From basic taxonomic data towards a synthesis in plant invasion ecology

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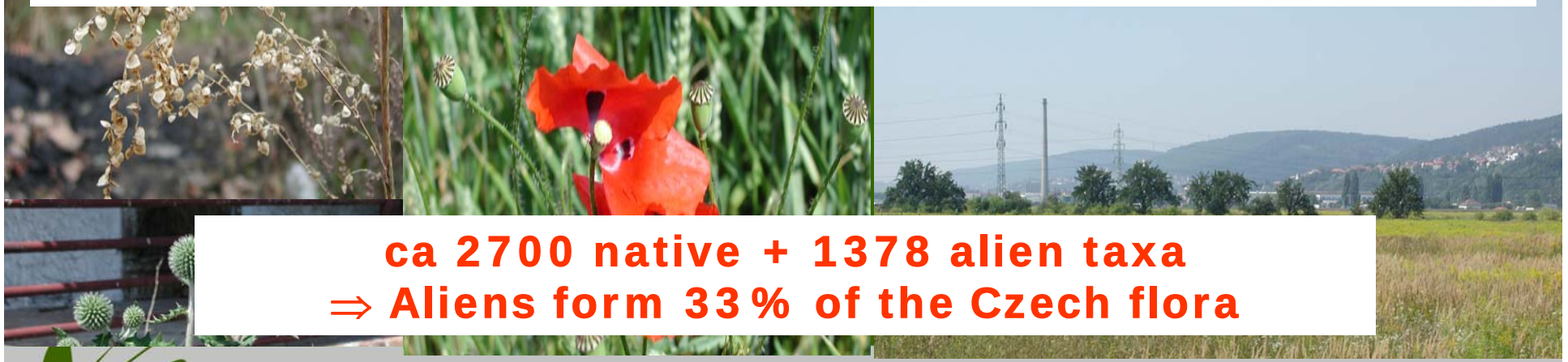
Alien flora of the Czech Republic

Table 2. – Composition of the Czech alien flora. Number of taxa in particular categories of immigration time and invasive status (see text for definitions). Hybrids are included (for their numbers see Table 4). Distribution of archaeophytes and neophytes with respect to invasive status are significantly different (G-test on contingency tables, $G = 379.04$, $df = 2$, $P < 0.001$).

	Casual	Naturalized	Invasive	Total
Archaeophytes	74	237	21	332
Neophytes	817	160	69	1046
Aliens total	891	397	90	1378



ca 2700 native + 1378 alien taxa

⇒ Aliens form 33 % of the Czech flora

Pyšek P., Sádlo J. & Mandák B. 2002. Catalogue of alien plants of the Czech Republic. Preslia 74: 97–186.

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Alien flora of the Czech Republic in Flora Europaea

Table. 1. Comparison of data on naturalized species given by Flora Europaea (TUTIN et al. 1964–1980) for the territory of former Czechoslovakia with their present status (based on data in PYŠEK et al. 2002 and GOJDIČOVÁ et al. 2002).

Group	Number of species
Total reported in Flora Europaea for the Czech Republic	**332**
Not relevant for the Czech Republic (occurring only in Slovakia)	8
Planted, not escaping from cultivation	11
Not relevant for the Czech Republic (native, alien only in Slovakia)	1
Relevant for the Czech Republic	**312**
Considered native	7
Erroneous records (not occurring in the Czech Republic)	15
Correctly reported as aliens	**290**
Naturalized in the Czech Republic (status correct in FE)	118
Casual in the Czech Republic but naturalized in Slovakia (status correct in FE)	11
Casuals in the Czech Republic (status incorrect in FE)	161

- **For 55 % of alien species in the Czech Republic, Flora Europaea erroneously states that they are naturalized in this country**
- **111 naturalized aliens in the Czech Republic (48.5 %) are not reported in Flora Europaea for this country**

Pyšek P. (2003) How reliable are data on alien species in Flora Europaea? Flora 198: 499–507.

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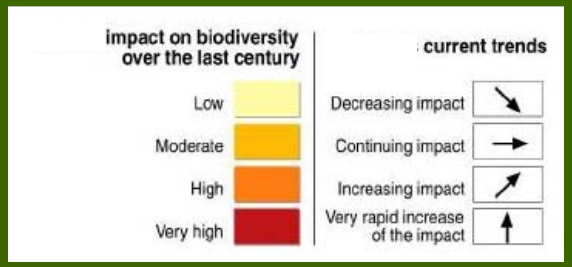
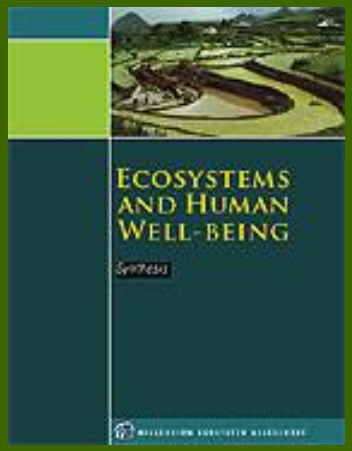
Biological invasions are a problem of global significance





Millennium Ecosystem Assessment: Ecosystems and Human Well-being – Synthesis 2005

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Invasions are global … How does it relate to taxonomy?

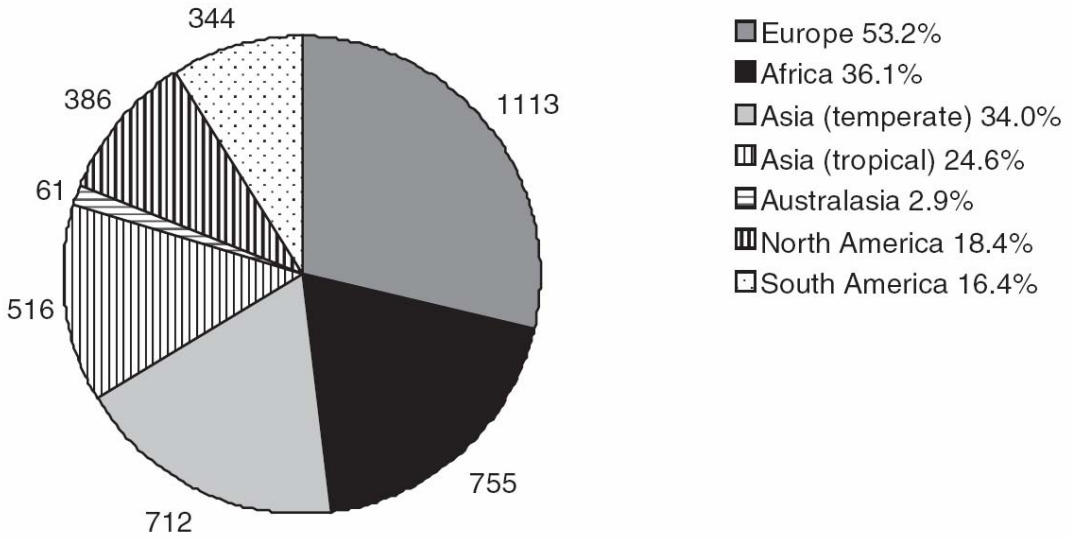

Fig. 5. – Donor regions of the alien flora of Europe. Based on 2271 naturalized aliens for which the region of origin was classified, including aliens with region of origin in Europe but alien to other parts of the continent. Species numbers are given in the pie-chart (those with native distribution in more than one continent were assigned to each of the continents), percentage contributions of regions to the total number of species follow their names.

In terms of taxonomy, global phenomenon has local consequences …

Lambdon P. W., Pyšek P., Basnou C. et al. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. Preslia 80: 101–149.

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Global risk from invasions by South African plants

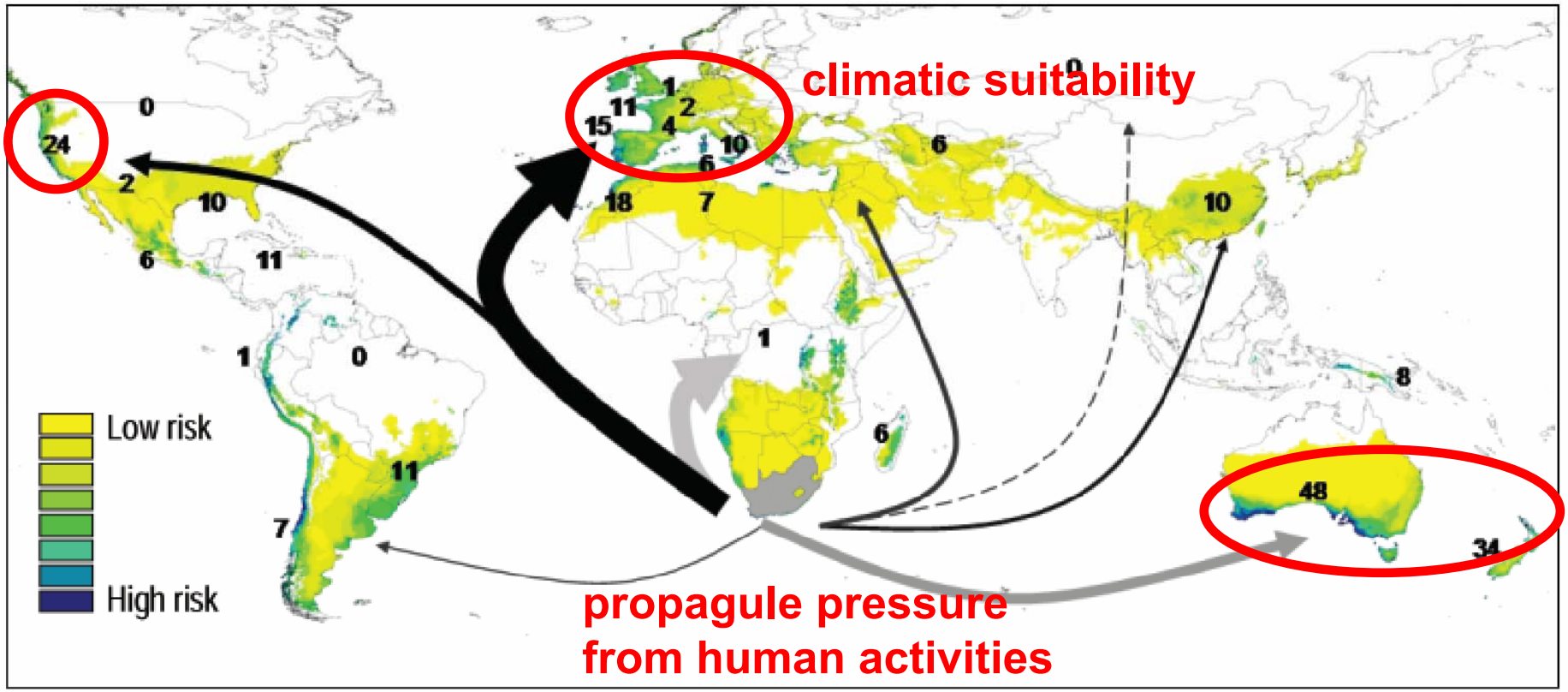

Fig. ... te
the ... ng
prop ... s.

number of South African species naturalized elsewhere can be explained by climatic suitability and propagule pressure (explaining 79% of variation in the data)

Thuiller W., Richardson D. M., Pyšek P. et al. 2005. Niche-based modelling as a tool for predicting the risk of alien plant invasions at a global scale. Global Change Biology 11: 2234–2250.

