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UFZ-Bericht

Nr. 14/2002

2nd International Conference of the German Working Group on Biological Invasions NEOBIOTA

Biological Invasions: Challenges for Science

Proceedings of the conference in Halle October 10th - 12th, 2002

Eds: Stefan Klotz & Ingolf Kühn

UFZ Centre for Environmental Research Leipzig-Halle
Department of Community Ecology

ISSN 0948-9452

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Archiv

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UFZ-Umweltforschungszentrum
Leipzig-Halle GmbH
Zentralbibliothek
Permoserstraße 15
04318 Leipzig

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Preface

Neobiota is the German working group on biological invasions (see http://www.tu-berlin.de/~neobiota/) and had its first conference in Berlin, 2000. The scientists in this group work together on theoretical and applied aspects of biological invasions, but also aim at educating the public and consulting with policy makers. This volume contains the conference proceedings of the 2nd NEOBIOTA-Conference held at the Department of Community Ecology, Centre for Environmental Research Leipzig-Halle, Halle, in October 2002. The aim of the first NEOBIOTA-Conference was to identify the challenges to act. This year, we focus on challenges for science.

Browsing through this volume, you will find the variety of fields touched by the problems of biological invasions, not only in biological science but as well in social sciences and economics. Though the conference was divided into the four topics Biogeographical Processes, Ecological & Evolutionary Interactions, Marine Invasions, and Challenges for Conservation Biology and Socio-Economics, we simply arrange the extended abstracts alphabetically by author.

The disputed decision to choose English as the conference language proved to be right. Almost one third of all participants are from non-German speaking countries. We hope that this will also enhance discussion and information in Central Europe across language barriers.

We hope that you will have a pleasant stay in Halle, enjoy the conference, and have a vibrant exchange with your colleagues in the international scientific community of this growing – or even invasive? - science.

Halle, August, 2002 Stefan Klotz & Ingolf Kühn

Key note speakers

Molecular systematic methods to clarify actual questions of biodiversity change – prehistoric, historical, and present botanical invasions

B. Neuffer

The spread of species beyond their natural ranges is not a new phenomenon and has always played a key role in the dynamics of biodiversity. But the present rate of species exchange is unprecedented. The evolutionary impact of biological invasions has only recently received a wider attention. The availability of many molecular marker systems allowed new informations according to gene flow, introgression and hybridization between native and invasive gene pools. To understand the biology of invasions and to give realistic predictions case studies are necessary. The analyses about *Capsella* (man-made postcolumbian colonization of extraeuropean regions), *Cardamine* (preglacial or glacial colonization of the southern hemisphere as well as the present man-made or climatically influenced speciation), and *Diplotaxis* (man-made speciation by hybridisation and expansion in historical times) are well studied examples. With molecular markers (e.g. isozymes, DNA-fingerprinting, DNA-sequencing of plastid and nuclear genome, and genomic in situ hybridisation) mating system, hybridisation, and introgression of plastids or parts of the nuclear genome between different taxa are examined. Fitness relevant investigations are especially important. Such studies are clearly relevant for assessing risks in connection with the release of genetically modified organisms. Furthermore case studies within the Brassicaceae family have model character for the closely related *Brassica napus*.

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The Economics of Alien Invasive Species

C. Perrings

Invasive Alien Species (IAS) have imposed significant costs on society. In 1993, the US OTA estimated that the damage costs to the US of 79 particularly harmful invasive species over the preceding 85 years amounted to $97 bn. Just a few years later a group of scientists led by David Pimentel estimated damage costs to the US of all invasive species to be $137 bn per year. The difference reflects both an increase in the scale of invasions, and awareness that the cost includes much more than the cost of damage and control. For example, the British foot and mouth epidemic has cost something like $3bn in control and compensation. It has cost closer to $15bn if we include the impacts on tourism and the wider rural economy.

Biological invasions are a quintessential ecological-economic problem. Their introduction, establishment, spread and consequential effects depend on both natural and social processes. But research into the problem, and the institutions established to address it, remain stubbornly fragmented. As the British FMD epidemic has shown only too clearly, epidemiologists or population biologists persist in analysing the spread of IAS without any reference to the human activities that drive the process. Institutions that seek to control particular classes of IAS act in isolation and without reference to the trade, transport and travel that structure the problem. Biological invasions demand a different scientific and institutional approach. They are beyond the reach of any one discipline. They are also beyond the reach of existing institutions. I argue that they require an organisation with specific responsibility for invasive species. That organisation should have a similar reach to the World Trade Organisation (WTO), research and monitoring responsibilities that encompass the scientific work of centres like the Center for Disease Control (CDC), and an executive arm capable of delivering support to the control of IAS in remote locations.

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Alien floras: state of the art and future perspectives

P. Pyšek

Data on alien floras currently available are reviewed with emphasis on the state of the art in Europe. Solid data sets are still rather scarce, with British Isles, Germany and Czech Republic being elaborated in detail. Most specialized data sets as well as flora focus on naturalized species and do not provide reliable accounts of casuals; this is the case of Flora Europaea, too. Achievements resulting from analyses of floras at various levels are summarized, and examples are given of what are the strong points and limitations of such data sets. The major limitation, apart from lack of reliable floral data, is in the quality of information on species traits which is rather scarce for large sets of species of alien origin. Future research possibilities and strategies at international level are outlined.

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Introduction and spread of aquatic organisms through shipping and aquaculture: Case histories from coastal and marine habitats

H. Rosenthal

Two major human activities contribute to the growing rate of transfer of marine and estuarine organisms world-wide: (a) the growth of marine transportation through modern shipping, and (b) the rapid expansion of aquaculture in coastal habitats with massive transfers of life specimens of cultured species for stocking and ranching.

With globalization of markets, the new scenarios have evolved that open new routes of transfer but also numerous pathways leading to success of establishment in new habitats. Case histories will be presented for species of different systematic categories as well as from different trophic levels, including data on population spread and development over more than a century. Examples accidental introductions will include well-known species belonging to different trophic categories such as toxic microalgae (e.g. *Chatonella),* macroalgae (e.g. *Dasysiphonia),* Bryozoans *(T. inopinata*), the copepod *Cercopagis,* the tunicate *Styela*, the slipper limpet *Crepidula*, the Asiatic crab *Hemigrapsus*, the polychaete *Marenzelleria*, the Chinese mitten crab *Eriocheir*, the zebra mussel *Dreissena*, and others while the spread of associated fauna and flora with deliberate life transfer of aquaculture species and through aquaria trade will also be demonstrated (e.g. Caulerpa taxifolia).

The issues of (a) multiple invasion, leading eventually to establishment and (b) re-invasion threads with specimens returning from areas where they have been introduced decades ago and were exposed to different ecological conditions – over many generations – potentially resulting into a change in physiological performance characteristics. It is hypothesized that this may lead to range expansions in foreign habitats which were not occupied by the original introductions.(secondary spread)

The multiple interactions of coastal resource users and their role in increasing the risk of unintentional transfers will also be addressed in particular in light of human diseases (e.g. Vibrio cholerae) and pathogens that do have importance to sustainable development of aquaculture (e.g. sealice = Caligus flexispina).

An outlook on potential new risks will be presented in dealing with new technology developments in modern transportation systems (ship generations towards 2025) while addressing various scenarios for impact mitigation (e.g. ballast water treatment; management plans, awareness campaigns for tourists and others). Finally, it is hypothesized that with global climate change, and increased development of human coastal resource uses (e.g. habitat changes), additional fauna and flora previously unsuccessful will succeed to invade and alter ecosystems along our coasts.

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Why are invasions so variable ?

M. Williamson

The importance of invasions has been known at least since the time of Charles Darwin. Most studies have been on particular species, but there have been quantitative comparative studies from Darwin onwards. We now have a quantitative framework for describing and explaining, if not predicting, the variability of invasions between different species and different places.

Invasions are a diminishing cascade with variability all the way down. Four major stages of the cascade may be distinguished: introduction, establishment, spread and major effect (including being a pest). These relate to the three themes of the meeting. Introduction is mainly affected by socio-economic processes, establishment by those and by biogeographic parameters, while variability in spread and major effects reflect ecological and evolutionary interactions.

Examples will be given of all these but, in essence, the variability of invasions reflects the variability of the interactions of these processes with the variability among species.

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Plant invasions – seed, site or interaction limitation?

M. Zobel

Plant invasions show variable patterns over the world. In this context, also more theoretical issues have been discussed, e.g. whether communities are saturated by species or not. Diversity of invasion patterns makes it difficult to draw generalisations. Huston (1999) proposed a general hypothesis that diversity is limited by abiotic conditions in low productivity habitats, by diaspore arrival in medium productivity habitats and by disturbances in highly productive habitats. I shall discuss whether known cases support this generalisation. In particular, I'll refer on experiments made by our group in co-operation with Rio Quarto University in Argentina, where seeds of aliens of European origin were sown under different disturbance regimes. Finally, I shall focus on the possible role of microbes (with emphasis on fungi) in plant invasion. There are some evidences that the presence of certain symbiotic mycorrhizal fungi may facilitate certain plant species, while other pathogenic fungi may inhibit the establishment of other plant species. These evidences are, however, too scarce to understand fully the role of microbial organisms. Because of that, much more descriptive and experimental information is needed on this topic.

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Talks and Posters

Population expansion of native orchids in anthropogenous habitats

W. Adamowski

Since 1989 the author has been studying the development of populations of three orchid species (*Epipactis* x *schmalhausenii*, *Platanthera bifolia*, *Listera ovata*) in poplar plantations near Czeremcha (E Poland).

The conditions of occurrence of these orchids show evident anthropogenic influence. As a result of deep ploughing in the past the stratification of particular soil genetic layers was disturbed and the old humus horizon was buried. The traces of former gleying visible above the present underground water level prove the drainage of land resulting from the reclamation. Fast growing poplar hybrids (*Populus* x *canadensis*, P. 'Hybrida 275') were planted in 1969-1971. In the first six years the soil was mechanically cultivated to stop development of vegetation competing with poplars; mineral and organic fertilizers were used and later lupine *Lupinus polyphyllus* was sown.

Two of the three observed orchid species show a long and rapid phase of population growth (from 31 to more than 13000 individuals in the case of *Platanthera bifolia* and from 1850 to more than 13000 individuals in the case of *Epipactis* x *schmalhausenii*). Maximal densities reach very high values (> 600 individuals per 100 m^2), not observed in natural conditions. These populations are almost completely restricted to poplar plantations. Some individuals reach exceptional dimensions (to 127.5 cm - *Epipactis* and 92 cm – *Platanthera*). Regular flowering enables successful generative reproduction, in each season from 73 to 83% of *Epipactis* specimens and from 25 to 30% of *Platanthera* specimens flowered [1]). Both species are most often found growing together.

Success of these populations is attributed to [1]:
1) disturbance of upper soil levels;
2) soil enrichment in $CaCO_3$;
3) good light conditions;
4) restricted competition from other plants.

Occurrence of orchids in secondary habitats could have both positive and negative effects. When a developing population is genetically pure, it could help to preserve the species for the future. On the other hand abundant hybrid populations could pollute neighbouring populations of pure species by introgression.

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Invasion of red oak Quercus rubra in Bialowieza Forest (NE Poland)

W. Adamowski

Quercus rubra is one of the most commonly planted alien woody species in Europe. This tree grows faster than the native oaks and produces valuable timber. It is also used as fodder plant for game animals (acorns, young shoots for grazing). As red oak thrives well in the Central European climate and regenerates freely from seeds, it spreads aggressively over a large part of our continent, out-competing native species, both woody and herbaceous. This species could pose great threat to the natural life of the Bialowieza Primeval Forest.

The first red oaks were planted in the Bialowieza Forest at the end of the 19th century, when the Palace Park was set up in the vicinity of the hunting lodge of Russian Tsars in Bialowieza. In the Polish part of the Forest *Q. rubra* was planted only in a few places, mainly in settlements. Unfortunately, in the Byelorussian part it was still planted, even in the 1990s, in forest monocultures, as a „biocenotic admixture" and along roads. The first data concerning its spontaneous regeneration in the Forest comes from the 1940s. In the study of the distribution of alien woody species in the Bialowieza Forest we found this species in more than 80 out of 1350 forest squares! Red oak is spreading predominantly in pine and mixed pine-oak habitats in both parts of the Forest. Recently in a woodland adjacent to old red oak trees, up to 15000 juvenile individuals per hectare were counted. Under old trees in Palace Park the ground layer vegetation and woody species regeneration are strongly supressed. Seedlings of red oak were observed as far as 3 km from parental trees. Red oak is joining the process of regeneration of forest communities under artificial pine plantations and in these conditions grows faster than native trees. In mixed cultures *Q. rubra* easily out-competes most native tree species. This species also changes habitat properties by accumulating a thick layer of litter and altering hydrological conditions.

