible after formation of artificial forest belt in the steppe zone that resulted in a large amount of additional mesophytic habitats. It is noted that many natural communities, especially along the bends of large rivers, such as the Don and Seversky Donets, are inhabited by migrants from the southeast of the European part of Russia (Kalmykia, the south of Astrakhan Region) under aridization conditions.

The South Atlantic Invasive Species Project: supporting the UK's South Atlantic Territories in taking a regional approach to invasive species issues

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It is widely recognised that a regional approach is more effective than a national one in addressing invasive species issues: invasive species have a low respect for borders. The governments of the five UK Overseas Territories in the South Atlantic (Saint Helena, Ascension, Tristan da Cuñha, the Falkland Islands and South Georgia), along with two NGOs, are partners in this project seeking to develop regional capacity in relation to invasive species. The project will aim to produce a regional strategy and early warning system: these will be the main outputs from a regional meeting in 2009. In addition, specific demonstration projects are being undertaken in each Territory. These include the collection of baseline information relating to specific groups of introduced species, as well as the provision of technical advice and control trials. This project is funded through the European Union's EDF-9 fund (Project N 9 PTO REG 5/1).

New electronic journal Aquatic Invasions: an important part of the developing European early warning system on aquatic invasive species

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Aquatic Invasions is an electronic open-access international journal with focus on biological invasions in inland and coastal waters of Europe, North America and other regions (ISSN: 1818-5487, http://www.aquaticinvasions.ru). The journal provides the opportunity of timely publication of first records of aquatic invaders and other relevant information needed for risk assessments and early warning systems. Also, relevant technical reports and conference proceedings can be considered for publication.

Currently Aquatic Invasions is serving as an important part of the developing Pan-European early warning system on aquatic invasive species. In 2006–2007, approximately 1500 new records of alien species in European inland and coastal waters were published in 117 papers in 8 regular issues of the first two volumes of the journal. The first records of the highly invasive ctenophore Mnemiopsis leidyi in the southern and north-eastern Baltic in 2006–2007 were published in Aquatic Invasions less than one month after the authors completed the field work, represents a sound example of the early warning service provided by this online journal.

One of the key benefits of e-journal Aquatic Invasions is the timely and readily available publication of essential primary scientific information, also needed for decision-making. This journal may enable timely and coordinated eradication efforts of newly found IAS. Manuscript publication, including a comprehensive review process, takes on average less than one month, thereby reduces the publication time lag typical of many peer review international journals. In addition, Aquatic Invasions provides a publication platform for important information on management efforts of invasive species and proceedings of relevant international meetings. Finally, the fast and comprehensive review process of manuscripts serves as effective quality insurance mechanism.

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Invasive plant species management tests and advices along river banks in the Walloon region

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The river network, as other linear elements in the landscape, plays a major role in the dispersal of invasive plants. These habitats are often disturbed and highly sensitive to invasions. Their linear structure facilitates the dispersal of invasive plants and subsequent invasion of other habitats, sometimes of high ecological value. With respect to the CBD (Rio, 2002) aims and managers' requests, the DGRNE-Direction of the non-navigable rivers (Walloon region, Belgium) has financed a research project from 2006, aiming at furnishing advices to manage three invasive plants species along rivers: *Impatiens glandulifera* Royle, *Heracleum mantegazzianum* Sommier & Levier and *Fallopia* spp.). Management methods mentioned in the litetature often lack scientific assessment and follow up. Since 2006, some mechanical and chemical management techniques are tested in the field, along long streams, to assess their efficiency, cost and feasibility. Data were collected each month during the last three years. Results and concrete implications for managers are given.

On the necessity of special study of flora synanthropisation in econet elements

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In Ukraine a system of nature conservation has been created and operates successfully. At present in the country the development of the national ecological network (a system of "green corridors") as a constituent part of the EECONET (European EcoNet) proceeds. Resently the first step was taken to begin the study on synanthropization of biocenters or natural floristic nuclei (biosphere reserve, state natural reserve, national natural parks and other objects of the natural reservation fund of Ukraine). The process of synanthropization of the flora of Ukraine and its regions as well as in elements of EcoNet has been constantly progressing; in many regions the processes of adventization prevail over apophytization. The increasing numbers of alien species, growth of both stable and unstable components of the alien flora, growing rates of immigration and dispersal, the increasing number and scope of invasions of certain invasive species are observed (Protopopova et al. 2002).