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1st Reason Why Taxonomy Is Important for Invasion Ecology

All ecology depends on taxonomy – you are telling us what our species are ☺

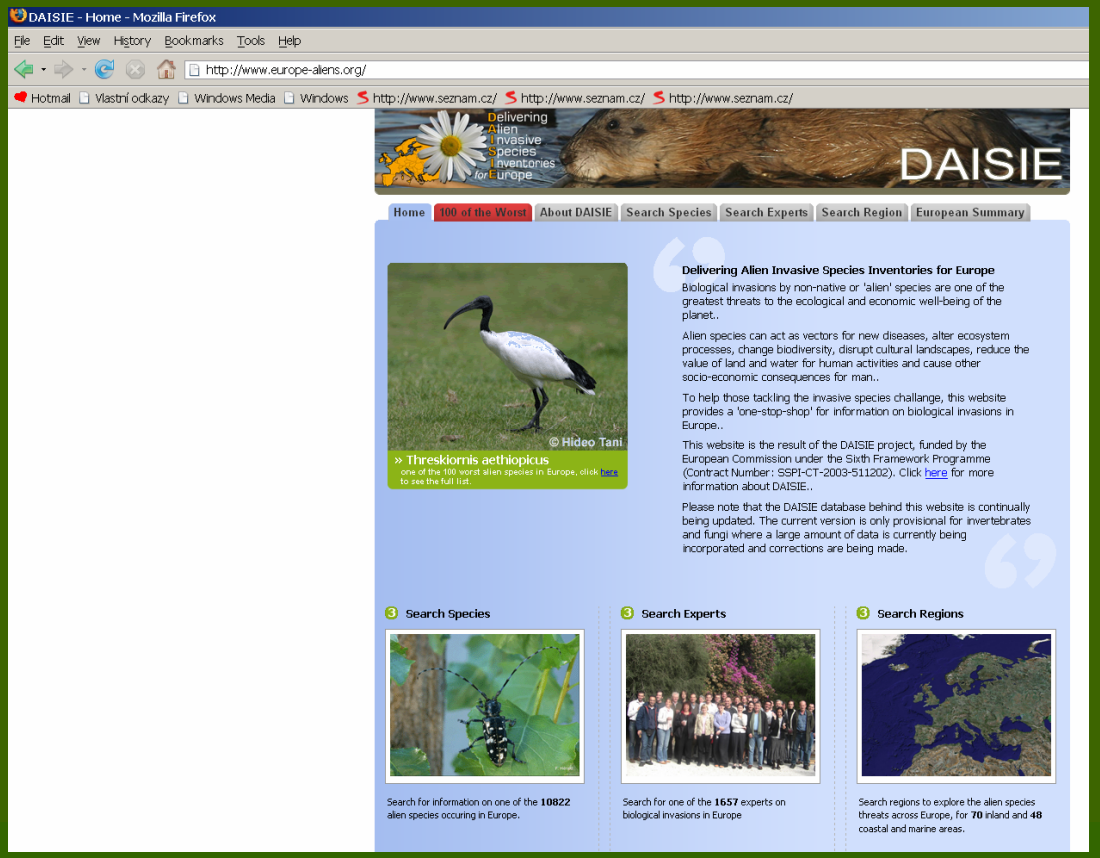
DAISIE: Delivering Alien Species Inventories for Europe

6th Framework Programme of the European Union

STREP (Specific Targeted Research Proposal)

Duration: 2005-2008

Coordinator: NERC Centre for Ecology & Hydrology, UK: Phil Hulme, David Roy



Delivering Alien Invasive Species Inventories for Europe

www.europe-aliens.org

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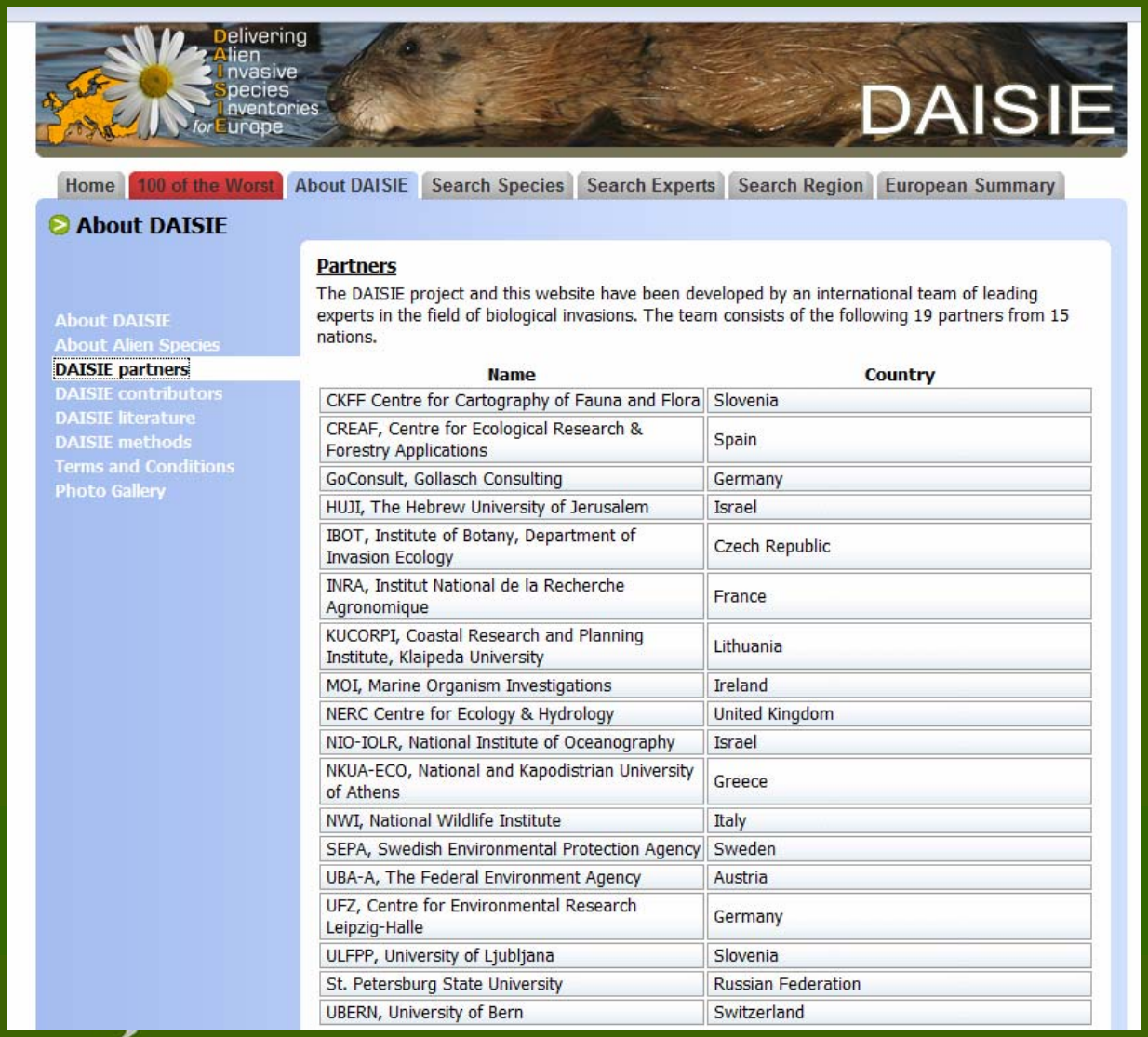
DAISIE: Partners



Name	Country
CKFF Centre for Cartography of Fauna and Flora	Slovenia
CREAF, Centre for Ecological Research & Forestry Applications	Spain
GoConsult, Gollasch Consulting	Germany
HUJI, The Hebrew University of Jerusalem	Israel
IBOT, Institute of Botany, Department of Invasion Ecology	Czech Republic
INRA, Institut National de la Recherche Agronomique	France
KUCORPI, Coastal Research and Planning Institute, Klaipeda University	Lithuania
MOI, Marine Organism Investigations	Ireland
NERC Centre for Ecology & Hydrology	United Kingdom
NIO-IOLR, National Institute of Oceanography	Israel
NKUA-ECO, National and Kapodistrian University of Athens	Greece
NWI, National Wildlife Institute	Italy
SEPA, Swedish Environmental Protection Agency	Sweden
UBA-A, The Federal Environment Agency	Austria
UFZ, Centre for Environmental Research Leipzig-Halle	Germany
ULFPP, University of Ljubljana	Slovenia
St. Petersburg State University	Russian Federation
UBERN, University of Bern	Switzerland

18 partners

15 countries:

Austria
Czech Republic
France
Germany
Greece
Ireland
Israel
Italy
Lithuania
Russian Federation
Slovenia
Spain
Sweden
Switzerland
United Kingdom

DAISIE: Objectives

1. **To create an inventory of invasive species that threaten European terrestrial, fresh-water and marine environments**

2. **To structure the inventory to provide the basis for prevention and control of biological invasions through the understanding of the environmental, social, economic and other factors involved**

3. **To assess and summarise the ecological, economic and health risks and impacts of the most widespread and/or noxious invasive species**

4. **To use distribution data and the experiences of the individual Member States as a framework for considering indicators for early warning**

Delivering Alien Invasive Species Inventories for Europe

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DAISIE: European Alien Species Database

1.To create an inventory of invasive species that threaten European terrestrial, fresh-water and marine environments

Over 10,667 taxa are alien somewhere in Europe

Terrestrial:

Plants	5789
Fungi	84
Invertebrates	2519
Vertebrates	370

Aquatic:

Inland	480
Marine	1069

> 45,000 introduction events (species-region records) documented

71 terrestrial countries/regions & 9 marine areas

Delivering Alien Invasive Species Inventories for Europe

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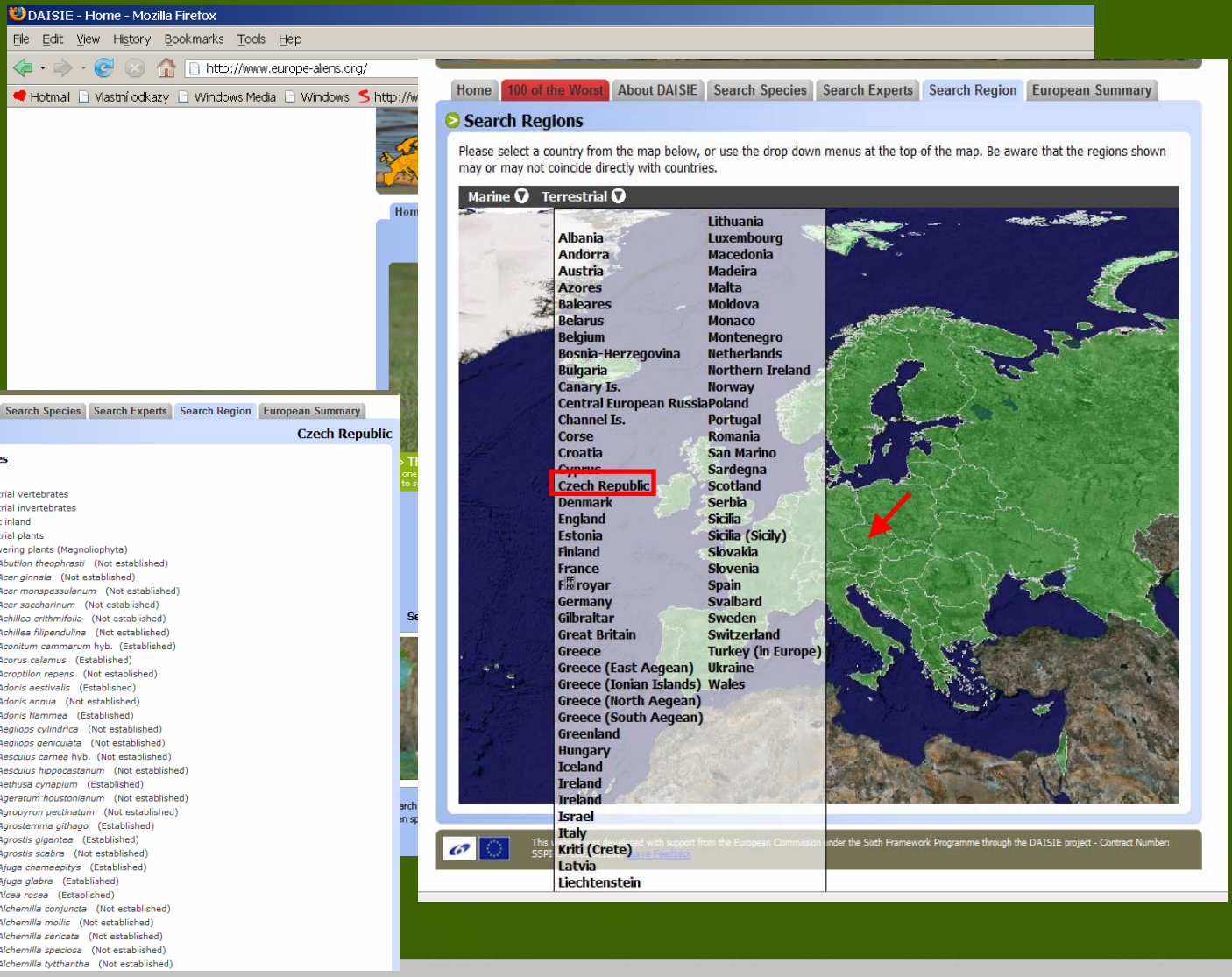
DAISIE: European Alien Invasive Species Gateway

Search by:

- Species
- Regions
- Summaries



Delivering Alien Invasive Species Inventories for Europe

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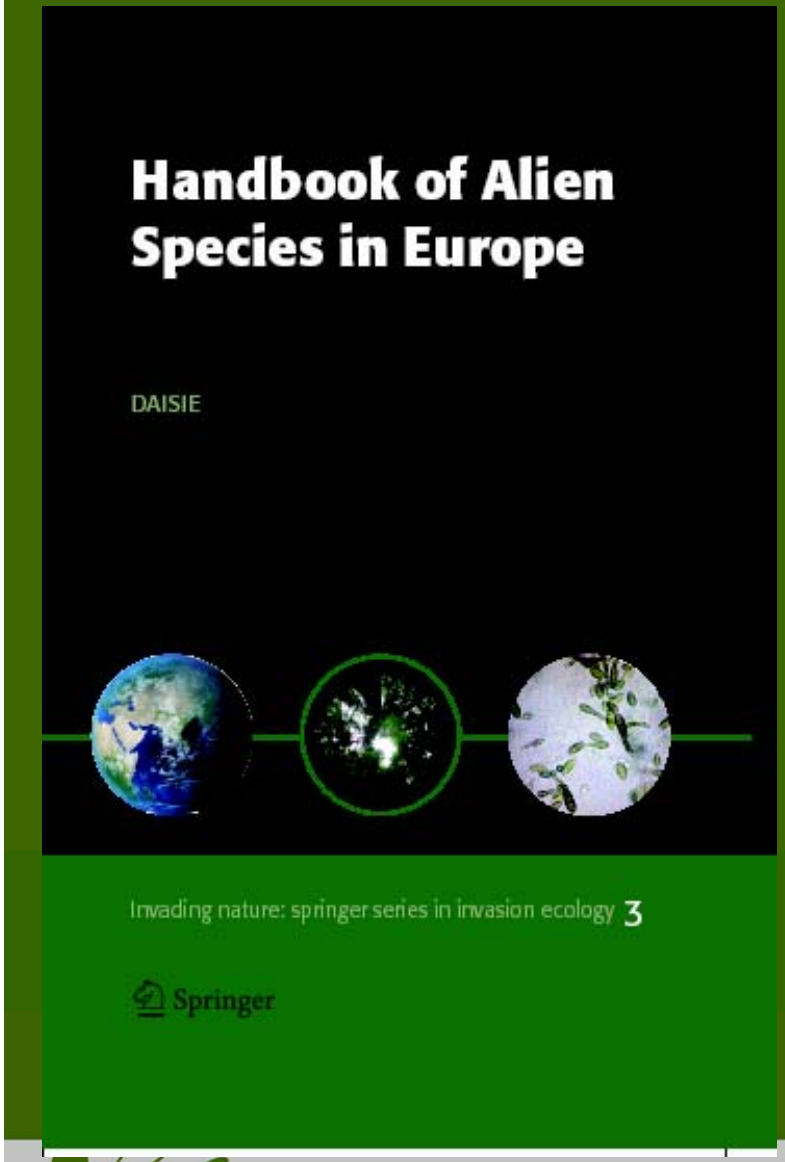
DAISIE: Handbook of Alien Species (2009)



Who is DAISIE?

83 authors from partner institutions & 99 collaborators

DAISIE is not only the project's acronym, it also represents the consortium of 83 partners and 99 collaborators and their joint effort. To acknowledge this concerted work, we all accepted DAISIE as author of this Handbook. Consequently, each partner and collaborator may refer to *Handbook of Alien Species in Europe* as part of her/his own scientific output.

Partners

Pavlos Andriopoulos, Margarita Arianoutsou, Sylvie Augustin, Nicola Baccetti, Sven Bacher, Jim Bacon, Corina Başnou, Ioannis Bazos, Pavel Bolshagin, François Bretagnolle, François Chiron, Philippe Clergeau, Pierre-Olivier Cochard, Christian Cocquempot, Armelle Cœur d'Acier, Jonathan Cooper, Darius Daunys, Pinelopi Delipetrou, Viktoras Didžiulis, Franck Dorkeld, Franz Essl, Bella Galil, Jacques Gasquez, Piero Genovesi, Kyriakos Georghiou, Stephan Gollasch, Zigmantas Gudžinskas, Ohad Hatzofe, Martin Hejda, Mark Hill, Philip E Hulme, Vojtěch Jarošík, Melanie Josefsson, Salit Kark, Stefan Klotz, Manuel Kobelt, Yannis Kokkoris, Mladen Kotarac, Ingolf Kühn, Philip W Lambdon, Eugenia Lange, Carlos Lopez-Vaamonde, Marie-Laure Loustau, Arnald Marcer, Michel Martinez, David Matej, Mathew McLoughlin, Alain Migeon, Dan Minchin, Maria Navajas, Pierre Navajas, Wolfgang Nentwig, Sergej Olenin, Irina Olenina, Richard Ostler, Irina Ovcharenko, Vadim E Panov, Eirini Papacharalambous, Michel Pascal, Jan Pergl, Irena Perglová, Andrey Phillipov, Joan Pino, Katja Poboljsaj, Petr Pyšek, Wolfgang Rabitsch, Jean-Yves Rasplus, Natalia Rodionova, Alain Roques, David B Roy, Helen Roy, Daniel Sauvard, Riccardo Scalera, Assaf Schwartz, Ondřej Sedláček, Susan Shirley, Valter Trocchi, Montserrat Vilà, Marten Winter, Annie Yart, Artemios Yiannitsaros, Pierre Zagatti, Andreas Zikos

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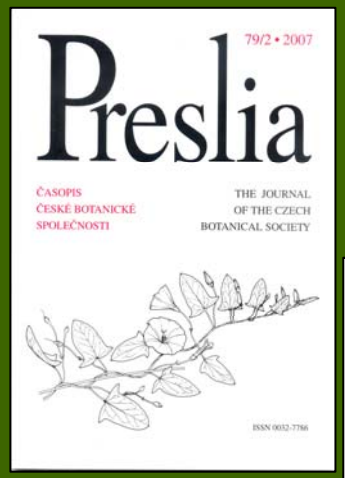
Alien flora of Europe



Preslia 80: 101–149, 2008

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

Zavlečená flóra Evropy: druhová diverzita, časové trendy, zákonitosti geografického rozšíření a oblasti budoucího výzkumu

Philip W. Lambdon[1,2#], Petr Pyšek[3,4*], Corina Basnou[5], Martin Hejda[3,4], Margarita Arianoutsou[6], Franz Essl[7], Vojtěch Jarošík[4,3], Jan Pergl[3], Marten Winter[8], Paulina Anastasiu[9], Pavlos Andriopoulos[6], Ioannis Bazos[6], Giuseppe Brundu[10], Laura Celesti-Grapow[11], Philippe Chassot[12], Pinelopi Delipetrou[13], Melanie Josefsson[14], Salit Kark[15], Stefan Klotz[8], Yannis Kokkoris[6], Ingolf Kühn[8], Hélia Marchante[16], Irena Perglová[3], Joan Pino[5], Montserrat Vilà[17], Andreas Zikos[6], David Roy[1] & Philip E. Hulme[18]

www.preslia.cz

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DAISIE: classification of origin

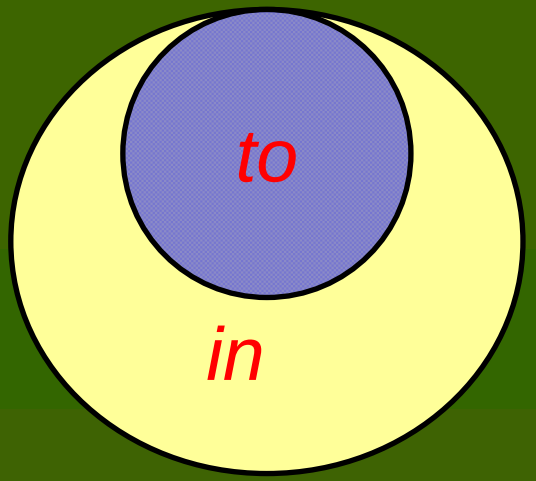
Aliens with **native range in some part of Europe**, but invading in other parts of Europe

+

Alien *to* Europe (native range outside European continent)

=

Alien *in* Europe (complete alien flora)



Lambdon P. W., Pyšek P., Basnou C. et al. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. Preslia 80: 101–149.