Thick, slowly decaying litter and changes in the availability of light throughout the year could stop the regeneration of native woody species, particularly pine and oak. These factors could also limit the occurrence of native herbs typical for pine and mixed pine-oak forests. The final result of this invasion could be the development of a new kind of forest community, similar in its character to the acidophilous oak or beech forests (*Quercetea robori-petreae*, *Luzulo-Fagion*) of West Europe. In the future, this floristically poor community could replace to a great extent the native oligo- and mesotrophic pine and mixed pine-oak forests which are characteristic for East and Central Europe.

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Neobiota in Press, TV and Radio

S. Blömacher

The fascination of exotics and the emotional bonds of man to nature are known since earliest times. Continuing success of nature-related documentation on TV and other media is the direct result of this devotion. Interest in reports on nature is increasing and will be of constant presence in the future.
Reports and archives of TV and radio stations (Bayrischer Rundfunk, N24, NDR, Tagesschau (ARD), WDR), newspapers and journals (Süddeutsche Zeitung, Welt, Zeit, Ostseezeitung, Frankfurter Allgemeine Zeitung, Spiegel, National Geographic) etc. were examined (Total: 77 news items).
News and reports on "newcomers, immigrants and invasive species" among plants and animals are gaining more and more importance in all media types. Public interest on this subject shows a growing demand for information, transparent terminology and clear definitions. However, enormous inconsistencies concerning news on the introduction of Neobiota oppose these efforts.
According to scientists and consequently the media Neobiota are definitely n o t the main reason for the present general change of biodiversity. In fact, the greatest threat to biodiversity is the destruction of natural habitats.
There are many examples in literature for continuing discussions between scientists who want to fight all newcomers [1,2] and those who try to defend and protect them or who recommend a more deliberate approach [3-6]. These disputes find their way into press, TV, internet and radio. Terms like "invading force", "front of foreign organisms", "opportunists" etc. are not uncommon within the media. Additionally, music in radio and on TV, for example, can cause or intensify strong feelings of insecurity and fear.
To improve communication and flow of information concerning Neobiota scientists have to provide clear and homogeneous definitions. These definitions should be applied in the media to ensure objective and moderate reports. This is the best way to counteract fears and insecurity.

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Strategies to restrict the potential of vegetative regeneration of *Robinia pseudoacacia* L.

R. Böcker, M. Dirk

Besides other factors the distinct competetive ability of *Robinia* is explained by its special root physiological morphology. Root suckers are formed from the surface root layer and from these suckers chain-like new surface root layers with suckers are formed. So rhizome colonies may be found upto 35m distance from the stem.
Based on this knowledge detailed investigations have been initiated in Baden-Württemberg 10 years ago:

- Monitoring programs on unchanged *Robinia* stands:
  even in old aged stands no deminishing vitality has been envisaged
- permanent plots in managed stands and periodical math of suckers:
  despite this management strategy root buds have been sprouting
- field measurements and observations:
  height growth up to 3-4m per vegetation period and speed of growth in the range of 40 cm - max.100 cm/month.
- pasture experiments with goats, starting in 1998. Tendency:
  3 years later still a short increase in sprout growth, but 75% less than in control plants (among other things success depends on duration of pasturing, race of goats, plant and feeding combination)
- Documentation of non-appropriate girdling attempts:
  no restraint of the potential for regeneration
- field research of more effective appropriate girdling, start February 2002:

Table 1: field research relating to girdling-practice

treatment	**stand situation**	**measurement**
girdling (winter)	shadow	girdling only
girdling (winter)	open stand	removal of stems
girdling (summer)	shadow	girdling only
girdling (summer)	open stand	removal of stems
windthrow	no removal of stems	none
windthrow	removal of stems	girdling of sprouts
Robinia cut	open stand	removal of stems
control	no removal of stems	none

Target of the investigation is to render a precisely documented database for prognoses of spread and methods to restrict *Robinia*.

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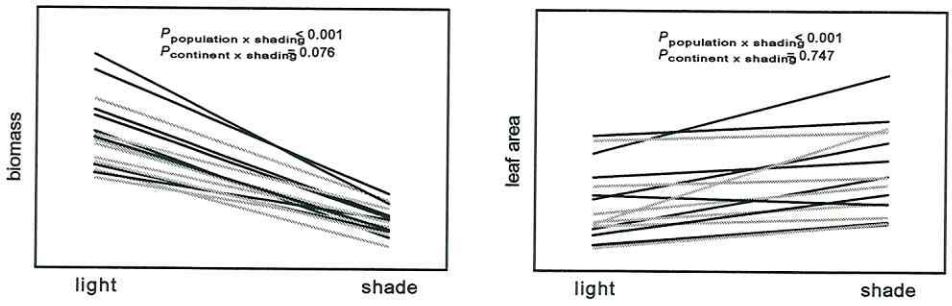
Microevolution in invasive populations of *Alliaria petiolata*

O. Bossdorf, D. Prati, B. Schmid, H. Auge

The idea of biological invasions as opportunities to study basic evolutionary processes has become increasingly popular in the last years [1,2]. Microevolutionary changes might be causes as well as consequences of invasions where invaders rapidly adapt to novel environments and native species evolve in response to the invaders, respectively. A straighforward way of investigating evolution in the invader is to carry out comparative quantitative genetic studies of native versus introduced populations. As an example, we present the results of a shading experiment with native European and invasive US populations of *Alliaria petiolata* (garlic mustard, Brassicaceae). The experiment is part of a comprehensive study of the ecology and genetics of *A. petiolata* invasions.
If phenotypic plasticity is of advantage and thus selected during plant invasions, one would expect genotypes from the new range to be more plastic on average than those from the native range. To test this hypothesis, plants from 8 US and 8 European populations of *A. petiolata* were raised under identical conditions and subjected to two shading treatments for three months. Plasticity to shading was quantified both in terms of morphological and physiological characters.

Figure 1. Reaction norms to shading of biomass and leaf area in European (bold lines) and US (broken lines) populations of *Alliaria petiolata.*



Shading had a strong effect on most of the characters investigated. There was significant genetic variation among populations for most of the traits studied, both in terms of main effects and genotype x environments interactions (Figure 1), suggesting local adaptation and genetic variation for plasticity among populations. However, there was no consistent pattern of plasticity differentiation between native and introduced populations.

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CORRIGIENDUM

Unintentional transfer of marine species to Norwegian waters and risks associated with them

H. Botnen

A total of 49 marine organisms (22 plants and 27 animals) have been introduced to Norwegian waters [1]. Of these at least 2 have been deliberately introduced for aquaculture; the oyster *Crassostrea gigas* in 1979 and the carpet shell *Tapes philippinarum* in 1987, and 1 for sport fishing and aquaculture, the rainbow trout *Oncorhyncus mykiss* in 1902. The Russian king crab, *Paralithodes camtschatica,* was deliberately released in the waters off the Kola peninsula for fishery enhancement, spreading to northeastern Norwegian waters in the 1980s. The American lobster, *Homarus americanus*, was illegally released in 1999. The remaining 45 species have been unintentionally introduced either accompanying organisms imported for aquaculture purposes, as fouling organisms on ships or in ballast water and sediments, or by natural range expansion after introduction to other European waters.

Annually approximately 40 million tonnes of ballast water, most of it from European and North American harbors, is discharged in Norwegian waters. The potential for unintentional transfers of species via shipping is clear: a ballast water survey found live organisms in 29 of 30 vessels [2]. It was also possible to culture micro-organisms from all ballast tank sediments samples [3]. Unless measures are taken to reduce the potential transfer of organisms, there will be new introductions to Norwegian waters in the future.

At risk from unintentionally introduced marine species are fisheries, aquaculture and tourism, contributing almost 6 billion € to the Norwegian economy. The aquaculture industry have incurred losses from the introduced *Chattonella* sp., *Gymnodinium aureolum*, and *Anguillicola crassus*, and the likely introduced *Alexandrium tamarensis*, whereas fishermen have seen their income drop due to *Paralithodes camtschatica.* However it is indisputable that some introduced species such as *Crassostrea gigas* and *Oncorhyncus mykiss*, and eventually *Paralithodes camtschatica* will have an intrinsic economic compensation.

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Invasive species in different urban land cover types: the case of Rome, Italy

L. Celesti Grapow, A. Acosta, M.L. Carranza, C. Blasi

Urban areas are recognised as centres of the introduction and spread of invasive alien species. In Central European settlements alien plant species make up a high share of the spontaneous flora, being on average 40%. There, invasive plants are mainly found in human-made habitats but also spread to seminatural habitats. On the other hand, in the Mediterranean Basin the role of alien and invasive species in the urban plant communities is less incisive and they are generally less numerous and more confined. Previous studies on the flora of urban areas in Italy showed a significative difference in the weight of aliens in cities in the temperate-continental region (Milan, Turin) and in the Mediterranean region (Rome, Naples, Cagliari, Palermo). In the latter, only a few species invade seminatural vegetation and the percentage of aliens in the flora is generally much lower: even in the most disturbed sites local plants count more than 80% and the dominant ecological group is made up of Mediterranean annuals, well adapted to human impact. Researches on such areas where the impact of alien species is relatively less strong may contribute to the understanding of the mechanisms of biological invasion. Aim of this study is to analyse the distribution and weight of alien species in different land cover types of the urban area of Rome. In the whole city alien species make up 19 % of the spontaneous flora. They are generally separated from local plants both in space, being more numerous in the urban centre, and in time, as many of them flower during and/or after the summer vegetative pause of the native Mediterranean flora. The percentage of non-natives tend to increase along with increasing urbanization and human impact, as a result, their importance should vary in different urban land use types.

A sample area was chosen in the mid-western sector of the city. Within the area 30 plots of 1 ha each were selected along a gradient from the centre outwards to represent the most common land cover types found in the urban territory: continuous urban fabric (residential and historical centre), discontinuous urban fabric, green urban areas (parks, gardens and archaeological sites), abandoned pastures and thickets. The spontaneous flora was recorded in each plot including both native and alien species, subdivided into casual, naturalised and invasive. For the whole sample area the percentage cover of each land use type was measured. The variation in the role of alien and invasive species in the different typologies, together with the life forms, chorology, origin and Ellenberg indicator values were analysed by means of multivariate analysis. The results show that the distribution of the non-native flora is more related to the environmental features of the land use type than to the centre-periphery gradient. Among the land cover types analysed, abandoned pastures and green urban areas show the lowest proportion of alien species coupled with the highest total species richness. In particular, despite the intense human impact and being situated right in the city centre, archaeological sites are the most resistant to invasion, being almost totally dominated by Mediterranean native species i.e. shrubs and perennial plants originating from rocky habitats and growing on ancient walls, as well as annuals from dry pastures which are found among the ruins.

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Economic effects of *Rhododendron ponticum* in the British Isles

K. Dehnen-Schmutz

Rhododendron ponticum was introduced into Britain in the late 18th century and has been widely planted, particularly in the 19th century. Today it is spreading in the countryside and causes problems not only in nature reserves but also in parks and forests. The control and eradication of the species is very labour intensive and expensive. In forests, dense Rhododendron shrubs could reduce timber production.

To get more information about the extent of the problem a survey was carried out among nature conservation and forestry authorities, local and national wildlife trusts, as well as private owners of estates and forests in the United Kingdom and the Republic of Ireland.

174 questionnaires were sent out and 103 returned*. As some of the recipients circulated the questionnaire further, the total number of recipients is unknown. 44 answers came from nature reserve managers of environmental charities like the local Wildlife Trusts, the National Trust or the RSPB (Royal Society for the Protection of Birds). Public authorities, mostly responsible for National Parks and National Nature Reserves (the highest protection status in the UK), sent 33 questionnaires back. Forest Enterprise, the official forest authority in the UK and Coillte, a private company managing the forests in the Republic of Ireland returned 13 questionnaires and private landowners also returned 13.

19 respondents stated that they do not have *R. ponticum* on the land for which they are responsible, 13 answered that they have it but were not able to give further information.

The answers of 71 respondents provide information about 35,500 hectares of land affected by *R. ponticum*. 107 out of 159 sites mentioned by respondents are designated nature reserves, 34 of them National Nature Reserves. The main habitat type affected is woodland followed by heathland. According to the respondents, more than £500,000 (~800,000 €) was spent on *R. ponticum* in the year 2001 alone, including the cost of eradication of 1147 ha of the plant and the restoration of habitats. The control costs are very variable depending on the methods used and the age of the Rhododendron stand. Follow-up treatments using only herbicides to spray regrown Rhododendron are usually cheaper than cutting in the first year of a control programme. When asked how much money they would need to control *R. ponticum,* the answers of 34 respondents came to a total of up to £3 million (~4.8 million €) per year over a period of five years.