However, a special study and monitoring of synanthropization processes in the flora of ecocorridors, buffer and renaturalization zones is lacking. We start a special investigation of synanthropic flora of some meridional Dnipro ecocorridors (Middle Dnipro region: from Kiev to Cherkasy). Synanthropic fraction of flora of the region is represented by 683 species of vascular plants, including 404 alien species. Along the river we register invasions of *Amorpha fruticosa*, *Acer negundo*, *Echinocystis lobata*, *Bidens frondosa*, *Xanthium albinum* and other species; meadows, especially those used as pastures, are commonly occupied by e.g., *Xanthium albinum*, *Phalacroloma septentrionale* and *Setaria glauca*; permanent components of sandy habitats are *Conyza canadensis*, species of the genus *Oenothera*, especially *Oe. depressa* and *Oe. rubricaulis*. These species successfully compete with native flora, and prevent restoration and reservation of the natural plant cover.

The main activities towards the improvement of plant diversity of EcoNet elements should concentrate on: (i) inventarisation of its flora, including aliens; (ii) special study and monitoring of the processes of synanthropizations in floristic biocenters, ecocorridors, buffer and re-naturalisation zones; (iii) determination of species with highly invasive potential and transformers in the national and regional elements of EcoNet, and their mapping; (iv) estimation of invasive ability of alien plants, their role in various floristic complexes and plant communities in the ecocorridors, and their phytosociological affinity; (v) a special study of model transformer species at the population level; (vi) preparation of the of Data Base EcoNet elements of the flora; (vii) improvement and restoration of natural plant cover on transformed territory; (viii) control and monitoring of transformers, elimination of their localities; and (ix) educational activities.

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Four years experience in classical biological control of *Dryocosmus kuriphilus* in Europe

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Dryocosmus kuriphilus Yasumatsu (Hymenoptera: Cynipidae) is one of the most serious pests attacking chestnut trees. It causes the formation of galls on buds in early summer and it is univoltine and thelytokous. These galls reduce the total photosynthetic area and stop the growth of the shoots. In case of heavy attack, the plant declines gradually and the production of fruits can be drastically reduced. The plant is more vulnerable to infections, such as the chestnut blight, and can die. Recently it was incidentally introduced into northwestern Italy and is now spreading throughout Europe, reaching France in 2005 and Slovenia in 2006.

This pest was successfully controlled in Japan by introducing a parasitoid, *Torymus sinensis* Kamijo (Hymenoptera: Torymidae) (Figure 1), from China's mainland. Although the time needed to establish the populations varied in different localities, after about 6–18 years the parasitoid controlled the pest effectively, keeping its population under the damage threshold, fixed at a 30% shoot infestation. Due to the severity of the damage caused by the rapid spread of the chestnut gall wasp through Europe and the encouraging results of using *T. sinensis*, proved over a long time in Japan and more recently in the USA, a quick and concrete response was made and the parasitoid was introduced into Italy from Japan, keeping in consideration the environmental risk associated with the introduction of an exotic natural enemy.

One year of preliminary studies led to a successful method of rearing imported galls with a synchronization between the parasitoid emergence and the presence of the target galls in the field. In four consecutive years individuals were released in several sites covering most of the infested area. Data about the settlement of the parasitoid are clear and its population is rapidly growing. A rearing method, called multiplication area, was set up by releasing the parasitoid in chestnut orchards isolated from other chestnut settlements. This innovative method is giving very good results and will provide specimens to initiate the biological control in new areas colonized by the pest.

Widespread aquatic/riparian weeds in Europe: it's not too late

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It is often tempting, when faced with scant resources, to focus on two of the CBD's guiding principles for invasive species management i.e prevention and early eradication. The danger is that we ignore those that are already causing widespread damage because they are deemed to be uncontrollable. A lack of experience in Europe means that tried and tested tools, such as the use of specialist natural enemies, have so far gone unused. Aquatic plants are excellent targets for such an approach and this presentation aims to highlight two of these, *Azolla filiculoides* and *Hydrocotyle ranunculoides*, alongside two current targets, *Fallopia japonica* and *Impatiens glandulifera*. The UK is leading this research into long-term and sustainable solutions to some of Europe's worst invaders. We argue that the requirements of the Water Framework Directive should spur other European nations to consider all the options available.

Ecological monitoring of highland pastures in the Kyrgyz Republic

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The Kyrgyz Republic is not a large, mountainous agrarian country in the Central Asia. Total area of high mountainous natural pastures makes 8.9 million or about 90% of all agricultural land. More burning and large-scale ecological problems in the sphere of land tenure is degradation of soil-vegetable cover of pastures. Overload of pastures by cattle in the near past has an impact on their ecological state; vast areas are exposed to water, wind and pasture erosion.