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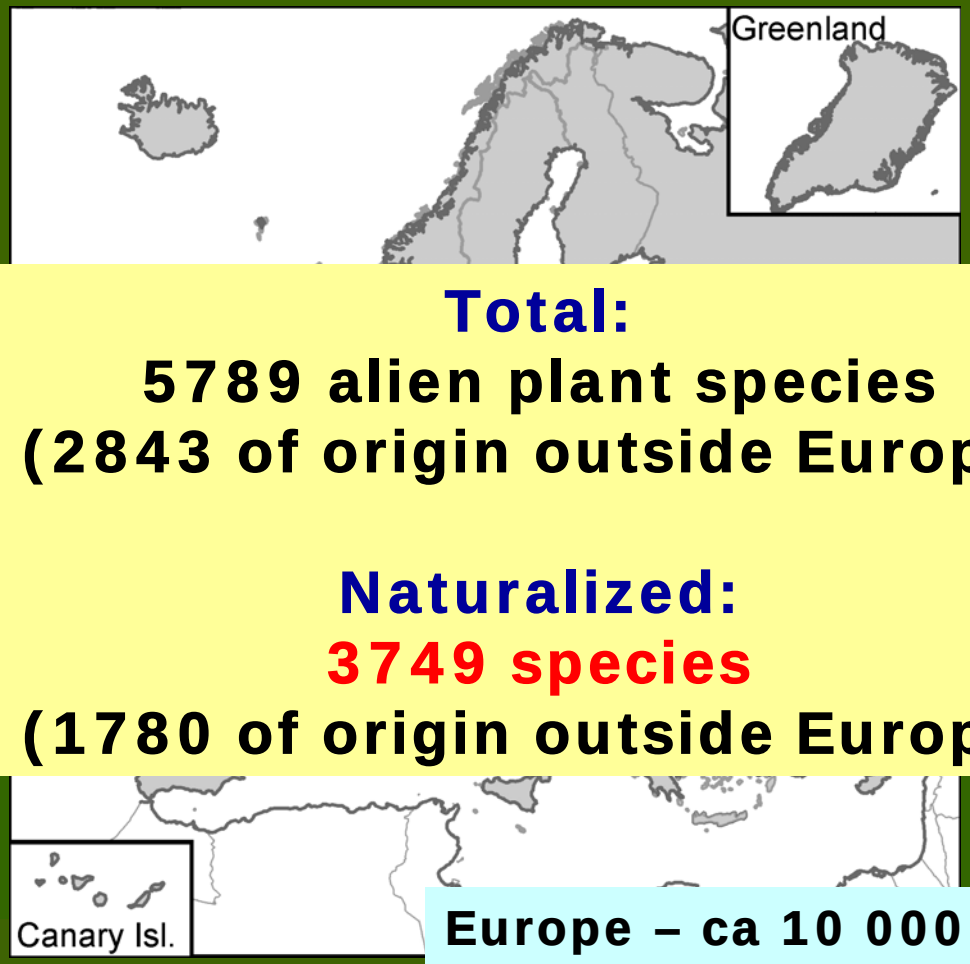
Alien flora of Europe: Big picture



49 countries / regions

Total:
5789 alien plant species
(2843 of origin outside Europe)

Naturalized:
3749 species
(1780 of origin outside Europe)

Europe – ca 10 000 native species
aliens = ca 22 %

Lambdon P. W., Pyšek P., Basnou C. et al. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. Preslia 80: 101–149.

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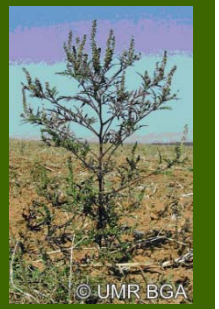
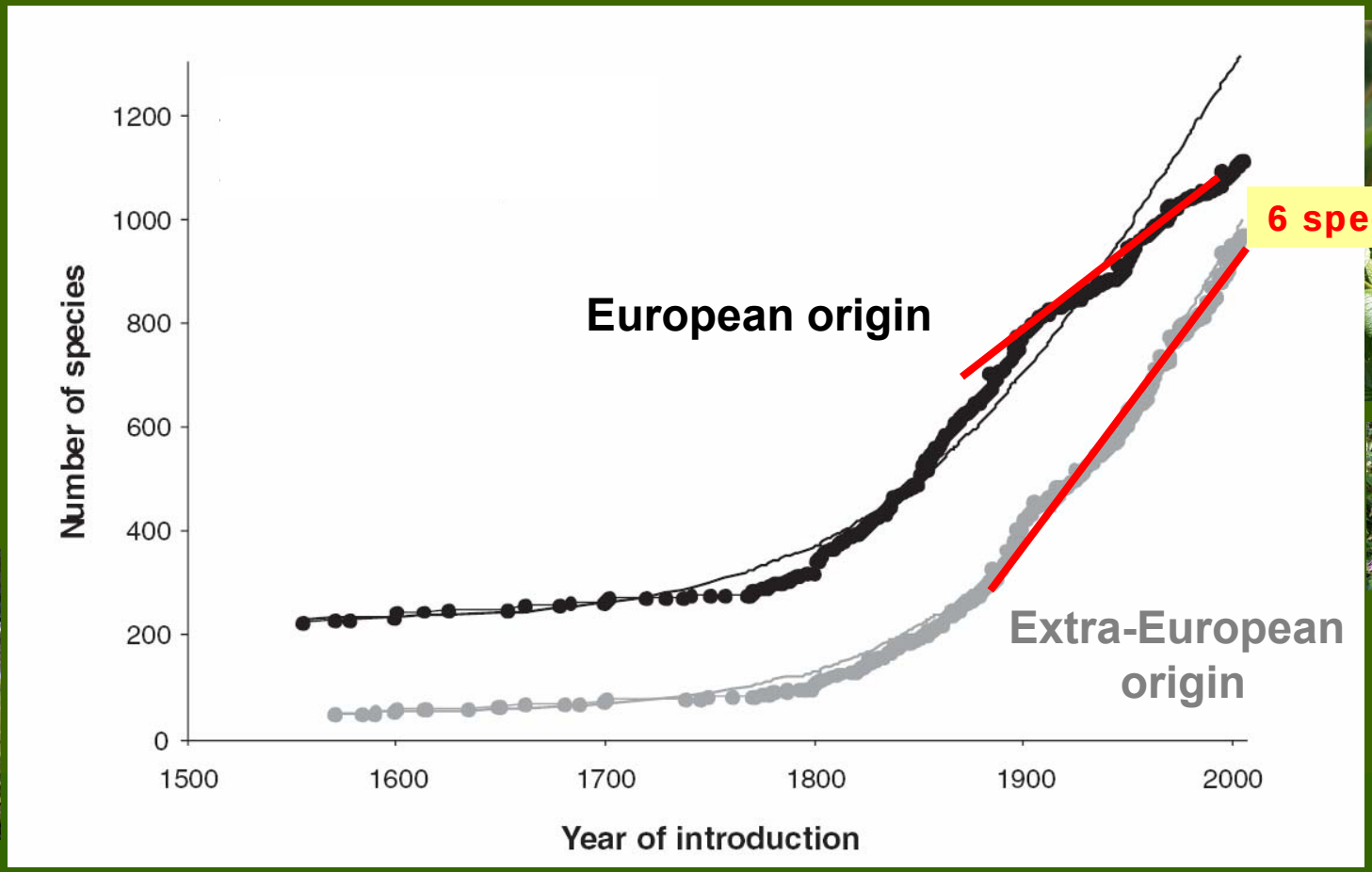
Invasion trends: alien plants in Europe





6 species / year

Lambdon P. W., Pyšek P., Basnou C. et al. 2008. Alien flora of Europe: species diversity, temporal trends, geographical patterns and research needs. Preslia 80: 101–149.

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Alien flora of Europe: distribution in regions

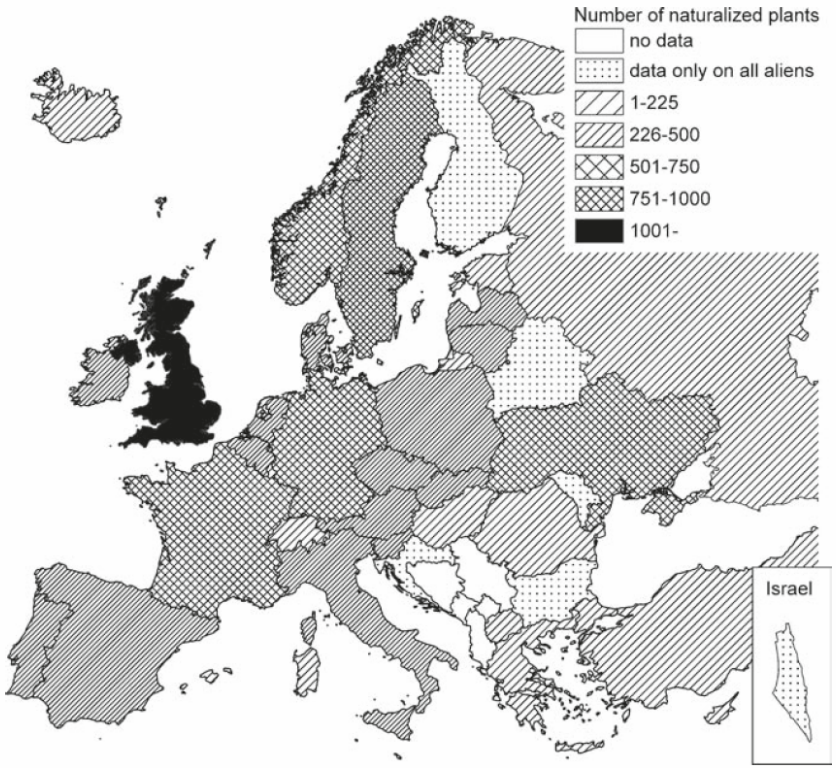

Fig. 4.1 Pattern of invasions by alien plants in Europe, expressed as numbers of naturalised alien plants in countries/regions; dotted areas indicate poorly researched regions for which only the information on the total number of aliens is available (Based on data from Lambdon et al. 2008); see this source for information on the numbers of species and assessment of the quality of data in particular countries/regions

Species distributions
Numbers of aliens in countries

Pyšek P., Lambdon P., Arianoutsou M., Kühn I., Pino J. & Winter M. (2009): Alien vascular plants of Europe. – In: DAISIE (eds), Handbook of alien species in Europe, p. 43–61, Springer, Berlin.

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2st Reason Why Taxonomy Is Important for Invasion Ecology

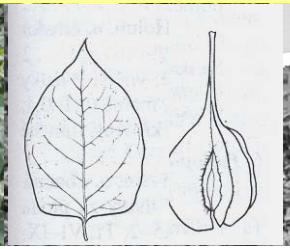
Much of the knowledge in current invasion ecology derives from the studies of congeneric species

Comparison of alien species with native, or invasive with non-invasive aliens:
- **filtering out phylogenetic bias**
- **bias associated with the region of origin**
- **congeners often occur in similar habitats**

... explicit role of taxonomy in studies on plant invasions

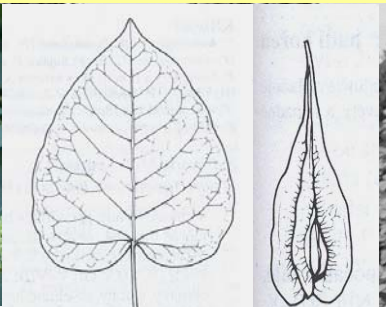
Taxa of the genus Fallopia in Czech Republic

Fallopia japonica (Houtt.) Ronse Decraene var. japonica



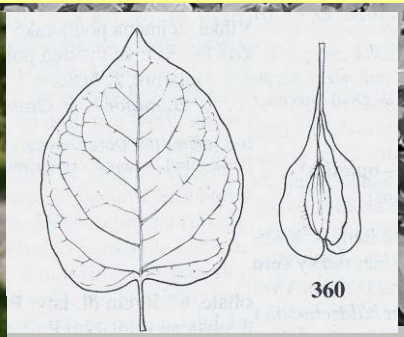
Native from North Japan through Korea and China to Taiwan

Fallopia sachalinensis (F. Schmidt) Ronse Decraene



native to Japan and Sakhalin

Fallopia × bohemica (Chrtek & Chrtková) J. P. Bailey



Mandák B., Bímová K., Pyšek P., Štepánek J. & Plačková I. 2005. Isoenzyme diversity in *Reynoutria* (Polygonaceae) taxa: escape from sterility by hybridization. Plant Syst. Evol. 253: 219–230.