Nearly half of the control measures in 2001 involved volunteers. Most volunteers were working for environmental charities, but some public authorities like the Killarney or Snowdonia National Park also used volunteers for clearance works. In total, more than 30,000 volunteer hours were spent working on control measures.

*The numbers in the text are preliminary and will be different by the time of the meeting

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Biomass and nutrient contents of riparian woodland neophyte stands

G. Dericks, R. Lösch

Riparian forests are naturally eutrophic vegetation units with a high biomass of the herb layer. They are invaded very often by a couple of tall perennial or annual herbs which tolerate short periods of inundation. Most prominent among them are rhizomatous *Reynoutria* and *Solidago* species and the therophyte *Impatiens glandulifera*. They often form facies stands with only few other plant intermingled. Facies structure of growth can be found also with some of the indigenous herbs, like *Urtica dioica, Impatiens noli-tangere* or *Circaea lutetiana*, which reach, at best, half the growth height of the invaders.

Edaphic habitat conditions and plant biomass were studied in a forest of the Rhine river floodplain near Düsseldorf, inundated every two to three years, where neophytes are abundant. The tree layer is dominated by ash trees. 4 m^2 plots were selected where the neophytes *Reynoutria japonica*, *Impatiens glandulifera* and *I. capensis* dominate the herb layer, always accompanied by *Urtica dioica*. Only in the *I. capensis* stands also other indigenous species can be found, viz. *Urtica dioica*, *Filipendula ulmaria*, *Rorippa amphibia*, *Lycopus europaeus*, *Polygonum mite*, *Calystegia sepium*, and *Phalaris arundinacea*. Soil pH (aqueous and $CaCl_2$ suspension, WTW ph Digi 88) and phosphate, nitrate, and ammonium concentrations were measured (P: Molybdate test; N: Merck kits 1.14773 and 1.14752, respectively). Plant biomass was determined at the height of the vegetation development in early autumn.

$pH_{(H_2O)}$ values were at 6.1 ± 0.3. Phosphate and nitrogen ion concentrations in the soil are given in Tab. 1. In all cases, the nutrient concentrations of the *I. capensis* plots were lower than those of the tall herb facies (for nitrate not significant). This results from stronger leaching of the longer and more frequently inundated growing places of *I. capensis* the soil surface of which is 30 – 40 cm below that of the tall herb stands.

Table 1: Soil phosphate, nitrate and ammonium concentrations [mg P_2O_5 (100 g soil)$^{-1}$; mg NO_3^-(100 g soil)$^{-1}$; mg NH_4^+(100 g soil)$^{-1}$] of *Reynoutria japonica*-, *Impatiens glandulifera*-, and *I. capensis*-dominated facies of a Lower Rhine floodplain forest.

Parameter	*Reynoutria* plots	*I. glandulifera* plots	*I. capensis* plots
phosphate	27.3 ± 6.6	27.3 ± 6.2	11.8 ± 3.7
nitrate	15.4 ± 9.2	15.7 ± 6.9	12.0 ± 5.3
ammonium	2.1 ± 0.7	2.5 ± 1.2	0.8 ± 0.4

Total biomass per plot was 6018 ± 250 g for *Reynoutria* (intermingled *Urtica* 140 ± 5 g), 1950 ± 250 g for *I. glandulosa* (*Urtica* 720 ± 390 g), and 330 ± 173 g for *I. capensis*. In the last case co-occuring *Urtica* made up 170 ± 125 g and the other species altogether 90 ± 54 g. By this way, *Reynoutria* contributes 97 %, *I. glandulifera* 73 %, and *I. capensis* 56 % of the total biomass of the plots. On average, *Urtica* makes up 11 % of the herb biomass of this forest. Root/shoot ratios were low in all species.

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Pacific oysters (*Crassostrea gigas*) invade native mussel beds (*Mytilus edulis*) in the Wadden Sea

S. Diederich

Since 1986 Pacific oysters (*Crassostrea gigas* Thunberg 1793), which originate from Japan are cultivated at the island of Sylt (northern Wadden Sea). Although the oysters were never intended to reproduce in this region, successful spatfalls occurred in 1991, 1994, 1997 and 2001 on natural mussel beds (*Mytilus edulis* L.). Mussel beds represent the only hard bottom structures on the extensive sand flats within the area and are therefore used as settling substrates by oyster larvae. After the first record of wild oysters in 1991 [1] they started to spread in range and abundance to up to 100 ind./m² in 2002.

To evaluate whether *C. gigas* is just at the start of an invasion and could possibly become a threat to mussel populations, its ecological properties are currently being investigated. Field experiments and data on abundance and length-frequency distributions from 1999 to 2002 revealed that the oysters are able to survive and grow over a long period of time in different habitats and are not harmed by cold winter temperatures. Oyster larvae settle preferentially on conspecifics, which could support a positive feedback theory. Prey choice experiments with the shore crab *Carcinus maenas* and the common starfish *Asterias rubens* revealed that the main local predators strongly prefer mussels over oysters.

These results and parallels to the oyster invasion in the Netherlands suggest that the Pacific oyster is firmly established in the northern Wadden Sea and is likely to increase in abundance and range over the next years.

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On the ecology of invasive plant species on the Islands of Robinson Crusoe, Juan Fernandez, and Isla de Pascua, Chile

K. Dierssen, I. Feeser

Fragile island ecosystems commonly suffer from the severe impact of species introduced by man.

The Juan Fernandez archipel and Easter Island differ from their phytogeographical position (austral versus austrosubtropical), their relief and altitudinal vegetation pattern, their distance from the South American continent and the history of invasion by man (sailors form Europe and Polynesia).

The Juan Fernandez archipel is prominent for its endemic flora and fauna, Easter Island is characterized by the overwhelming importance of introduced species. The different land use history with sporadic fires and cattle grazing mainly in lowland areas of the Juan Fernandez islands favoured deforestation, severe erosion and the settlement of weeds and shrubby species (especially *Acaena argentea, Rubus ulmifolius, Ugni molinae, Aristotelia chilensis*) from Chile and Europe, while on Easter Island recent introductions of invasive grasses from tropical and subtropical areas (*Sporolobus africanus, Melinis repens*) in order to improve pasturing reduces the anyhow low species diversity of the islands grasslands.

The interaction between preadaptive characteristics of the invasive species and the predisposition to invasion by former and recent landuse practices will be discussed in detail.

A classification and mapping of vegetation types and hemerobic steps characterizing the influences of erosion and neophytic species is proposed as a first planning instrument for a risc assessment and concepts of a further wise conservation and landuse planning.

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Shifts in dominance of native and invasive plants in experimental vegetation

H. Dietz, M. Woitke

While there is ample evidence that (anthropogenic) disturbance is a crucial preconditon for many plants to invade foreign habitats, few studies have attempted to tease apart the different aspects of disturbance that might influence invasions. In addition, there is the need to relate disturbance effects to specific traits of the invaders and to test whether beneficial responses of the invaders to disturbances are robust against varying composition of the dominant native species in the recipient habitats.

In our study we examined how type of regeneration, type and frequency of disturbance, species composition and life history traits of two Brassicaeae forbs, *Bunias orientalis* (L.) and *Rorippa austriaca* (Crantz) Besser contributed to distinct dominance patterns of the species in low diversity herbaceous vegetation at productive disturbed sites. While the two invasives are frequently found associated with a small number of abundant native species the relative dominance of the species varies strongly between sites, both within the invasives and between the invasives and the natives, suggesting high between-site variability in the factors influencing the local invasion process.

In a controlled field experiment individuals of the two invasive and of four native species were grown in mixed stands for almost 3 years. The plants were subjected to different treatments, i.e. we varied type of regeneration, disturbance (mowing, soil perturbation) and species composition. The development of the plants was monitored by using cover values as a non-destructive measure of above-ground performance and by analysis of above-ground biomass, number of shoots and mean shoot length at harvest time.

All factors included in the study contributed considerably to the development of distinct (co-) dominance patterns in the species mixtures. For example, while both invasive species were generally promoted by disturbances relative to the natives, they differed in their response to distinct disturbances and these differences were strongly affected by species compostion. Our results indicate that invasion success of *R. austriaca* will be more dependent on soil disruption, transport and deposition while *B. orientalis* is expected to particularly expand at mown sites that do not have dense cover by meadow grasses. In addition, it may be of critical importance for the invasion success of the two invasives whether the native resident vegetation is mainly composed of successional competitors that suffer from disturbance or of ruderal competititors that compete early and strongly with the invasives. Our results caution against preliminary conclusions on the causes and future developments of plant species invasions because the invasion processes, at least in the long term, may be quite dependent on even subtle changes in environmental conditions.

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The invasion success of *Rhododendron ponticum* explained by habitat and genotype

A. Erfmeier, H. Bruelheide

It has often been suggested that both an invader's genotype and a new habitat are important components of biological invasions. The relevance of both factors was assessed for the invasive evergreen shrub *Rhododendron ponticum*. The species originates from the Mediterranean and Black Sea area and has been introduced for horticultural purposes to the British Isles, where it has become a very successful invader. It serves as a suitable system to evaluate the major contribution to the species invasion success.

Habitat analyses with respect to vegetation, climate and soil characteristics were performed in six native populations each in Georgia and Spain and in six invasive ones in Ireland.
Irish sites showed a significantly higher nutrient supply, correlating with an accelerated growth of shoots and a higher seedling density compared to Spanish and Georgian sites. Thus, site conditions seem to promote the invasiveness in Ireland.

The genotypic contribution to the invasion success was analysed by germination and growth experiments under controlled conditions. Seeds of invasive Irish populations showed both a higher and a faster response in various treatments. Greenhouse experiments with cuttings revealed higher relative growth rates (RGR) for invasive Irish populations compared to the native Georgian and Spanish ones. Thus, genotypic characteristics are also crucial for the invasiveness.

To assess genotype – environment interactions we transplanted *Rhododendron* cuttings of all origins back to all countries and recorded viability after one year of establishment and growth in the field. The results suggest that, in addition to favourable site conditions of the new habitat and genotypic traits promoting invasiveness, adaption of genotypes to habitats is another important factor explaining invasion success.

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Non-Indigenous Species in Austria: results of a national inventory

F. Essl & W. Rabitsch

According to the requirements of the CBD, ratified by Austria in 1994, the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management and the Austrian Environmental Agency commissioned a national inventory of non-indigenous species (NIS) occurring in Austria. This survey resulted in annotated lists of plants, fungi and animals, with information on the distribution and habitat requirements in Austria.
The species were classified for their mode of introduction into Austria (anthropogenic induced expansion, unintentional introduction and intentional release), for status (casual/naturalized), for conservational (invasive species posing a threat to indigenous ecosystems and species) and for economic relevance.

So far, approximately 1.110 plant, 83 fungi and 500 animal taxa are documented for Austria (Table 1). In the assignments 35 plant, 6 fungi and 46 animal species were considered as possible threats to biodiversity. These species change ecosystem functioning by habitat alteration, competition or transmission of parasites. Economic impacts were much more prevalent among animals and fungi than in plants.
Recommendations and strategies for exotic species management in Austria are addressed, e.g. the essential significance of prevention, public awareness and the continous monitoring of NIS in Austria.

Table 1: Currently recognized NIS in Austria. [1] including 2.950 indigenous species and archaeophytes (Niklfeld 1999) and 1.110 neophytes (Walter et al. 2002); [2] including 51 probably established species; [3] including potentially invasive species; data taken from Essl & Rabitsch (2002).

group	complete species number in Austria	neophytes, neomycetes, neozoans	established	invasive
vascular plants	4.060[1]	1.110	275[2]	35[3]
mosses	1.020	4	2	0
lichenes	approx. 2.100	2-3?	2-3?	0
algae	Unknown	4?	?	0
fungi	Unknown	83	61	6
animals	45.000	>500	300	46[3]

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The age, repeatability and permanence of the effects of anthropogenic impacts on plant cover and the environment

J. B. Falinski

Abstract: The more recent diversity to plant cover, flora and vegetation; and indeed to ecosystems and overall geographical ranges, cannot be explained solely by reference to the action of contemporary factors. Rather its causes may be concealed by successive human activities, even of an extensive nature, or be a reflection of ecological processes that have come into play in the meantime (e.g. regeneration, secondary or primary succession and regression).

The occurrence of certain phenomena lke invasion, hybridisation and changes in reproductive strategy are not explicable solely by reference to the pre-adaptation of species, or the contemporary changes in the environment and landscape.

The effects of earlier human impacts "imprinted into the environment" will thus be considered in regard to the effects of the secondary isolation of forest and marshland complexes.

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Neophytic tree species – foreign bodies or chance in our forests?

M. Gossner, U. Simon

Fast growing tree species like Douglas Fir and Northern Red Oak are of great economic interest in German forestry. The question arises if the plantation of these species can come along with purposes of nature conservation, like maintaining a high faunistic diversity in managed forests. Until now no comprehensive studies exist.