During the last years, as a result of unsystematic and intensive using of land, water, pasture and other kinds of natural resources, there is an ecological concern about pastures near villages in the territory of the Kyrgyz Republic. Nowadays, the area of pastures near villages makes more than 2,136,00 hectares. At present all population of cattle is kept in spring-autumn pastures near villages, which suffer much more overload than earlier. Such pressure resultimg from the placement of cattle population leads to further degradation of pasture territories near villages. Observations of the order of cattle grazing became impossible because of economic reasons, the traditional cycle of pasturing, spring-summer-autumn-winter, has been disturbed. In these conditions, characterized by favourable climate, lack of replacement of pasture areas, ploughing of large areas, cultivating of pastures and inappropriate irrigation of land assigned for agriculture, distribution of animal helminthiasis, especially fascioliasis, is promoted.

Our research has shown that the freshwater mollusc *Lymnaea truncatula*, which is an interim host of Fasciolidae, spreads in pastures near villages. The biotopes of *L. truncatula* can be divided into constant and temporary. Temporary biotopes are ephemeral reservoirs, i.e. marshes (lowland bogs), small reservoirs with rich vegetation (macrophytes) and small well-warmed water tables, ponds, hollows and “pits of animal hooves”, located on the bottom of ravine and hollows. The reason of forming of these biotopes is the expansion of irrigation canal net, water filtration from main canals and unsystematic irrigation of land.

Is *Impatiens glandulifera* a good candidate for biological control in the UK?

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Impatiens glandulifera (Balsaminaceae), commonly known as Himalayan balsam, is a highly invasive annual herb native to the western Himalayas and now established as a weed in 23 European countries, 10 states in the USA, parts of Canada and New Zealand. Since its introduction into the UK as a garden ornamental in 1839, *I. glandulifera* has spread at a rate of ca 645 km^2 per year, using riparian habitats as corridors.

In its native range *I. glandulifera* grows in clusters of 30–60 plants no more than 1.5 m tall and is attacked by an array of arthropods and plant pathogens which impact considerably on populations. This is in stark contrast to the 2 to 3 m tall monocultures which harbour an impoverished fauna and mycoflora in the introduced range. Of the natural enemies collected during the first phase survey in Pakistan in August 2006, two plant pathogens showed promise as potential biological control agents: *Phoma exigua* and *Puccinia* cf. *argentata*. A flea beetle, *Altica himensis*, was rejected as a potential agent due to the high levels of non-target feeding observed in choice tests but other potential arthropod agents exist.

This poster reviews all previous research conducted on the biological control of *I. glandulifera* and introduces the second main phase of the biocontrol programme which started in 2008. During 2008 two surveys will be conducted throughout the growing season of the plant, to collect natural enemies, concentrating on the Indian region of the Himalayas. Coupled with compilation of a full test plant list, host range testing of potential agents and molecular biogeography studies of the plant in the introduced and native range, the research conducted in phase 2 should give a clear indication of whether Impatiens glandulifera is a suitable candidate for biological control.

Building capacity on Tristan da Cuñha to protect rodent-free islands and monitor for "rodent spills"

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Of the four main islands in the Tristan da Cuñha group, two remain rat-free. These two islands (Nightingale and Inaccessible) are refuges for a large number of unique species, and in particular host huge colonies of breeding seabirds. Tristan da Cuñha is the most remote inhabited island in the world. There is no airport, and to reach the island from Cape Town requires a sea voyage of at least five days. Recent research on rodent behaviour indicates that invading animals change their behaviour soon after arrival, so in order to minimise the chance of a new population becoming established, an early response is vital. During a visit to Nightingale Island, training was provided to local conservation staff in how to respond to a rodent sighting or shipwreck event, and a protocol was provided. Monitoring devices were left in situ to be checked every six months. It is hoped that this work will raise local awareness, and reduce the risks of a new rodent population becoming established on Nightingale Island. This work was funded through the European Union's EDF-9 fund (Project N 9 PTO REG 5/1).

Towards a comprehensive evaluation of neobiota for management decisions on invasive alien species

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Invasive alien species are considered as a threat to biodiversity by definition. Therefore, the Convention on Biological Diversity urges its member states in Article 8, paragraph h, to prevent the introduction of, control or eradicate those alien species, which threaten ecosystems, habitats or species. This research applies an interdisciplinary evaluation framework by a condensed amount of criteria to evaluate the impacts of neobiota on biodiversity. It covers the intrinsic value of biological diversity and the ecological, genetic, social, economic, scientific, educational, cultural, recreational, and aesthetic values of biological diversity and its components, which are mentioned in paragraph 1 of the preamble of the Convention on Biological Diversity. In conclusion, risk assessments of neobiota need to consider specific advantages and disadvantages within a certain area and period of time. The applied comprehensive values and condensed criteria of biodiversity provide a practical, transparent, and comparable framework for the assessment of invasive alien species.

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