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Taxa of the genus Fallopia in Czech Republic

In invaded range knotweeds reproduce and spread almost exclusively vegetatively, but rare hybridization events do occur

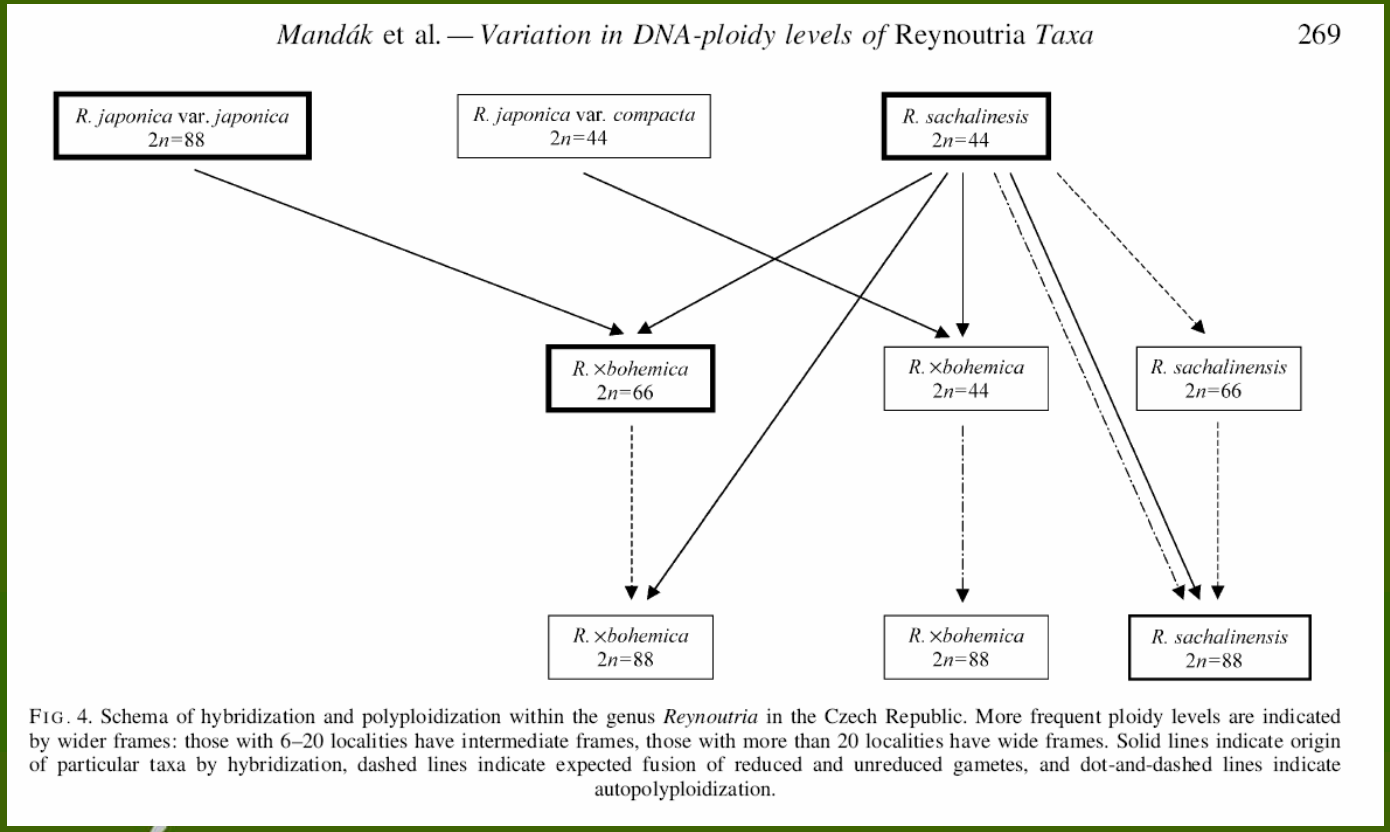

FIG. 4. Schema of hybridization and polyploidization within the genus *Reynoutria* in the Czech Republic. More frequent ploidy levels are indicated by wider frames: those with 6–20 localities have intermediate frames, those with more than 20 localities have wide frames. Solid lines indicate origin of particular taxa by hybridization, dashed lines indicate expected fusion of reduced and unreduced gametes, and dot-and-dashed lines indicate autopolyploidization.

the pattern of hybridization is complex and hybrids are difficult to determine

Mandák B., Pyšek P., Lysák M., Suda J., Krahulcová A. & Bímová K. 2003. Variation in DNA-ploidy levels of *Reynoutria* taxa in the Czech Republic. Ann. Bot. 96: 265–272.

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Problems with determination of knotweeds in floristic literature

Table 2. Overview of misidentifications of *Reynoutria* taxa in original data obtained from literature, herbaria and unpublished records. Number of localities in which the clone persisted (n) until recently and which were used for verification of the past determination in *Reynoutria* species is shown. Cells showing incorrect determination are shaded.

	Correct determination (%)		
Original determination:	*R. japonica*	*R. ×bohemica*	*R. sachalinensis*
R. japonica (n = 120)	**86.7**	10.8 (n=13)	2.5 (n=3)
R. sachalinensis (n = 43)	7.0 (n=3)	9.3 (n=4)	**83.7**

correct determination of Fallopia japonica in floristic papers = 87 %

correct determination of F. sachalinensis in floristic papers = 84 %

proportion of F. bohemica determined as either of parents = 20.1 %

Pyšek P. et al. (2001) Persistence of stout clonal herbs as invaders in the landscape: a field test of historical records. In: Brundu G. et al. (eds.), Plant invasions, p. 235–244, Backhuys Publishers, Leiden.

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History of invasion and distribution in the Czech Republic

Table 1. – Number of localities recorded for *Reynoutria* taxa in the Czech Republic up to 2000. Percentages of the total number of localities recorded for all taxa are shown in brackets, those of the total number of localities recorded for a given taxon in parentheses.

	R. japonica var. *japonica*	R. *japonica* var. *compacta*	*R. sachalinensis*	*R. ×bohemica*	Total
Date of the first documented record	1883	1948	1921[1]	1950	–
Total number of recorded localities	1335 [67.3]	5 [0.3]	261 [13.2]	381 [19.2]	1982
Number of specimens in herbaria	152 (11.4)	1 (20.0)	60 (23.0)	58 (15.2)	271
Number of localities in settlements	1030 (77.2)	5 (100.0)	200 (76.6)	238 (62.5)	1473
Number of localities outside settlements	305 (22.8)	0 (0.0)	61 (23.4)	143 (37.5)	509

[1] Indirect evidence suggests 1869 (see text for details)

Fallopia japonica

first record 1883
1335 localities

F. × bohemica

first record 1950
381 localities

F. sachalinensis

first record 1869
261 localities

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

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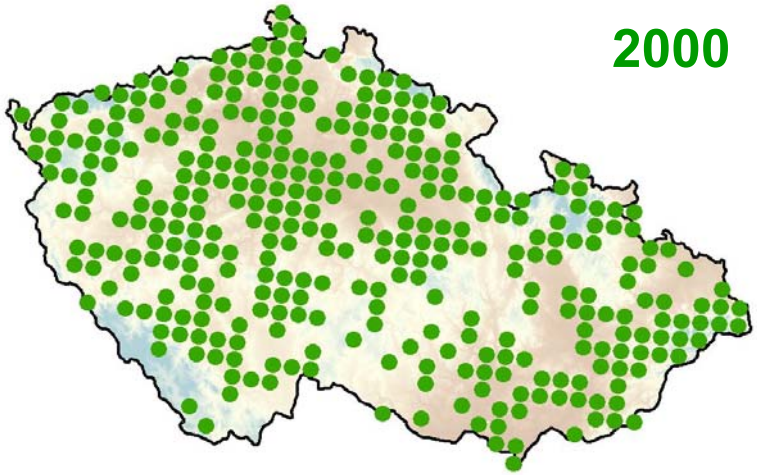
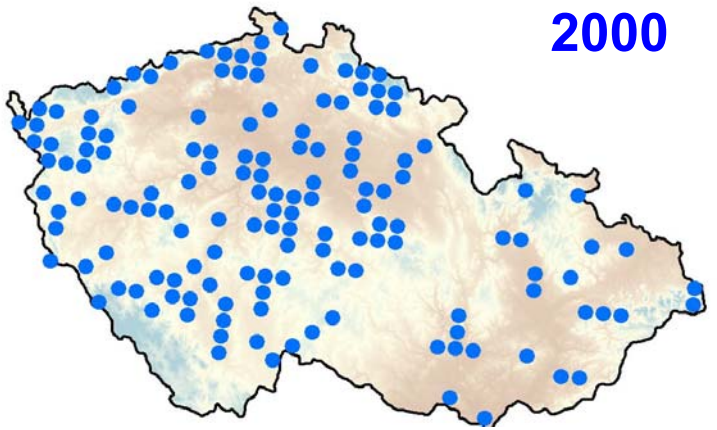
Distribution of Fallopia taxa in the Czech Republic



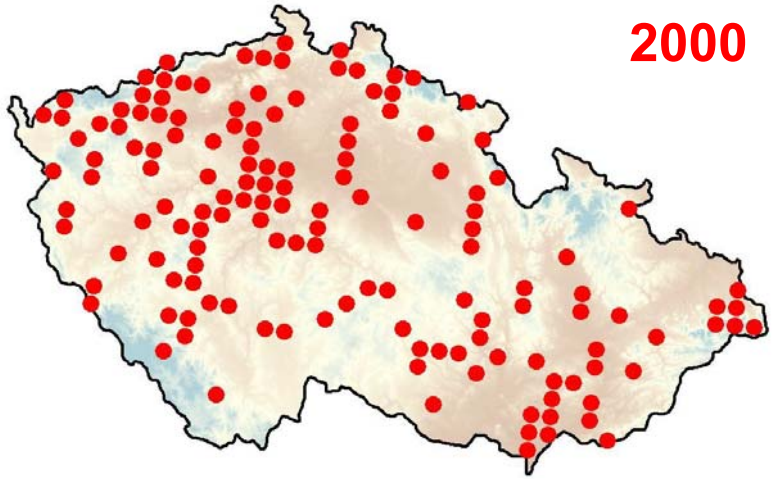
F. japonica:
381 grid cells (54.6 %)

×



F. sachalinensis:
158 grid cells (22.7 %)

Fallopia japonica is most widespread but the hybrid is as much widespread as F. sachalinensis



F. × bohemica:
149 grid cells (21.4 %)

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

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Persistence of Fallopia clones in invaded sites