To fill this gap of knowledge we studied the arthropod fauna in tree crowns of neophytic and indigenous tree species at different structured old growth forest sites in Bavaria. Pure stands of neophyts as well as mixed stands of indigenous tree species intermingled by foreign tree species were investigated. Trapping took place in the conifers Douglas fir (*Pseudotsuga menziesii*) and spruce (*Picea abies*), and deciduous species Red oak (*Quercus rubra*) and oak (*Quercus robur*), using flight interception traps. The main focus is set on beetles and true bugs.

Our results show that a differentiated consideration of foreign tree species is necessary. The effects of their cultivation depend on tree species as well as on stand structure. But both neophytic tree species can't be characterised as so called "ecological deserts".

For **Red Oak** the expectation of a reduced arthropod community on introduced species can be confirmed for beetles as well as for true bugs. We found a almost complete lack of phytophagous oak specialists on Red Oak (Figure 1). The impoverishment of the arthropod fauna compared to pedunculate oak was more distinct in pure stand than in mixed stand.

Whereas for **Douglas fir** no impoverished arthropod community could be detected compared to spruce, for individuals as well as for species. Also the proportion of specialists and generalists was similar. The community structure, however differed between the two tree species [1,2]. Thus e.g. in conifer-dominated forest stands the number of aphidophagous beetles (Figure 2) as well as the number of lace wings was significantly higher on Douglas fir compared to spruce. Due to the influence of the deciduous trees this difference could not be ensured in beech-dominated stand by a statistical test.

Based on these results for faunistic-ecological purposes Red oak can't be recommended for forest practice. Whereas a small admixture of Douglas fir seems to be maintainable.

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Douglas fir stands deprive overwintering bird species of food resource

M. Gossner, H. Utschick

In coniferous forests spruce trees (*Picea abies*) are known to be an important food source for numerous insectivorous bird species, both in summer and in winter. Due to a high density of arthropods (mainly spiders) above all spruce matters during the months of limited food sources

To estimate the impact of Douglas fir (*Pseudotsuga menziesii*) as a food source for bird species, bird activity and arthropod density in winter as well as in summer were studied. Bird density of activity in different forest stands as well as utilisation of different tree layers were measured. The arthropods were sampled by branch beating in the upper canopy of spruce and Douglas fir trees in a 100 year old pure stand of Douglas fir that is surrounded by spruce forest.

It could be shown that birds avoid pure stands of Douglas fir in winter while mixed stands of Douglas fir and spruce were used as food source (summer and winter). On the single tree level the birds were foraging trunk and crown layer of spruce during summer and winter. In contrast no activity in the canopy could be detected in Douglas fir. This could be explained by the availability of food resources. Whereas high densities of spiders in the canopy of spruce trees probably guarantee the survival of birds during winter time, nearly no spider could be found on Douglas fir.

If this results could be confirmed at other forest stands, the often stipulated expansion of Douglas fir plantation on the part of foresters might have momentous consequences for overwintering birds. Although the consequences of Douglas fir on the arthropod communities in summer seem to be more subtle [1], these results lead to the conclusion that forester really have to practise caution in expanding planting Douglas fir (see also [2]).

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The importance of invasive predatory amphipod *Dikerogammarus villosus* for the macroinvertebrate community in the Rhine river

G. Haas

In the middle of the 1990ies the Ponto-Caspian crustacean *Dikerogammarus villosus* invaded the Rhine by passing the Rhine-Main-Danube canal and colonized predominantly the littoral riprap. Today, the predatory *D. villosus* dominates the macroinvertebrate fauna throughout the navigable sector of the Rhine. Before its invasion, *Corophium curvispinum, Gammarus tigrinus* and *Echinogammarus ischnus* were the co-occurring nonindigenous amphipods [1]. Native amphipod species *Gammarus pulex* and *G. roeseli* have already disappeared.

From 1996 on, all gammarid species declined, except *D. villosus*, which nowadays occurs in high densities of more than 3,000 ind. m^{-2} (locally more than 6,000 ind. m^{-2}) in the Northern Upper Rhine.

In the period of abundant *C. curvispinum* population densities from 1989 till 1995, this muddy crustacean reduced available habitat areas by transferring coarse and hard surfaces into fine and muddy areas. Consequently, other epilithic species were negatively affected by this muddy layer. In particular, the sessile zebra mussel *Dreissena polymorpha* was the most impaired species by a lost competition for space. *D. villosus* interfered into the competition between the two filter-feeders *D. polymorpha* and *C. curvispinum* by exerting a strong predatory effect, especially on *C. curvispinum* [2,3].

Subsequent to the appearance of *D. villosus*, *G. tigrinus* disappeared finally in 1999 out of the transitional zone of the Northern Upper and Middle Rhine [1]. Further decreases in abundances of characteristic species in the Rhine such as *Heptagenia sulphurea*, *Ephoron virgo* (both Ephemeroptera), *Aphelocheirus aestivalis* (Heteroptera) and turbellarian species were recorded [1]. The influence on these species by *D. villosus* cannot be excluded, however, it remains partially unresolved.

The recent arrival and mass development of *D. villosus* in coincidence with strong changes in abundances of other native or exotic species support the theory that predatory invaders have the most powerful effect on the species community.

Presently *D. villosus* distributes into other large navigable rivers (Moselle, Rhône). Because of its broad salinity and temperature tolerances, *D. villosus* is identified as a potential invader of waterways worldwide possibly resulting in a cosmopolitan distribution [1,3].

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Patterns of species characteristics in invading plants: The ghost of invasion past

T. Heger

Ever since biological invasions were in the focus of ecological research, one aim was to find species characteristics which help to predict which species will become invasive. But even today, many attempts to detect patterns of species characteristics out of data sets on invasive alien plants show inconsistent and seemingly idiosyncratic results. Some studies find certain traits which are significantly correlated with the invasiveness of species and therefore seem to characterise invasive plants, but others do not find any such traits. Those species characteristics which in many cases seem to be typical for invasive plants - like e.g. a high relative growth rate - are not useful to distinguish between invasives and natives in every case. There even are studies which come to contradicting results, e.g. concerning the seed size of invasive species.

The paper hypothesises that this inconsistency is mainly due to the influence of history. This assumption is based on the results of a theoretical analysis of invasion processes using a scheme of invasion steps and stages [1]. To look at invasion processes as multi-step phenomena gives the opportunity to analyse the factors determining an invasion process during each step in time separately. The model of invasion steps and stages (INVASS model) names potential problems which may arise during each invasion step, species characteristics, which are useful to overcome them and favourable conditions which may be given in the new environment.

This stepwise analysis makes it possible to reveal the "ghost of invasion past": Depending on the situation, a specific chain of crucial situations acts as a filter on the available pool of organisms or species characteristics, respectively. The patterns which can be found in the characteristics of invading species therefore may in many cases not be the result of adaptation of the species to the new environment, but of the filtering effect of the crucial situations occurring during the invasion process. Due to the contingency of events, every single invasion process may differ from another and thus lead to a unique chain of crucial situation, thus favouring a specific pattern of species characteristics.

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Natural Populations of *Solidago gigantea* AIT. (Asteracea) in their Native and Introduced Range

G. Jakobs, E. Weber, M. Baltisberger & P. J. Edwards

Numerous studies address the question, why particular plant species become invasive where introduced and what the mechanisms of such success are. Blossey and Nötzold (1995) suggest an evolution of increased competitive ability (EICA) in introduced plants due to altered selection pressures, resulting in plants with a stronger competitive ability but lesser defence against herbivores and parasites.
Solidago gigantea is an aggressive invader of moist sites in Europe, and we compared native and introduced populations of this species to test whether its colonization success in Europe can be attributed to the EICA hypothesis. We surveyed 48 populations in three areas of the U.S. (Iowa, Pennsylvania, Wisconsin) and 42 populations in three areas of central Europe (South of the Swiss Alps, Northern Switzerland/ Alsace and Germany) in summer 2001. For each population, we determined shoot density, population size, and average size of plants above- and belowground. Shoot density was significantly higher in European than in American populations: in Europe, mean shoot density was 78.5 (4.6 m-2, whereas in America, it was 35.6(4.0 m-2. Shoots of European populations were generally taller, thicker and produced larger inflorescences than American populations. In addition, number and length of rhizomes of European populations was significantly higher than in American populations. Generally, differences between continents were stronger than differences between areas within continents. The results obtained so far demonstrate that European plants of *S. gigantea* are more vigorous, suggesting probable post-invasion genetic changes in *S. gigantea* and supporting the EICA-hypothesis.

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No increase in numbers of alien plants in permanent plots in a German floodplain during 13 years

G. Kasperek

From 1989 to 2001, 83 permanent plots have been investigated on a regular basis in the floodplain of river Rur (Northrhine-Westphalia, Germany). Plots are located in forests (alliances Carpinion, Alno-Ulmion), poplar plantations, reeds (Phragmition, Magnocaricion), and in grazed or disturbed areas (Cynosurion, Agropyro-Rumicion, Aegopodion, Senecionion fluviatilis; see [1] for details).

23 alien plant species were recorded (Table 1). In about 20 % of the plots, alien plants reached proportions of more than 10 % of total species number; highest value for a single year / plot was 33 %. Almost 40 % of the plots were free of alien plants. Proportions of alien plants in relation to indigenous species varied considerably from year to year, indicating highly dynamic processes in the river's floodplain. Most changes in vegetation can be attributed to natural fluctuations.

Table 1: List of most important alien plants, with number of occupied permanent plots

species	plots	species	plots
Epilobium adenocaulon	28	*Galinsoga ciliata*	3
Impatiens glandulifera	21	*Galanthus nivalis*	2
Bidens frondosa	18	*Hesperis matronalis*	2
Impatiens parviflora	12	*Lactuca serriola*	2
Senecio inaequidens	6	*Heracleum mantegazzianum*	1
Acorus calamus	4	*Polygonum cuspidatum*	1

On a 13-year-scale, no clear trend could be detected in numbers of alien plants within the plots. As an example for species with strong fluctuations from year to year, occurences of *Impatiens glandulifera* in reeds are investigated with reference to flooding and ground water changes. The highly dynamic behavior of this species could lead to the term "temporary invasion".

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Ergasiophygophytic trees and shrubs in the Ruhrgebiet (West Germany)

P. Keil & G. H. Loos

A tradition of investigation of alien plant taxa in the former largest German industrial region Ruhrgebiet (Ruhr area) was founded 120 years ago and still continues. More than 1000 adventitious plant species were detected within this area. Within the investigation period the origin of herbal aliens changed significantly from mainly xenophytic to ergasiophygophytic occurrences. But within alien trees and shrubs ergasiophygophytic occurrences are traditionally predominant.

Robinia pseudoacacia, *Buddleja davidii*, *Acer negundo*, *Platanus xacerifolia*, *Prunus cerasifera*, *Prunus mahaleb*, *Rubus armeniacus*, hybrids of *Populus nigra* cv. Italica and *Ailanthus altissima* are characteristic and conspicuos tree and shrub (and subshrub) species of the Ruhrgebiet; most of them could easily be recognized while riding by train or car because of their typical characters in combination with extended occurrences.

The general part of the ergasiophygophytic trees and shrubs consists of famous ornamental species in gardens and parks, e.g. *Acer ginnala*, *Acer tataricum*, *Berberis thunbergii*, *Betula papyrifera*, *Caragana arborescens*, *Catalpa bignoniodes*, *Corylus maxima*, *Crataegus pedicellata*, *Fraxinus angustifolia*, *Fraxinus ornus*, *Physocarpus opulifolius*, *Prunus persica*, *Quercus cerris*, *Rosa multiflora*, *Rosa spinosissima*, *Rosa rugosa*, *Spiraea douglasii*, *Spiraea japonica* s.lat., *Spiraea pseudosalicifolia* etc. Some taxa are found more frequently within the last years, e.g. *Paulownia tomentosa*, *Chamaecyparis lawsoniana*, *Crataegus persimilis* and *Cornus sanguinea* subsp. *australis*.

A greater part of escaped taxa belongs to species with evergreen leaves. Frequently escaped species are *Mahonia aquifolium*, *Prunus laurocerasus*, *Berberis julianae*, *Lonicera nitida* and *Cotoneaster* div. spec. Within the last years, *Viburnum rhytidophyllum* und *Pyracantha coccinea* escaped also frequently.

The contribution includes an overview of recent occurrences of escaped taxa and their phytosociological importance; additionally, the possibilities of establishing of the taxa and the problems in protection of biotopes and species caused by a possible establishment are discussed.