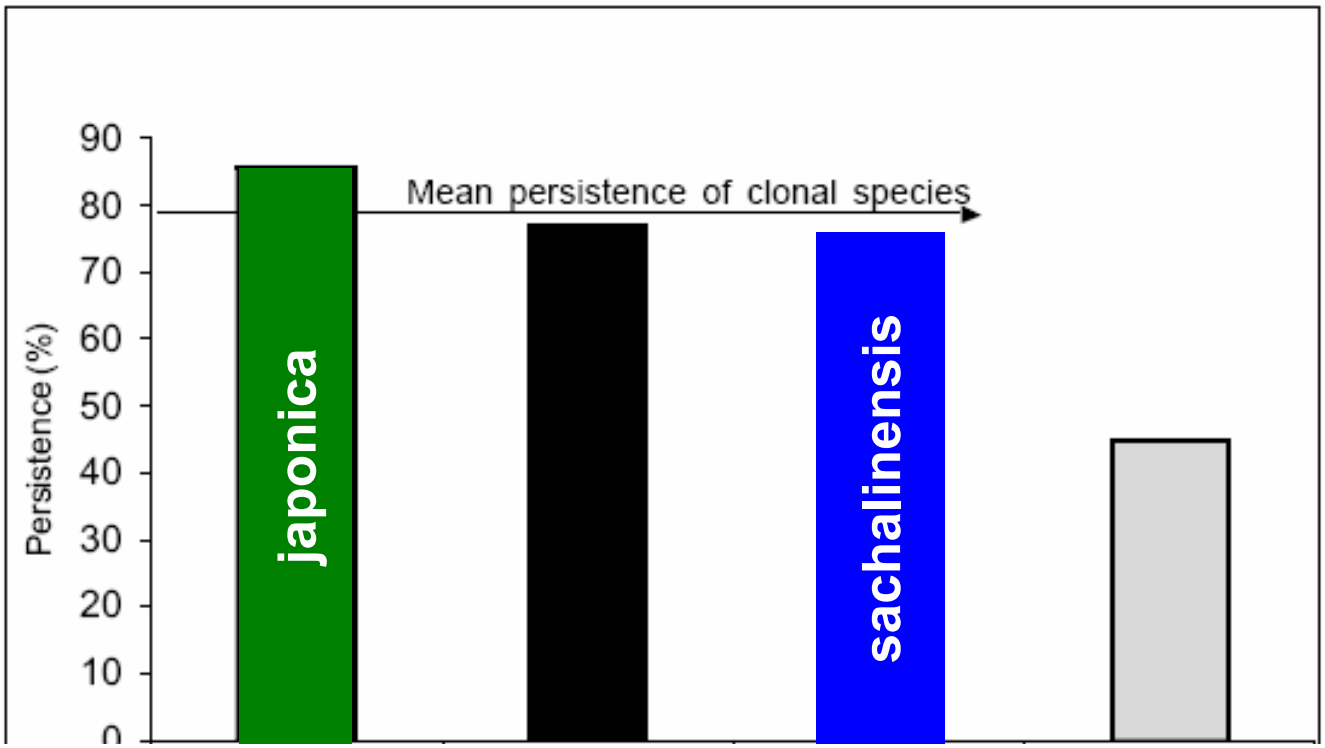

Fig. 3. Comparison of the persistence rate of the three clonal species presented in this study (solid bars) with a non-clonal invader *Heracleum mantegazzianum* (hatched bar, data from WADE *et al*. 1997). Mean values calculated from the pooled data of clonal species is indicated.

Fallopia japonica – persistence in 86 % localities
Fallopia sachalinensis – persistence in 75 % localities

Pyšek P. et al. (2001) Persistence of stout clonal herbs as invaders in the landscape: a field test of historical records. In: Brundu G. et al. (eds.), Plant invasions, p. 235–244, Backhuys Publishers, Leiden.

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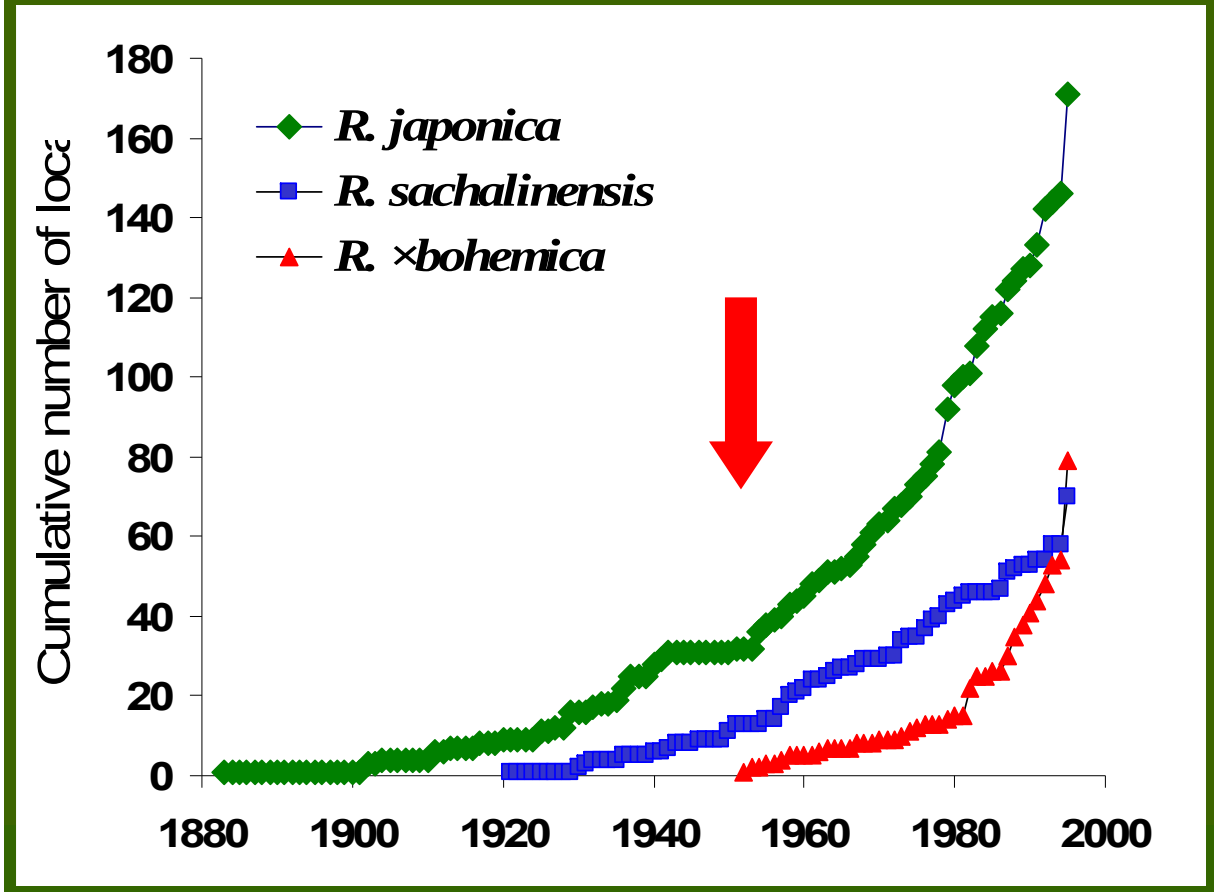
Comparing the rate of invasion in the Czech Republic



statistical analysis: 1950-2000

Differences in slopes (= measure of the rate of invasion) were tested using ANCOVA with species as a factor and year as a covariate

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

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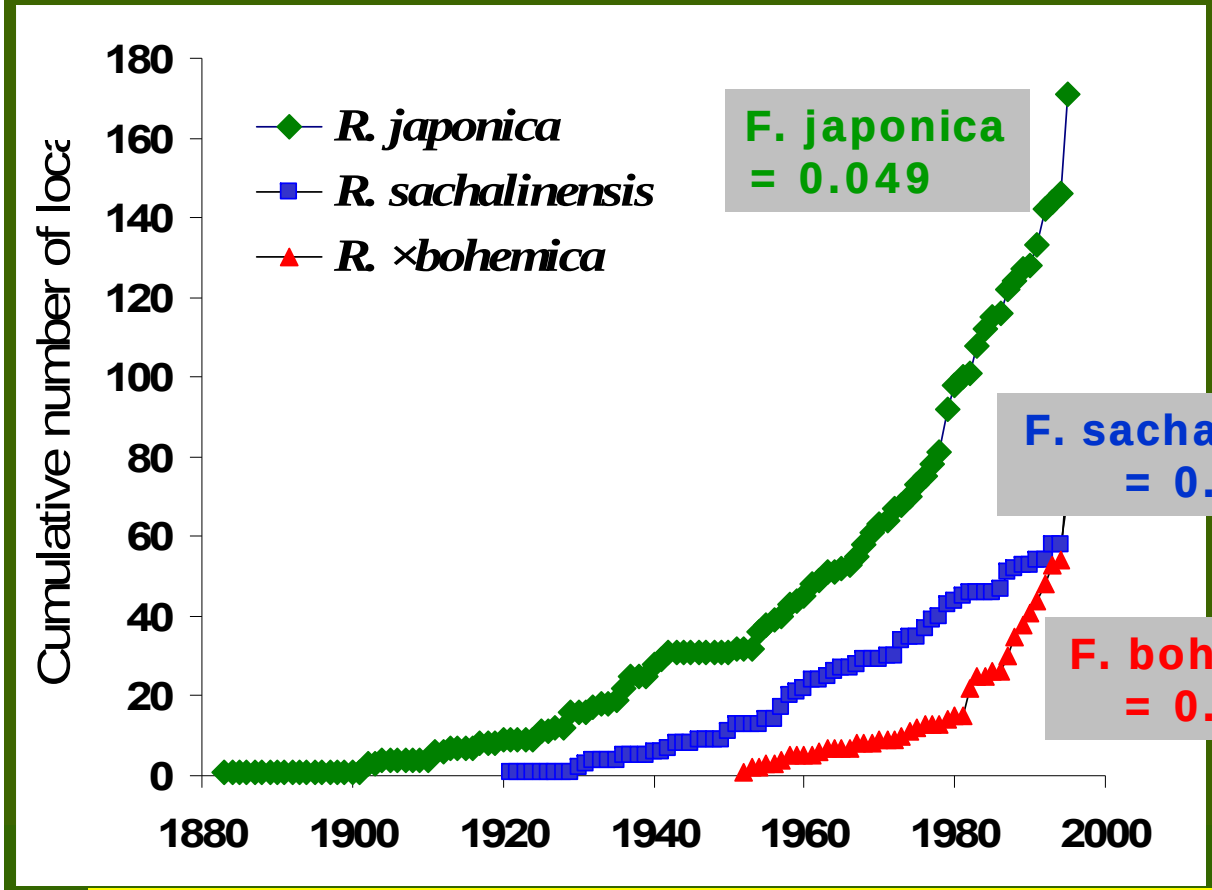
Comparing the rate of invasion in the Czech Republic



Rate of invasion:
F. × bohemica
> F. japonica
> F. sachalinensis

Since this first record in the wild, the hybrid exhibits twice the rate of invasion of its parents, measured as the number of occupied localities