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The dispersal of Douglas-Fir diaspores in forests in Germany

D. Knoerzer

Douglas Fir (*Pseudotsuga menziesii* (Mirb.) Franco) is one of the few non-indigenous conifers in Germany, which is able to persist on specific sites and is very competitive in specific native biocoenoses. As for most conifers regeneration of Douglas Fir is solely generative and dispersal anemochorous. Thus the establishment potential depends on i) the distance of diaspore dispersal and ii) the existence of suitable sites for the regeneration. The latter is landscape-specific, generalizations are therefore difficult. The study thus focuses on seed dispersal.

Sampling methods: For dispersal distance determination the frequency of the spontaneous regeneration rather than that of the seeds was sampled (e.g. [2]). The selection of suitable study sites is thus crucial: A 'ceteris paribus' situation especially for the frequency and abundance of safe sites is necessary.

Transects between two Douglas Fir stands, separated by a 700 m beech (*Fagus sylvatica*) stand and transects starting at a Douglas Fir group in a mixed beech-spruce-silver fir stand are investigated. Thus long-distance seed dispersal is not taken into account.

Analysis method: For allocation of the spontaneous regeneration to the oppositing stands (seed sources) quadratic splines are used, with varying penalty-term. Rather than a physical model for diaspore dispersal, parametrizations of density functions of the spontaneous regeneration are estimated for a more general modelling. A lognormal function is applied in the following (e.g. as proposed by [1]. Additionaly to the type of density function two estimation algorithms were used: a variance-based and a maximum-liklihood-based one.

Results: Maximum distances based on the spline analysis of 265 to 380 result, depending on the chosen penalty-term (model-inherent effect) and exposition of the transects.

For the lognormal function the distances vary greatly with the estimation algorithm chosen. The mean distances (i.e. half of the density function) differ for both methods ((a) the variance based and (b) the maximum liklihood) with the direction of the seed flight relative to the main wind direction (MWD). For (a) the distance is approx. 158 m in MWD, and 246 m in opposite of MWD, whereas for (b) the oppositing dispersal distances have neither the same relation nor the same mean distances.

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Neobiota as object of invasion biology

I. Kowarik

A clear terminology is a prerequisite for communication in science. The history of invasion biology has however yielded a vast variety of terminological layers that have been developed more or less independently in different parts of the world. In Europe, this tradition dates back to the second part of the 19th century. The paper starts from the insight that it may be more useful to aim at a very small repertoire of internationally convertible terms instead of trying to harmonise the broad variety of existing synonyms and homonyms. Neobiota may serve as such an umbrella term in invasion biology. It has recently been coined at the initial meeting of the German research consortium on biological invasions in 1999, but a sound definition is still missing. The proposed concept of Neobiota includes a specification of diverse groups of organisms that are or might become objects of studies in biological invasions.

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Risk assessment of non-native plants: Do existing procedures and databases fulfil the requirements of nature conservation?

I. Kowarik, R. Bartz, U. Heink, U. Starfinger

An assessment of the impacts of alien plants on certain ecosystems is needed for several purposes, e.g. for a decision on management or control activities or for banning or allowing the use of a given species in certain ecosystems. The latter is a requisition by the Federal Nature Conservation Act (§ 41.2 BNatSchG) which prohibits the release of non-native species without a permission.
For a risk assessment two components are needed: basis data about non-native plants and a risk assessment procedure including preservation goals. In order to develop such a risk assessment applicable for individual alien plant species in specific habitats, we conducted a literature and internet survey to assess whether existing databases and procedures take the specific impacts of plants in certain biotopes into account.
The analysis of assessment procedures puts its emphasis on the following aspects:

Is the assessment of the impact species-specific or case-specific?
How are the effects measured and quantified?
Are both risks and benefits examined?
Which types of risk are covered (e.g., human health, economy, environment)?

The poster presents preliminary results of a project which is funded by the Federal Environmental Agency (UBA).

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Internet handbook for the determination and control of problematic invasive alien species in Germany

I. Kowarik, U. Starfinger

The poster presents the aims and general ideas of a project which is funded by the Bundesamt für Naturschutz (Federal Agency for Nature Conservation).
Invasive alien plants can cause severe problems for human health, nature conservation and various economic activities on a world-wide and on a national level [1], [2]. Even though this fact is widely acknowledged by scientists, politicians, nature conservation volunteers, and the public, an accepted overall policy on invasive plants in Germany is lacking. Consequently, there is no unanimity regarding the control of invasive plants. Some consider control unnecessary or altogether useless. On the other hand, a lot of energy and money flows into control activities that have little or no success due to a lack of planning and/or knowledge [3]. In addition, the evaluation of control measures is hampered by a lack of monitoring.
The work described here aims at ameliorating this situation by enhancing the information flow among and between scientists and practitioners. It will offer collected information and at the same time invite comments, experiences, and questions.
In a web-based database, the user will access information on biology, taxonomy and the natural and human-induced distribution of the species. The description of the effects of the species on plants, animals, and ecosystems in Germany, as well as human health and economic effects will guide the user towards a decision on the necessity of control measures. The potential success of control methods, their cost and effectiveness are analysed and evaluated. One major approach of the internet handbook is the diversification of information on impacts, control and prevention on the landscape level (types of biotopes, geographical variation in Germany).
In the beginning, the handbook will contain ca. 30 species that are known as causing trouble resp. provoking control activities. In will be structures in such a way that in the future, more plants and also invasive alien animal species can be included.

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Plant distribution patterns in Germany – will aliens match natives?

I. Kühn, S. Klotz, R. Brandl

The introduction of plants across biogeographic barriers by humans causes alterations of regional floras. We used current plant distribution patterns in Germany to deduce processes of colonization and effects of possible homogenization (i. e. that discrete regional species pools become more similar due to biological invasions).

First, we could show that species richness of native plants is highly correlated with that of alien plants. There is a slightly overproportionate increase of archaeophytes (pre 1500 aliens) and a strongly overproportionate increase of neophytes (post 1500 aliens) with native plant species richness. Considering the positive effect of time since introduction on occupancy and the effect of up-scaling, we conclude that aliens establish first in areas of high native diversity and then colonize other areas.

Second, analyzing 45 environmental parameters regarding geology, soils, climate, topography, and land use and correcting for spatial autocorrelation, we found that the same underlying factors cause this pattern for both groups: Most important factors for all three groups of species is the richness of different geological substrates. Furthermore, archaeophytes are positively correlated with the area of loess landscapes and neophytes with urbanized area.

Third, we calculated different measures of similarity of the alien plant species vs. natives. We found a highly significant positive correlation between the similarity matrices. We argue that aliens do not lead to the homogenisation of the German flora but (at least) partly follow biogeographic patterns provided by natives. Therefore, we do not regard alien plants in general as threat but largely as enrichment of biodiversity.

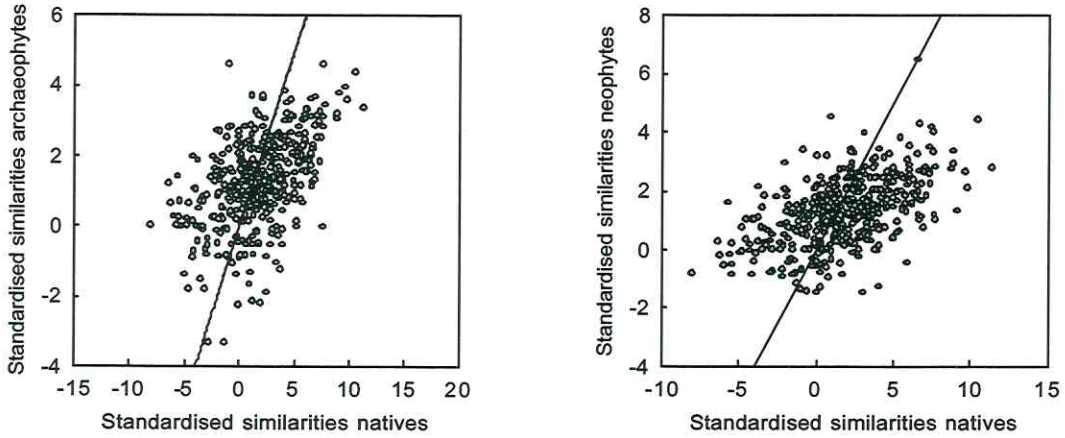

Figure 1. Pairwise comparisons of standardized similarities between aliens and natives: archaeophytes vs. natives (left) and neophytes vs. natives (right). Black lines are bisectors.

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BIOLFLOR - a database on biological and ecological traits of vascular plants in Germany

I. Kühn, S. Klotz

There is a long history of botanical research in Germany in general and by means of databases in particular [1-3]. Nevertheless, a database containing biological and ecological traits for the majority of species for entire Germany is still missing except for some internet offers (www.floraweb.de, planto.de). However, easily accessible data is crucial for the understanding of ecological patterns and processes as dispersal, distribution, succession, and species composition on local as well as global scale. To bridge this gap at least for Germany, the database BIOLFLOR [4] is being compiled at the Department for Community Ecology of the Centre for Environmental Research Leipzig-Halle.

This database handles more than 3600 native as well as established and common casual alien species. More than 1200 references where evaluated by ten collaborators to provide character states for about 50 characters of more than ten categories. The thematic coverage incorporates taxonomy, floral ecology, dispersal ecology, morphology, live strategies, genetics, chorology, ecology, agriculture, and details on naturalisation.

The data will be made available on a CD-ROM together with an easily manageable programme which is intuitively to use, similar to common internet browsers. There will be several features to compose complex queries across several information categories. Thus it is easy to search for plants with specific characters, but also listing a variety of characters for specific (groups of) plants. A description of the methods of compiling the different sets of data, the ways to validly use the data and a few introductory analyses will be presented in the book on BIOLFLOR. Book and CD are expected to be published early 2003 by the Federal Agency for Nature Conservation.

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Observations on Ligustrum lucidum (Oleaceae) behavior in natural, semi-natural and cultivated forests in Latin America

E. Martinez Carretero & F. Roig

The great majority of *Ligustrum* species were introduced in Europe between the XVIII and XIX centuries, from where they spread across temperate climates in different parts of the world as ornamental plants. In this work the behavior of *L. lucidum*, as naturalized in different environments from Argentina and Mexico, is analyzed. *L. sinense* and *L. lucidum* are the species of greater worldwide diffusion, the former being used especially as a living fence, and the later as urban tree lines. Both species have become naturalized in different environments due to their intense annual flowering and their good fructification and germination, processes that favor their naturalization *L. lucidum* tends to form shady, monospecific coppices of high coverage in flooding-prone soils, behaving as an edapho-hygrophytic species. The behavior of *L. lucidum* was analyzed in different environments where this naturalized species was observed:

1) natural of the marginal forest of the Río de la Plata and of the Mesopotamian area in Argentina (Punta Lara, El Destino Reserve and Otamendi Reserve); and lower subtropical forest (Aconquija, Tucumán);
2) semi-natural in Mexico D.F. and Villa Urquiza, Entre Ríos (Arg.),
3) cultivated forest in Mendoza (Arg.).

Phytosociological releves were made in all three types of forests, and floristic and phytosociological information was collected, all these data were gathered in the comparative table (Table 1). In all cases *L. lucidum* is the dominant species, displacing the native plants in natural forests. In semi-natural and cultivated forests man has contributed to modifying forest structure through gardening practices that facilitate the naturalization and dominance of this species. It dominates the upper layer, forming a quite continuous and semi-closed canopy that modifies the floristic composition of the invaded forest. *L. lucidum* nearly always forms dense coppices with coverage ranging between 25% and100%. In the three forest types, the *L. lucidum* forest constitutes neo-ecosystems that tend to monospecific forests. Granivorous birds are the primary agents of dispersal of this species, as has been verified for all three types of forests.

Table 1: Comparative releves in three forest types (1° layer: up to 12 m, 2° layer: 6-8 m, 3° layer: up to 2 m high)(partial table)

Forest type	Natural									Seminatural			Cultivated			
Ligustrum lucidum 1° layer	53	55	55	55	12	55	23	1	3	33	32	42	22	22	33	43
Ligustrum lucidum 2° layer	.	.	.	.	11	.	.	1	1	11	.	+2	21	32	.	+
Ligustrum lucidum 3° layer	.	44	.	.	.	+	.	1	1	.	+2	+2	22	+3	.	.
Terminalia australis	+	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.
Celtis tala	.	.	.	.	.	.	32	5	.	.	.	.	.	.	.	.
Salix humboldtiana	.	+	.	+	.	.	.	.	5	.	.	.	.	.	.	.
Taxodium mucronulatum	.	.	.	.	.	.	.	.	.	31	22	.	.	.	.	.
Manguifera indica	.	.	.	.	.	.	.	.	.	21	21	.	.	.	.	.
Cassia farnesiana	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Populus alba var. nivea	.	.	.	.	.	.	.	.	.	.	.	.	21	11	32	21
Acacia visco	.	.	.	.	.	.	.	.	.	.	.	.	11	+	.	.
Quillaga saponaria	.	.	.	.	.	.	.	.	.	.	.	.	.	11	.	.
Viburnum tinus	.	.	.	.	.	.	.	.	.	.	.	.	+2	11	.	.
Crataegus monogynea	.	.	.	.	.	.	.	.	.	.	.	.	+2	.	.	+

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Predicting the risk of aquatic invasions, challenges for management

D. Minchin

Exotic aquatic species continue to expand worldwide using a wide range of vectors (Table 1), some of these will be invasive and will result in some economic hardships, add to biodiversity and may have impacts on animal and human health. Managing the spread of some exotics will not be possible because they have already become established and will continue to expand as a result of secondary spread. Attempts to control exotic species from primary movements by shipping are thwarted by poor controls on exotic species spread by ballast water and its sediments and by hull fouling, the banning of the toxic organotin antifouling coatings and a general plan to improve water quality in Europe. These matters acting in tandem are almost certainly going to result in new species invasions.

There are ambiguous approaches to the management of exotic species spread within an expanding European Union. There will be increases in movements with fewer trade restrictions and consequently a spread of species from the Ponto-Caspian and Mediterranean Sea regions within Europe and vice-versa. Animal health management does isolate and manages serious diseases but those of lesser impact are not controlled and so are easily spread, unfortunately this includes undescribed diseases. The expanding trading network compounds these problems because it will encompass different biological provinces with inevitable changes to biodiversity and biogeography.

Apportioning relative risk of vectors is a difficult process as the introduced medium is usually deduced following an establishment of some years and in some cases may be wrongly assigned. Unless we have an understanding of the relative overall risk and the correct vectors we are unable to apportion the management of research appropriately. The classification of a species by life-mode instead of by taxonomic group would seem to be more appropriate and this should be related to the risk of its transfer by different vectors. Some indication of the inoculum size capable of colonizing is also important to assess.

We also need to consider Europe as a donor of species to other regions worldwide. In this way similar ventures with workers in other world regions will aid in identifying species with invasive potential.

Table 1: The main vectors transmitting aquatic species and their relative risk of being introduced.

Vector	Problem area	Current management	Risk
Ship ballast releases	One treatment method partly used	IMO Guidelines	High
Ship ballast sediments	Difficult to remove cysts etc.,		IMO
Guidelines	High		
Ship hull fouling	Banning TBT will promote invasions	None	High
Watersports	Increases of secondary spread	Public awareness	High
New transport routes	Trade favoured over ecological issues	Some regulation	High
Unapproved movements	Ill informed public, careless acts	Public awareness	High
Aquaria imports	Parasites, diseases & host releases	Some health controls	Mod.
Live food imports	Releases and biodiversity changes	Some regulation	Mod
Aquaculture	Importing, pests, parasites & diseases	ICES Code of Practice	Low
Angling bait imports	Unstudied	None	?___

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Nutritional ecology of the invasive pest species *Diabrotica virgifera virgifera* in Southern Europe

J. Moeser, S. Vidal

Almost 500 years after the arrival of maize in Europe its worst insect pest finally caught up. This invasive leafbeetle was first encountered in 1992 near Belgrade and is continuously spreading with a rate of up to 80 km per year ever since. In the U.S. it is considered to account for 1 billion US $ yield loss and costs for countermeasures [1]. Models forecast similar economic losses for Europe [2] . The insect primarily feeds on maize tissue [1], but weeds and other crops may act as alternative host plants and even facilitate the spreading. One aim of this study was to investigate the impact of the different European agro-ecosystems on the feeding ecology of *D. v. virgifera*. Maize fields in Europe present a more diverse landscape compared to the U.S. corn belt. The study presented here provides detailed information about the use of alternative food resources by the adult beetle, like weeds or other crops. Quantitative and qualitative pollen analyses of the gut content were performed. The diversity and abundance of pollen in the beetle gut was compared to the abundance of pollen resources found in the field. About 75% of the weed species found inside maize fields served as alternative pollen sources [3]. It was shown that beetles from weedy fields used significantly more alternative pollen resources than beetles from non-weedy fields. The pollen use was time dependent: As the availability of the principal pollen source (maize) decreased, the alternative sources (like *Amaranthus* sp., *Chenopodium* sp.) were used more frequently. Furthermore the pollen use was habitat dependent: beetles from weedy fields fed on a more diverse array of plants. Finally the pollen use was species dependent: Plant species which flowered late in the season (*Ambrosia* sp.) were used similarly by beetles from both field types. This pollen source was so attractive that beetles left non-weedy fields to feed and returned later for oviposition. While the insects have only limited access to alternative pollen sources in the area of origin, the European agroecosystems provide a large array of potential alternative food resources. Thus the feeding behaviour shows a higher plasticity than was expected from studies in the US. This adaptability in the use of various food resources facilitates the invasion of new areas as well as increases the area that can be invaded.

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Approaches for modeling invasive species: The Giant Hogweed (*H. mantegazzianum*)

N. Nehrbass, E. Winkler

Mechanisms and consequences of biological invasions have become a global issue. In many cases, when a species becomes invasive, means of control are desirable, because a large number of these species are agricultural pests or endangering native species by invading semi-/ natural ecosystems. For practice it is therefore of additional interest that research detects weak points of invasive species where control can be successfully applied. The GIANT ALIEN project was initiated by the European Union to develop sustainable management strategies for alien invasive plants in Europe.

Temporal dynamics play an important role when dealing with invasions. Due to limited resources it is almost impossible to gather empirical data over a time span that is appropriate to describe the relevant temporal scale. To overcome this limitation, models are used to capture key processes of ecological systems. The reliability of the prediction depends on the structure and complexity of the models used. Modeling approaches to describe and estimate plant population dynamics vary from very simple transition matrix models, without any consideration of space or stochasticity to highly complex simulations of spatial and temporal variance in the population and its environment. When trying to answer an ecological question with a model there is always a trade-off between complexity and the risk of not considering relevant detail. For modeling invasive species, in contrast to other population models, there are a number of conditions, which have to be explicitly considered: 1) It cannot be assumed that populations are at a stable stage. Demography might be determined by emigration and immigration events and population size might be too small to exclude demographic stochasticity. 2) Spatial dynamics: invasion refers to the occupancy of previously not used habitat. Therefore spatial aspects are inseparably part of the question. In the different model approaches incorporation of these considerations is not possible to the same extent. The most important question in modeling is therefore, which model approach is most suitable for the given question. The straightforward approach to clarify to which extend a matrix model might be satisfying, or whether a more complex individual-based model has to be used to be able to incorporate key processes determining invasive dynamics is to compare the different techniques. In order to answer this question, different model approaches will be compared and analyzed in view of their ability to help understanding the system in question. Since empirical data are not available at present, a virtual landscape will be created and plant communities in different states (stable, invading...) simulated. This virtual landscape will then be used to gather "empirical" data, e.g. data with the same accuracy and mimicking methods used in empirical research. The data set will be used to parameterize different models which then are analyzed to determine their ability to predict the fate of the population. Thus the most appropriate modeling approach will be identified.

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Spreading alien species - indicators for landuse change

A. Otte

With the signing of the Convention on Biological Diversity in 1992, Germany, as one of meanwhile 168 nations, has pledged itself to the conservation of biological diversity. Since virtually the entire land area in Germany is cultivated, this goal must be realised by sustainable land use over as large an area as possible. This especially applies to agriculturally used landscapes, whose biological diversity has been in decline for several decades, owing to overly intensive land use or land use abandonment. A crucial aspect of the total biodiversity of a landscape, and one discussed as a correlate thereof, is its floristic diversity. As with the closely associated diversity of phytocoenoses, floristic diversity in agricultural landscapes is essentially dependent on the former and current land use forms, intensities, patterns and dynamics present in these landscapes.

These phytocoenoses are resistant against alien species as long as those traditional landus-regimes are practised which have caused this special vegetation type. The biocoenotic success of an alien species depends on its property to change the structure, the composition and the functions of an ecosystem (components of biodiversity in the sense of NOSS 1990). Species who have these properties are able to form dominant stands e. g. Lupinus polyphyllus, Solidago canadensis, Heracleum mantegazzianum in marginal grassland-ecosystems. They indicate phases of landuse-de-intensification and abandonment and in this context they are indicators for processes which will lead to special forms of secondary succession on anthropogenous sites.

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Resistance to herbivory in the invasive plant *Impatiens glandulifera* ROYLE (Balsaminaceae)

B. Prots, M. Frenzel, S. Klotz

Evidence for alien plant species providing biotic resistance to native herbivores is controversial. The literature reviews reveal that: (1) introduced plants can attract a diverse assemblage of native herbivores and that (2) native herbivores can reduce introduced plant growth, seeds survival and production. However, the generality of these impacts is unclear, and evidence that herbivory actually limits or reduces introduced plant spread is not sufficient. The degree to which exotic plant species provide biotic resistance to native herbivores may be greatly determined by their functional and numerical responses. We studied the highly invasive plant Himalayan Balsam *Impatiens glandulifera* as a model for short-lived plants (annuals) that rely on current seed production for regeneration. It may be most vulnerable to herbivory that reduces seed production. Contrary, this plant may gain the greatest advantage from escaping their specialist enemies in recipient communities.

The goal of the study was to evaluate, understand and simulate the impact of herbivory on *I.glandulifera*. The study objectives are: (1) to identify the impact of herbivores on highly invasive *I.glandulifera* due to habitat differences and soil type; (2) to check if a local population of this species has lower losses to herbivores compared with a distant population; (3) to simulate a rise of herbivory on the growth rate of *I.glandulifera*. The methodological approach includes three experiments: (1) insect exclusion experiment; (2) palatability test; (3) clipping experiment. The Burgholz forest massif and the riverside of the Weisse Elster river channels (surroundings of Halle city, Germany) have been chosen as a field study area.

The data received demonstrate that *I.glandulifera* is highly resistant to herbivory. No significant differences were found between the insecticidal and non-insecticidal treatments for above ground dry biomass, specific leaf area, leaf thickness, leaf greenness, time of first flowering and number of flowers/capsules for the local (Halle city, Germany) and the distant (Umea city, Sweden) populations. Only the impact of herbivory has been close to marginal significant values within the low-middle shady forest habitats. The palatability test showed no difference between the populations and treatments as well. Even more, the plant could partly compensate the loss of leaf parts through the rise of photosynthetic activity around the damaged area. The chlorophyll content index was significantly higher within damaged parts of leaves compare to undamaged parts. The high resistance to herbivory may be explained due to (1) the absence of adapted herbivores and (2) compensation and internal trade-offs abilities in allocation of resources. The clipping experiment showed asymmetric changes for vegetative and reproductive traits. The interactions of these traits are decreasing with a rise of simulated defoliation. The lost of significance of these interactions was monitored after 25% defoliation treatment. The phenotypic plasticity could be an important factor not only to survive, but to keep a high fecundity rate under a high pressure of herbivores. The high resistance to herbivory and high invasion abilities of *I.glandulifera* may lead to a decrease of biodiversity of native herbivores within invaded sites and may have (not recognised yet) serious ecological and conservation consequences.

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Ecology of invasion of *Heracleum mantegazzianum* in the Czech Republic: information about a European project and preliminary results

P. Pyšek, J. Pergl, I. Koukolikova, L. Moravcova, L. Krinke

Various aspects of the ecology of invasion by *Heracleum mantegazzianum* are studied in the Slavkovský les protected landscape area, 180 km W of Prague, within the frame of the 5 FW European project "Giant alien" (see http://www.flec.kvl.dk/giant-alien). *Heracleum mantegazzianum* is present in the region since 1862 when it was introduced as a garden ornamental; at present, vast areas are infested. Eleven localities were selected at the territory of about 400 km^2, with respect to the land use, altitude and geography, to provide a representative sample of variation in the study area. Background information for each locality will be obtained in the course of the project, including measures of spatial isolation, character of invaded vegetation, and soil fertility. From 2002, the species population dynamics is studied in permanent plots where all individuals are repeatedly recorded from the beginning of the growing period and their phenological and morphological status is evaluated. Seedling dynamics and self thinning is also studied by using permanent fixed frames. A detailed study of phenological pattern was conducted, using 11 distinct phenological stages to describe phenological statuts within each umbell of all sampled plants. Significant differences were found in the germination pattern of seeds, depending on (a) individual plant, and (b) their position on the plant, and (c) within an umbell. Seasonal dynamics of seed bank was studied to evaluate its possible duration in the soil. Regeneration ability will be evaluated by removing vegetative and generative parts at different times of the year. The aim of the project is to provide a complete picture of the species life cycle in invaded habitats. Preliminary results are presented, and future research priorities are outlined.