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

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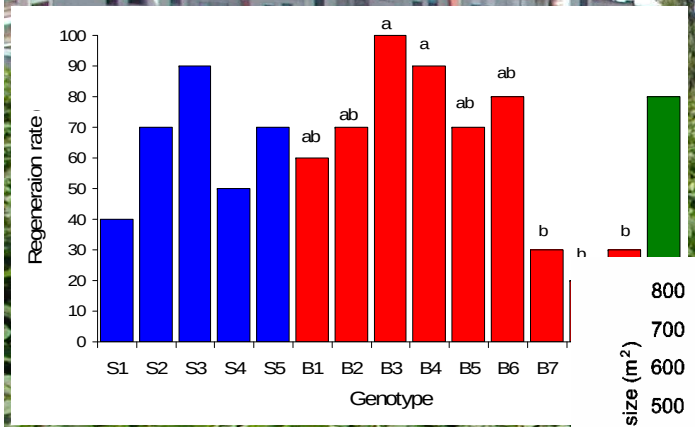
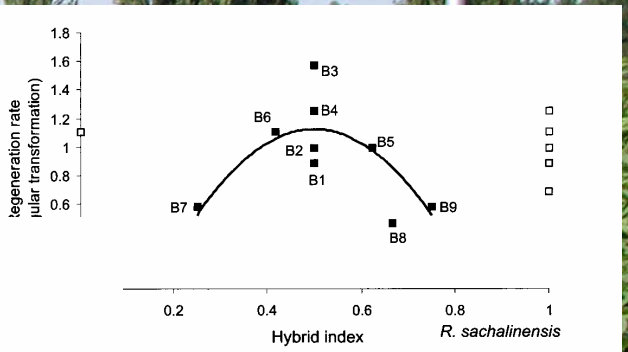
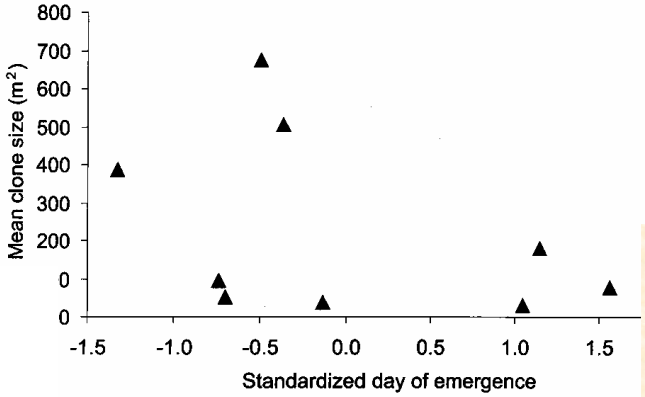
Fallopia taxa: hybrid superior to the parents

EXPLICIT ROLE OF TAXONOMY: Only after the taxonomy was disentangled, we were able to analyse the invasion dynamics, and conduct a number of ecological studies …

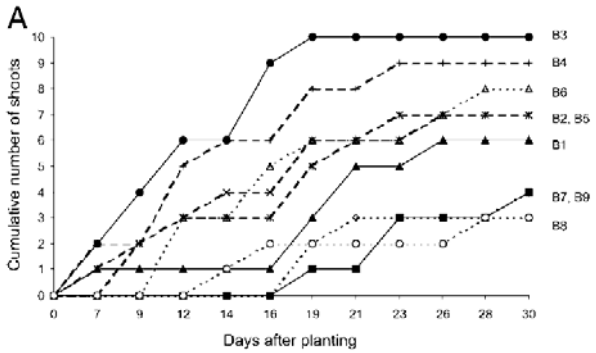


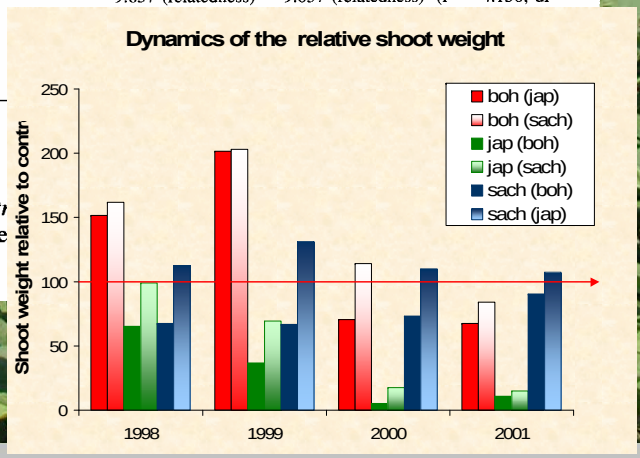


ionship between the regeneration rate of *Reynoutria* ×*bo*-
s and the hybrid index showing the relatedness of particular
ental species. The relationship is described for angular-trans-
ion rates by the symmetric quadratic equation: regeneration
- 9.637 (relatedness) − 9.637 (relatedness)² (*F* = 4.156; df



. The relationship between mean clone size of *Reynoutr*
genotypes in the landscape and the standardized value of the
ce in the experiment.





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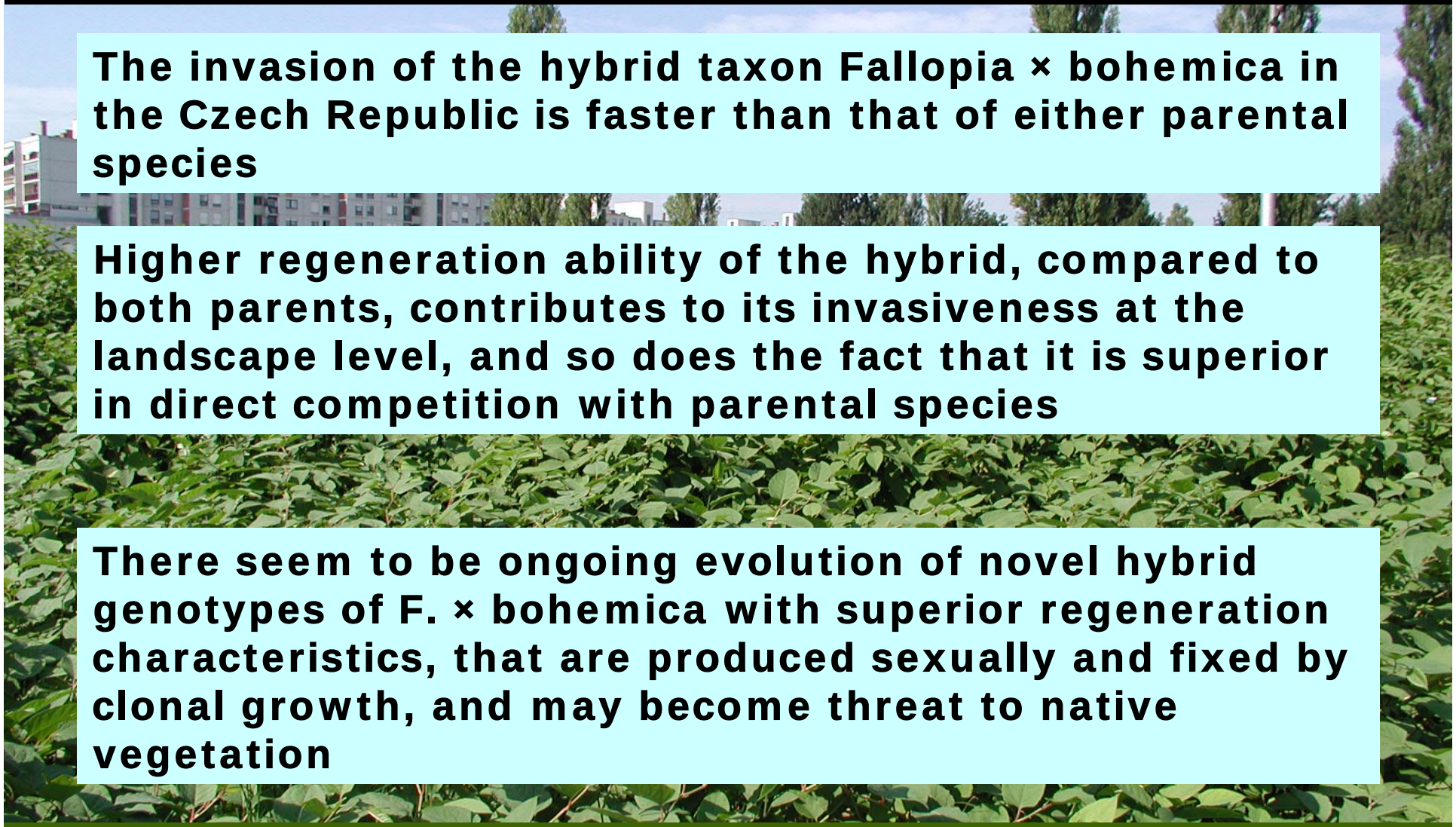
Fallopia taxa: hybrid superior to the parents



The invasion of the hybrid taxon Fallopia × bohemica in the Czech Republic is faster than that of either parental species

Higher regeneration ability of the hybrid, compared to both parents, contributes to its invasiveness at the landscape level, and so does the fact that it is superior in direct competition with parental species

There seem to be ongoing evolution of novel hybrid genotypes of F. × bohemica with superior regeneration characteristics, that are produced sexually and fixed by clonal growth, and may become threat to native vegetation

3rd Reason Why Taxonomy Is Important for Invasion Ecology

Invasion Ecology Is About Distributions

In macroecological studies based on whole floras, it is impossible to deal with each species in detail – yet such studies depend on good primary taxonomic, floristic and phytogeographic information

… implicit role of taxonomy in studies on plant invasions

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Central-European flora as a source of invasions

A study

- **using source area approach**
- **evaluating invasion success at global scale**
- **distinguishing between two phases of invasion**
- **exploring relative importance of distribution and traits**
- **considering direct and indirect effects of biological traits**

1. **Distribution in native region is the major determinant of the probability of a species to become an alien, but not necessarily invasive**

1. **The role of biological traits is stage-dependent: traits have direct effect when it comes to the probability of a species to become invasive**

The minor and only indirect role of traits in early stages of invasion process advocates for precautionary approach to the management. Common species which have large native ranges should be paid increased attention upon introductions

Pyšek P., Jarošík V., Pergl J., Randall R., Chytrý M., Kühn I., Tichý L., Danihelka J., Chrtek J. jun. & Sádlo J.: Relative effects of species traits and native distribution ranges on the global invasion success of Central-European plants depend on the stage of invasion (in review)

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How is it in reality:
Does taxonomy interact sufficiently with invasion ecology?