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Integrated assessment of biological invasions

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Societal actors have to decide how to handle biological invasions. Therefore, the impact of such invasions on the ecological, social and economic environment of humans has to be assessed. Economists use different methods to assess the consequences of biological invasions. The more classical approach is to attempt to calculate the Total Economic Value (TEV). This value covers not only costs of agriculture, forestry and other economic sectors, but also, for example, monetarised expressions of individual concern about endangerment of species. By comparing the TEV of different measures of control or prevention, economists are able to propose efficient measures which further most the well-being of the concerned individuals.

Critics arise, though, against this approach for several reasons: first, monetarisation may not yield a good measure of well-being, second, there are doubts concerning the assumed overall substitutability of all different values linked to biological invasions and their consequences, third, irreversibility and uncertainty are difficult to handle in this approach, and finally, skepticism is expressed about the practical utility of a classical cost-benefit-analysis for many decision processes. It will be examined whether some forms of integrated assessment can overcome these difficulties without losing theoretical foundations as well as practical applicability. The embedding of a multi-dimensional evaluation method into a well structured decision process might be a way towards a decision aid that – without losing the societal force of economic arguments – does more justice to expert knowledge from natural science and to non-economical values of individuals.

Firstly, such an approach needs less transformation of expert knowledge into citizens' values by avoiding overall monetarisation. Secondly, it gives the possibility to use explicit thresholds, partially due to irreversibility, in distinct fields of impacts hereby reducing overall substitutability. Thirdly, different forms of uncertainty, i.e. uncertainty about the relative importance of the different dimensions, uncertainty about the prognostics of the impacts, and uncertainty about the decision actors to be considered, can be taken into account separately. Finally, this decision aid process may be designed transparent for outsiders and open to changes occurring during the process, hereby adapting to the evolving needs of the decision actors. Changes might concern the impact dimensions, the different alternatives, the participating decision actors and the relevant alternatives for preventing or fighting the invasion.

In order to compare different economic assessment methods of biological invasions, mathematical rigor and axiomatic consistency will be balanced again practical usability and openness and the full use of interdisciplinary assessments in the decision process.

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Anemone blanda (SCHOTT & KOTSCHY) on graveyards at Stuttgart

M. Richter

Since many years Grecian Windflower is an escapee of gardening culture at Stuttgart. Whereas the specimen is widespread at Zürich [1] about its existence in the region Mittlerer Neckar nothing has been reported. In mountainous regions of Turkey where it is growing as a wild plant, tubers of this specimen are digged up and transported to Germany and other western european countries. There they are sold and planted on graveyards and in private gardens.
The study serves to document the spread of *Anemone blanda* at Stuttgart and to detect reasons for its occurance and the potential for its further spread and persistence.
In the blossom period of Grecian Windflower (in April 2002) twelve graveyards with a total area of 70 hectar have been controlled by walking in order to find planted and spontaneously growing specimen. Within a total area of 50km^2 in and around the city center of Stuttgart all graveyards are research area.

On 75% of the graveyards planted specimen have been detected, on eight out of twelve graveyards (66%) *Anemone blanda* already occurs spontaneously. Considering all graveyards together it is planted at 26 places (as ornamental plant on graves) and grows wild at 14 places with a total number of about 150 (-200) ramets.
On 3 graveyards the specimen was detected growing wild without direct neighbourhood of planted ones. There is a correlation between the number of places per graveyard, where it is planted and the number of wild growing ramets (see fig. 1).

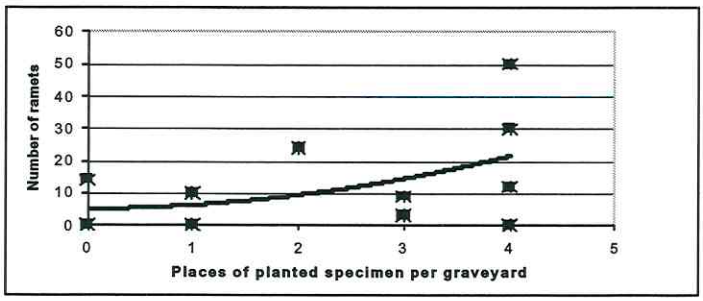

Fig.1: Number of places with planted specimen per graveyard versus number of spontaneously growing ramets

Starting from planted specimen Grecian Windflower in most cases spreads vegetatively but in some places generatively too. Presumably as a consequence of cultivating the graves tubers are brought into bordering zones of the graveyards were the specimen can be found too.
In the research area *Anemone blanda* has a great potential to grow as a garden escapee but in most cases it is locally restricted to immediate neighbourhood of planted specimen. There are some reasons that spontaneously growing Grecian Windflower will persist and spread even if only in small populations.

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Annotated Bibliography on Transplantations and Transfers of Aquatic Organisms and their Implications on Aquaculture and Ecosystems

H. Rosenthal

Collection of references for this bibliography started in 1987. he present version contains about 15 800 references from reviewed journals, textbooks, conferences, governmental reports, leaflets and newsletters of societies. Case histories reported therein date back to about 1849. Many of the references are in languages other than english (About 3 000 entries), most of which do not contain an english (or french) abstract.

Abstracts are provided for about 67% of the publications. For about one third of the entries the original paper has not been seen. The accuracy for these entry is therefore not guaranteed. Information extracted from the references is structured in view of the ICES Code of Practice on Transfers and Introductions of non-indigenous species in order to provide users of the CODE with the required background information. Because of the varying quality of the reported information, abstracts are not structured in a consistant manner. Brief information is provided, including common and scientific names of the species introduced (and/or affected), date of transfer, origin of shipment, purpose of transfer and the result of the introduction.

The Bibliography is in two parts: (a) an introductory chapter, summarizing well-documented case histories (e.g. location of first release, further spread/range extension; some geographic map;. Manual sheets explaining search profiles and data extraction options; software information etc); (b) the Bibliography proper with four principle screens (layouts). The first one (master-screen) lists in separate fields a serial number, the names of authors, year of publication, titel and source of reference, abstract field, and index fields: **species index** (common/scientific names), geographic index (down to location whenever possible) and a general index (eg. 1st record, alien, cryptic, affected, endangered, extinct, ecosystem change; the thesaurus contains over 250 terms).

The abstract field contains information relevant to the introduction and/or its consequences. Each citation follows the format: Serial number, Author(s)- Date- Title-, source of publication (Volume, Issue, pages) At the end the original language of the publication is indicated. The second layout contains specific information on the language and translations of papers. The third layout contains an expanded species index (hierarchy of systematic categories from Phylum to genera and common names), and the fourth a geographic index (breakdown to locality whenever possible). The geographic categories refer to political bounderies using entities that were valid at the date of publication (e.g. USSR until 1989, Russia and other States of the former Sovjet Union from 1990 onward and so on).

It is planned to provide this bibliography in electronic form (CD-ROM and on the world wide web) with linkages to FishBase, CoralBase and other databanks dealing with introductions (e.g. Mediterranean; IUCN)

A printed version of the Bibliography will be available in a limited number of copies covering a total number of about 5 000 pages, excluding species and geographic index.

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The effects of herbivory and competition on *Senecio inaequidens* DC. (Asteraceae), an invasive alien plant

C. Scherber

Narrow-Leaved Ragwort (*Senecio inaequidens* DC.) belongs to a group of closely related species within the genus *Senecio* that are currently invading Europe, Australia and parts of South America. Many *Senecio* species produce pyrrolizidine alkaloids that can be toxic especially to vertebrate herbivores such as cattle or goats (e.g. [1]).
Whilst *Senecio madagascariensis* Poir. is already considered a 'problem plant' (sensu [2]) invading pasturelands throughout Australia [3], little is known about the potential habitats that might be suitable for its close relative, *Senecio inaequidens*. Whether or not *S.inaequidens* is capable of invading grassland ecosystems is a question that has not been answered yet.
For this reason, a series of greenhouse and field experiments has been carried out using transplanted *Senecio inaequidens* seedlings in order to find out about the effects of herbivory and interspecific plant competition on growth and reproduction of *Senecio inaequidens*. Both herbivores and competing plant species were of European origin. The specialist insect herbivores used had previously been recorded from *Senecio inaequidens* [4]. Experimental designs used were either factorial (greenhouses) or split-plot (field experiments).
Growth, survival and fecundity of *S.inaequidens* was significantly affected by the presence or absence of a competing plant species (*Festuca rubra* L., Poaceae) in greenhouse experiments, and by the presence or absence of a generalist vertebrate herbivore (*Oryctolagus cuniculus* L., Mammalia: Lagomorpha) in field experiments. Specialist insect herbivores showed different effects. Whereas adults of *Longitarsus jacobaeae* Walters (Coleoptera: Chrysomelidae) were feeding and reproducing on *Senecio inaequidens* in free-choice trials in the field, larvae of *Tyria jacobaeae* L. (Lepidoptera: Arctiidae) showed strong specificity to their host plant, *Senecio jacobaea* L., in laboratory and field free-choice and no-choice experiments. All five larval instars of *Tyria* were only feeding on *S. inaequidens* when directly raised on this species from the egg stage.
It can be concluded that both generalist vertebrate herbivores and plant competition may have strong effects on growth, survival and reproduction of *S. inaequidens*. *Longitarsus jacobaeae* is able to perform host-switching and to feed and reproduce on *S. inaequidens*. Some of these results may be in contrast to predictions of the enemy release hypothesis (reviewed in [5]), suggesting that resident specialist insect herbivores can reduce the probability of invasion of an alien plant.

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The influence of the length of vegetation period upon the grade of naturalization of different neophytic *Amaranthus* species

U. Schmitz

In a culture experiment seeds of three naturalized and two ephemeral *Amaranthus* species were sown in weekly intervals from mid of June till mid of September. Shoot length and biomass of all five species decreased distinctly the later they germinated. The two naturalized and abundant species *A. retroflexus* and *A. powellii* were still able to produce mature seeds on dwarf plants, that had germinated until August, whereas the naturalized but rarer *A. albus* had to germinate until end of July to produce mature seeds (fig. 1). The two ephemeral species *A. cruentus* and *A. spinosus* had to germinate even earlier in the year to be still able to produce mature seeds. The different characteristics of the examined species, which correspond with their different status of naturalization, show the species specific least necessary time interval for the development period. This is limited on the riversides from the retreat of the summer flood on the one hand and the beginning of the cold season on the other hand. This time interval is the decisive factor for the survival of the annual river bank vegetation, in particular considering the recent increase of high water levels during summertime.

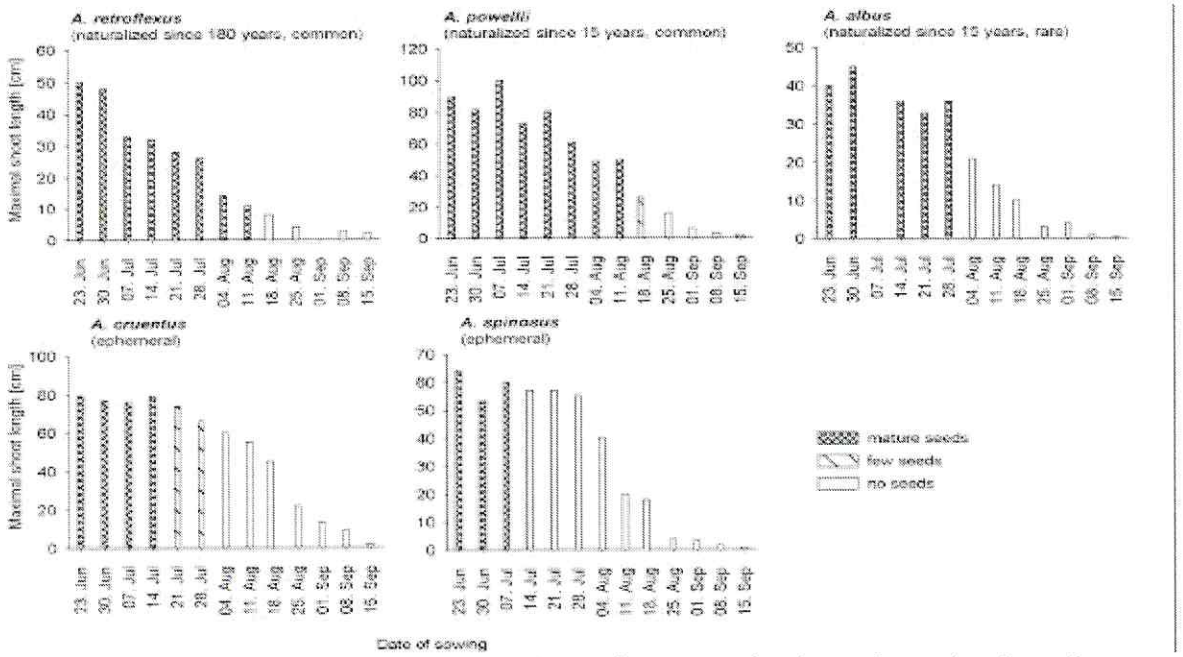

Fig. 1: Seed production and shoot length depending upon the date of germination of *Amaranthus* species of different grade of naturalization.

A prolongation of the vegetation period by climate warming could thus help *A. cruentus* and similar ephemeral species to become also naturalized on the riversides of Central European floodplains.

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Analysis of Environmental Risks of Alien Species in the framework of the International Plant Protection Convention

G. Schrader, J.-G. Unger

The revised International Plant Protection Convention (IPPC 1997) provides for rights and obligations to identify plant pests, assessing their risks and determining the strength of measures to be applied against their introduction and spread. The IPPC's applications are associated with international trade but not limited in this aspect. In the framework of the IPPC, international standards for phytosanitary measures (ISPMs) are developed, which are acknowledged by the WTO via the Sanitary and Phytosanitary Agreement. According to the mandate and definitions of the IPPC, the scope of the Convention applies to the protection not only of cultivated plants but also of wild flora, resulting in an important contribution to the conservation of biological diversity. In its decision VI/23, the 6th Conference of the Parties to the Convention on Biological Diversity (CBD) acknowledges the contribution of the IPPC to the implementation of Article 8 h of the CBD, and recommends its Parties and other governments consider ratifying the revised IPPC. The analysis of environmental risks of alien species relevant for plants can in principle be provided by the IPPC standard "Pest Risk Analysis (PRA) for Quarantine Pests". Quarantine pests are in most cases considered to be invasive alien species relevant for plants. In the sector "plants" PRA aims at minimising phytosanitary risks and is the process to determine if an organism is hazardous to plants or plant products within an identified area, if the organism is a quarantine pest, and if it should be regulated. Objectives of the standard are: identification of the pest and its pathways, pest categorisation, assessment of probability of introduction and spread, assessment of potential economic consequences including environmental impacts, and risk management options. The PRA standard focuses especially on direct pests (pathogens, insects, nematodes etc.). Although it considers the cases of plant invasiveness and the environmental effects of bioinvasion in principle, it needs more detailed guidance regarding effects of plant pests on uncultivated/unmanaged plant species, habitats and ecosystems within the PRA area. Therefore, a supplement to the standard is under development, and an advanced version is already at hand. The supplement is not a stand-alone document but should only be used in conjunction with ISPM No. 11. It considers for example reduction of keystone species; reduction of species that are major components of ecosystems (in terms of abundance or size), and of endangered species (including effects below species level where there is evidence of such effects being significant); significant reduction, displacement or elimination of other native plant species. The standard and its supplement are useful tools to prevent the introduction of invasive alien species relevant for plants and to select adequate control strategies if an introduction could not be prevented.

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American slipper limpet *Crepidula fornicata* (L.) limited by winter mortality in the northern Wadden Sea

D.W. Thieltges, M. Strasser

In Europe, the introduced slipper-limpet (*Crepidula fornicata* (L.) ranges from the Mediterranean to southern Norway. In the central part of its distributional range (France, GB, Netherlands) it may become superabundant with up to several thousand ind/m^2. In the northern Wadden Sea mean abundance remains below 100 ind/m^2. To test what limits the abundance of *Crepidula* there, four factors known to influence the population dynamics of marine benthic invertebrates were investigated: 1) predation, 2) parasitism, 3) low water temperatures (restrictions of specific stages in the life cycle) and 4) severe winters (winter mortality). The study was conducted in 2000 and 2001 near the island of Sylt in the northern Wadden Sea and included an experimental and observational approach. Predation, parasitism and life cycle restrictions had no or little limiting effect on *Crepidula* in the basin, while high winter mortality of up to 90% is supposed to account for the lower abundance of *Crepidula* in the study area compared to populations in central Europe as well as for the northern limit of the species' distributional range. In the future, milder winters as a corollary of climate change are expected to increase abundance in northern populations combined with a northward shift of the species' distributional range. Correspondingly, the wide array of ecological and economical effects already known especially from French coats may also affect the northern Wadden Sea.

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Wood Packaging Material as a Pathway for Invasive Alien Species and Internationally Harmonized Measures against those Species

J.-G. Unger, T. Schröder

Organisms like insects, nematodes, bacteria or fungi are associated with trees or shrubs worldwide, many of them are still limited to a single continent or ecological region. The introduction of such species into new areas caused severe damage to forests and/or single tree species in the past. Dutch elm disease introduced from North America eradicated the European elm from many areas. The nematode *Bursaphelenchus xylophilus* naturally occurring only in North America has been introduced into Japan and also China decades ago. About 16 Mio pine trees were killed in China 1998 and about 1 Mio m^3 is the annual loss in Japan. Recently this nematode has been introduced into Europe/Portugal, where the Plant Protection Service runs an eradication campaign for about 1.7 Mio EUR per year. This nematode as other invasive alien pests of trees like the organisms causing Chestnut blight, Dutch elm disease and Asian longhorned beetle *(Anoplophora glabripennis)* has probably been introduced into Europe by wood packaging material as repeated findings of the nematode by the Plant Protection Services of the EU Countries in such material from the USA and China indicates. The US Plant Health Inspection Service (APHIS) performed an in depth pest risk analysis based on 1204 interceptions (3 years) and identified about 156 Taxa that may be introduced by this pathway and that could pose a serious threat to their forests.

Several countries already have put in place phytosanitary requirements for imported wood packaging material, however such individual requirements are difficult to implement and monitor because the amount and diversity of products packed in wood boxes or on pallets is very high. As the risks of the introduction and spread of such species are similar worldwide the IPPC (International Plant Protection Convention) developed and adopted in March 2002 an International Standard on Phytosanitary Measures (ISPM 15) in order to help countries to establish protective measures and to harmonize them [http://www.ippc.int]. This standard provides a list of approved measures, that should be accepted worldwide. Heat-treatment (56°C/30min core temperature) and fumigation are approved up to now. A list of other "candidate" treatments is also part of the standard, however efficacy data are needed urgently. Producers meeting the provisions of the standard are authorized by the National Plant Protection Services to mark the material accordingly. The harmonized mark with a logo confirms the application of the treatment and allows easier and faster checks on import. It is expected that this standard will be used and required in particular for intercontinental trade worldwide within a few years. Out of 17 International Phytosanitary Standards against the introduction and spread of invasive alien pests of plants this standard is the first that lays down specific measures for a specific pathway.

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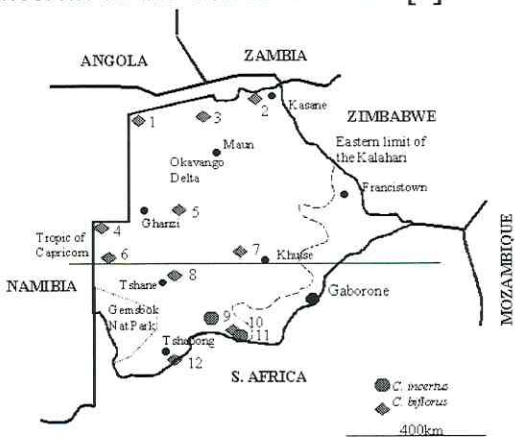
Alien or Sahelian? Profile of an alien invasive grass species in the Kalahari, Botswana, Southern Africa.

E.M Veenendaal, W.H. Van Der Putten, J. Bond, G.A. Kowalchuk, B.R. Sekhute, T. Mubyana & A. Gray

This paper reports findings from a three year study of plant ecology and genetics, and plant- microbiota interactions of an alien invasive grass species *Cenchrus biflorus* Rox in the Central Southern Kalahari (Figure 1) [1,2]. At least three genotypes of the apomict *C. biflorus* have invaded Southern Africa in historic times. Two of these have reached Botswana, but only one is responsible for the current invasion.

Figure 1. Distribution of an alien invasive grass species *Cenchrus Biflorus* and a related species *Cenchrus incertus* in the Central Kalahari [2].



C. biflorus has a number of distinct plant traits. A large seed size (2,8 mg) facillitates a strong emergence from greater depth in sandy Kalahari soils. In fertile conditions, the species produces a large seed rain (> 6000 seeds m^{-2}). The species needs open disturbed areas for establishment, while soil fertility may have an added effect. In the field mutualist AM fungi rapidly infect young seedlings of *C. biflorus*, but preliminary molecular analysis reveals that these AM fungi associations may be less diverse than in *Eragrostis lehmaniana* an indigenous perennial grass species [3]. Indigenous fungal pathogens had in some experiments (but not in all) a stronger effect on the growth of indigenous grass species than on *C. biflorus*. These results suggest that as an invader, *C. biflorus* is less affected by such pathogens.
In conclusion, the ecology of C. *Biflorus* favours its dispersal in areas that are intensively grazed such as cattle areas around artificial watering points in the Kalahari and make it there a successful invader.

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Lupine invasion on poor meadows

U. Visser, H. Volz, K. Johst, E. Winkler, A. Otte, C. Wissel

Lupinus polyphyllus is a plant native to northwest American mountain habitats. For about 100 years it is spreading rapidly in central Europe. The neophyte threatens the diversity of rare specialized communities on poor meadows no longer undergoing traditional land use.
Establishment and dispersal events are crucial factors in the invasion process. However, dispersal and establishment rates are often rare events and as such difficult to estimate from field data. Therefore, we investigated the invasion process by means of a spatially explicit simulation model based on population biological field data. The model includes hypothetical long distance seed dispersal.

With a pattern oriented approach, on the basis of vegetation maps of a lupine stand in the nature preserve „Lange Rhön", we could calibrate the proportion of long distance dispersal and the field establishment rates of *Lupinus polyphyllus* . Thus, minimal invasion speed could be estimated.

However, the field data are statistically too weak for a significant fit of the long distance dispersal function. This is a common problem in estimating invasion speed. We give recommendations for planning field data collection on long distance dispersal.

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Success in plant invasions: How do casuals differ from established species?

M. von der Lippe, I. Kowarik, & M. Schnittler

The question which species will become a successful invader or which will fail is one of the central topics in invasion biology. Studies on this question are often faced by two kinds of problems: the dimension of success is not clearly defined and the used data often result from a pre-selection of more or less successful species because information on obviously unsuccessful species are often not available. The main idea of this paper is to compare bio-geographical and biological features of established and not established species. This analysis refers to a most recent list of plant species alien to the German flora that includes about 400 established and 600 casual species.

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Fauna comparison in decaying oak wood - native versus foreign species

A. Willburger, V. Nicolai

Coarse pieces of wood from the native oak species *Quercus petraea* (Matt.) Liebl. and of the foreign oak species *Q. rubra* L. were sampled in the winter of 2001 in the Grunewald forest in Berlin, Germany and moved into the laboratory. The age of both tree species was 50 – 60 years and the wood was cut one year prior to analysis. The wood pieces were put into separate containers from which the arthropods were collected. The containers were in a
22 ± 2°C temperature controlled room with automatic lights. The light to dark cycle was 14:10h. The emerged arthropods were collected twice a week for a total of 266 days. All arthropods were counted family based and beetles were determined by species. For the results to be comparable, the amount of wood for *Q. petraea* and *Q. rubra* was of similar size: *Q. petraea* 83,885 cm^3 and *Q. rubra* 88,177 cm^3. The *Q. petraea* wood arthropod harvest was 2,481 and the *Q. rubra* wood arthropod harvest was 2,729. In descending order, the most abundant fauna collected from both woods was Collembola, Psocoptera, Diptera, Coleoptera, Acarina and Hymenoptera. In turn, of the Coleoptera to have hatched from the wood of both species, the highest numbers were in the families of Scolytidae, Laemophloeidae, Buprestidae and Cerambycidae. On species level the Scolytidae *Scolytus intricatus*, *Crypturgus cinereus*, *Taphrorychus bicolor,* the Laemophloeidae *Cryptolestes duplicatus,* the Buprestidae *Agrilus laticornis,* and the Cerambycidae *Xylotrechus antilope* and *Phyrrhidium sanguineum* were found in high numbers (n = 315 for *Q. petraea*; n = 405 for *Q. rubra*). The diversity of species was found to be higher on native wood, which is also in accordance to the literature. Moreover, a small and similar variety of arthropods were found in equal high numbers in both oak species. Some of these beetles are known as pest in Germany, e.g. *Scolytus intricatus* and *Agrilus laticornis*. These species are able to reproduce to a high amount in the foreign wood. Low numbers of other arthropods, e.g. predators were found in the foreign wood. This in turn might result in a greater reproduction of the pests, due to low competition. Their status as a pest species may increase. Attention should be paid whether they are able to go back to the native oak after having reproduced on the foreign oaks or if the competition from the accompanying arthropods and predators in the native oak will keep their numbers down.

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