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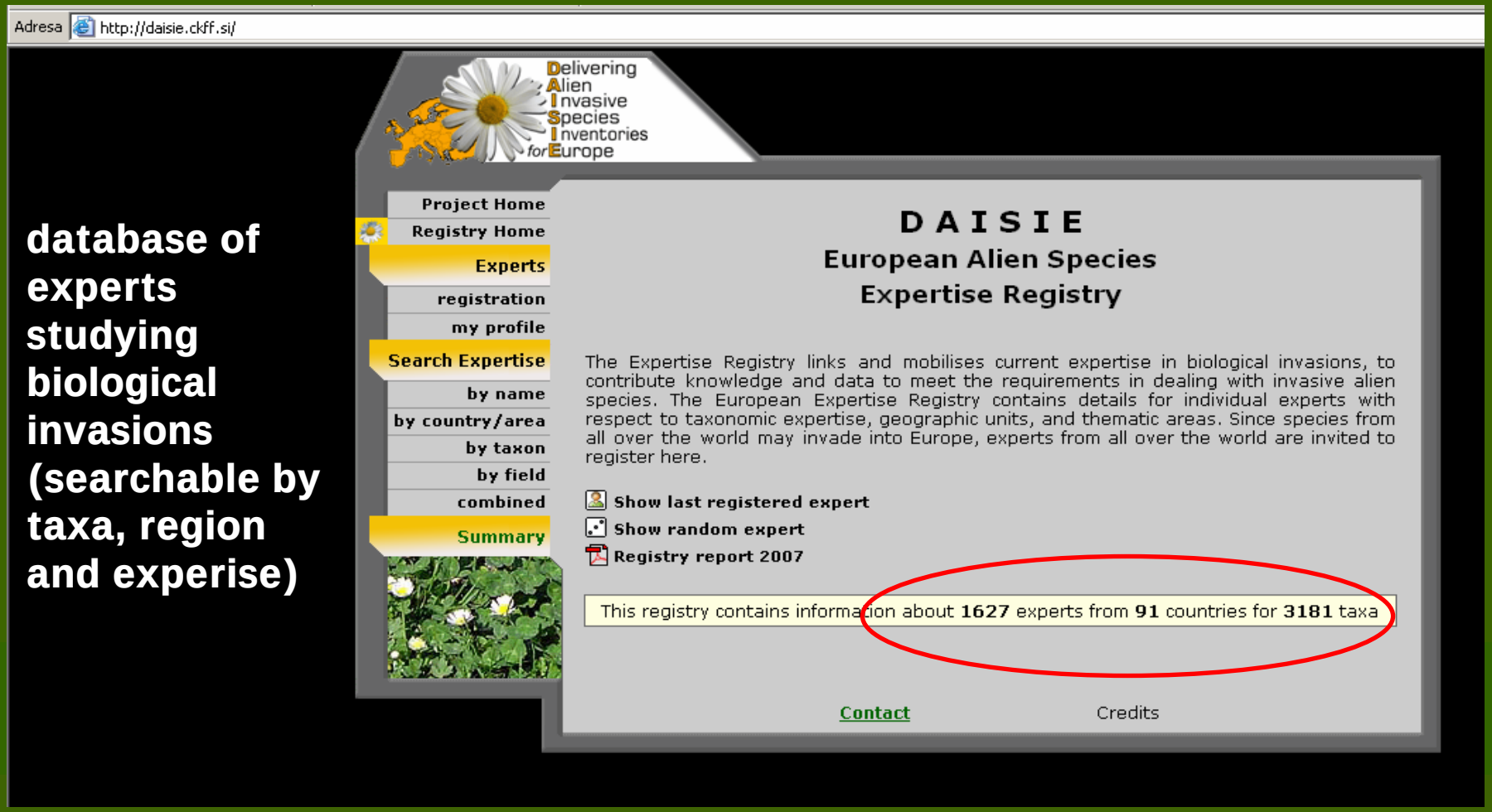
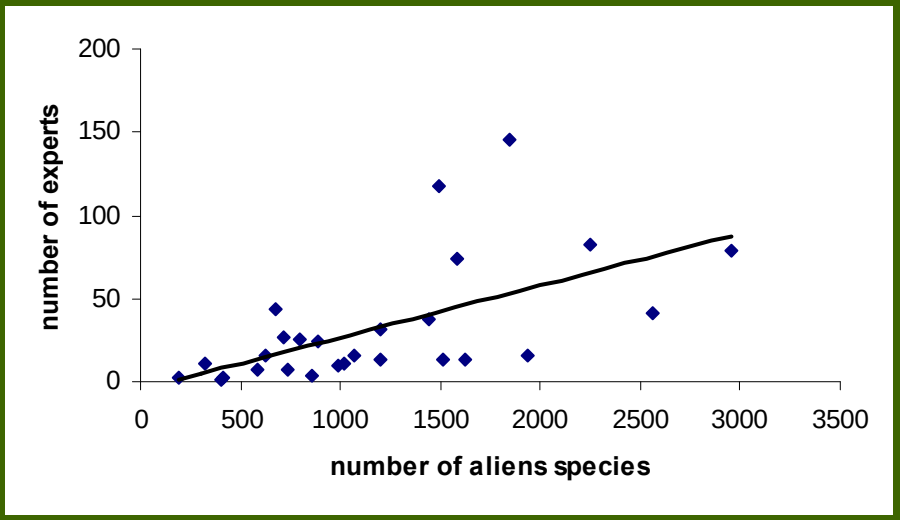
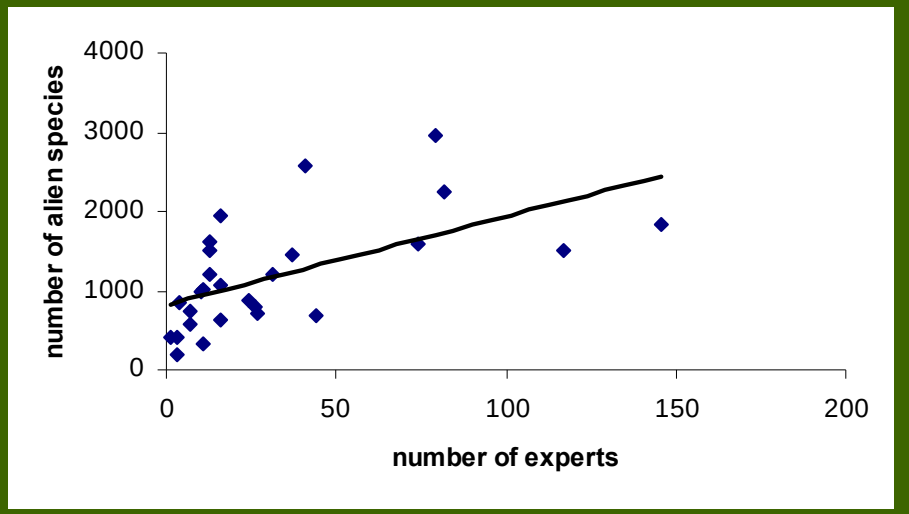
DAISIE: European Alien Species Expertise Registry

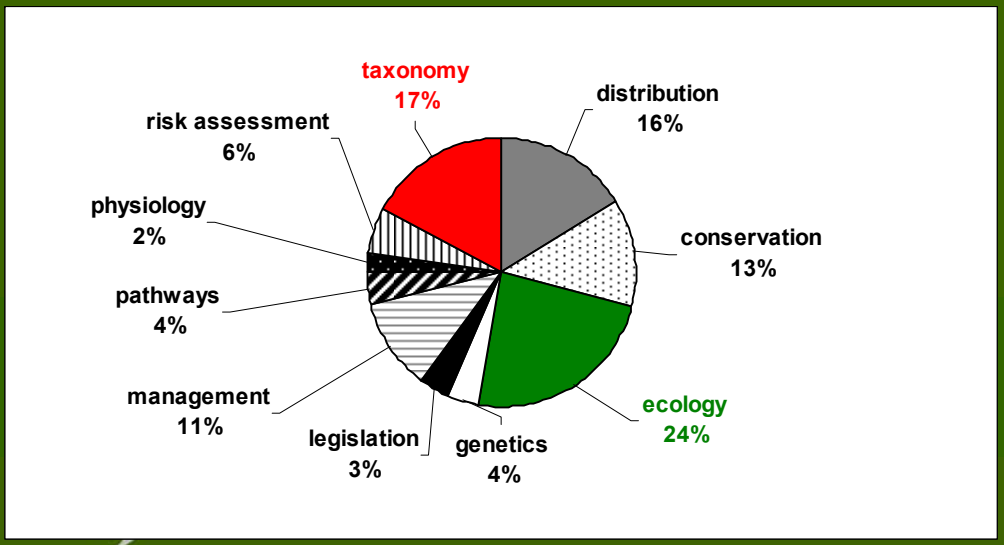
database of experts studying biological invasions (searchable by taxa, region and experise)



DAISIE: European Alien Species Expertise Registry







Only 17% of the registered claim to be taxonomic experts

Delivering Alien Invasive Species Inventories for Europe

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Invasive alien species in Europe: The future

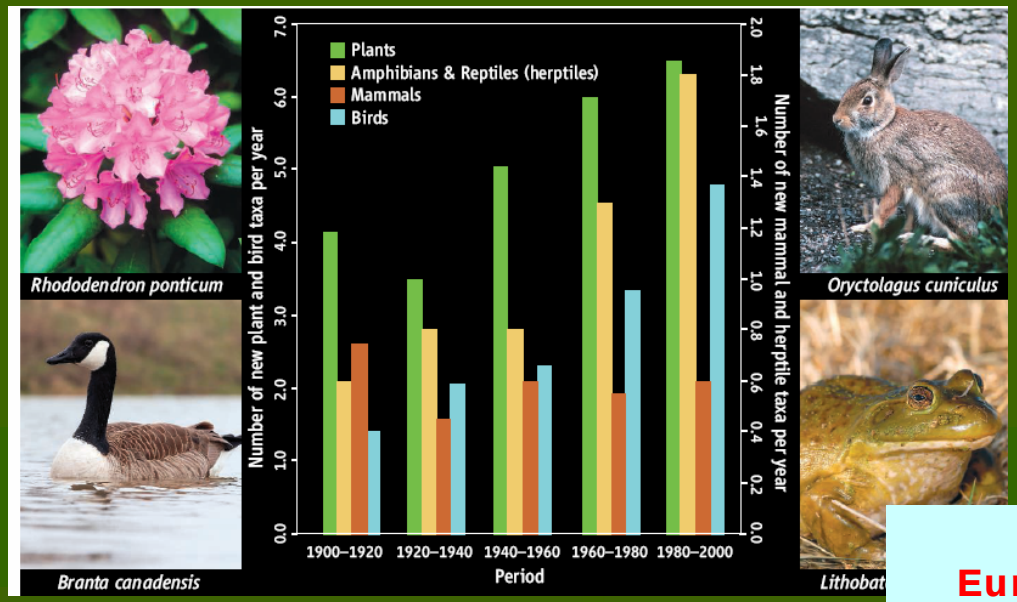
POLICYFORUM

ECOLOGY

Will Threat of Biological Invasions Unite the European Union?

New data on the extent of biological invasions pose major regulatory and political challenges to European institutions.

Philip E. Hulme,[1]* Petr Pyšek,[2] Wolfgang Nentwig,[3] Montserrat Vilà[4]



Rates of introduction in all taxonomic groups accelerate – the need for taxonomic expertise will increase in Europe

Costs of biological invasions in Europe estimated at: 12,700,000,000 € annually (Genovesi et al., in prep.)

European Centre For Invasive Species Management (ECISM) ?

Hulme P., Pyšek P., Nentwig W. & Vilà M. 2009. Will threat of biological invasions unite the European Union? Science 324: 40–41.

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European Centre For Invasive Species Management (ECISM) ?

Scientific Advice and Research Direction
Information service to the Commission, the Parliament, the Member States and their citizens; advise on targeting research, identifying gaps

Surveillance and Early Warning
Maintenance of the DAISIE database and its development to early warning system; warning lists, immediate removal of newly detected invaders

Horizon Scanning and Risk Assessment
Development of an integrated invasive species risk assessment scheme; monitoring of pathways; regular reporting of emerging threats

Rapid and Continuing Response
Timely reaction to invasion threats; coordinated approach; mobilization of experts; guidelines and operating procedures for eradications

Training and Capacity Building
Public awareness and stakeholder consultation ….

Hulme P., Pyšek P., Nentwig W. & Vilà M. 2009. Will threat of biological invasions unite the European Union? Science 324: 40–41.

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Credits

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Bohumil Mandák
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Ivan Ostrý
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Montse Vilà
Marten Winter

DAISIE Delivering Alien Invasive Species Inventories for Europe

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