NEOBIOTA 2014

from understanding to action

8th International Conference on Biological Invasions

from understanding to action

Proceedings

Edited by

Ahmet ULUDAĞ Ayşe YAZLIK

Khawar JABRAN Süleyman TÜRKSEVEN Uwe STARFINGER

Antalya-TURKEY, 03-08 November 2014

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Designed by

Aytekin AKTAŞ

Batı Akdeniz Agricultural Research Institute (BATEM)

Antalya/TURKEY

Cover Photo by
Süleyman Türkseven

Pressed by

XMAT

November-2014

Antalya/TURKEY

ISBN: 978-605-4672-80-6

Organized by

Çanakkale Onsekiz Mart University, Turkey
NEOBIOTA

Collaboration with

Ministry of Agriculture, Turkey
Mustafa Kemal University, Turkey
Düzce University, Turkey
EWRS
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OUTLINE

	2 November	3 November		4 November		5 November		6 November	7 November	8 November
08:00				**Registration**		**Registration**		**Registration**	**Registration**	
08:30				INVITED LECTURE (Inderjit)		INVITED LECTURE (Yan Sun)		INVITED LECTURE (A. Serhan Tarkan)	INVITED LECTURE (Niall Moore)	
09:00										
09:30				Temporal and Spatial Trends (1)		Drivers and Pathways of Invasions (1)	Prevention and Early Detection of Biological Invasions	Impacts of Biological Invasions (2)	Policy and legislation	
10:00										
10:30	COST meeting	COST meeting		Break		Break		Break	Break	
11:00									Public Perceptions and Communication of Invasion Risks	
11:30				Temporal and Spatial Trends (2)		Drivers and Pathways of Invasions (2)	Alien species in South and East Europe	Biotic and Abiotic Control of Alien Species		
12:00										
12:30									Closing	
13:00										
13:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**		**Lunch**		**Lunch**	**Lunch**	
14:00										
14:30				Alien plants in agricultural areas		Drivers and Pathways of Invasions (3)	Evolution of biological invasions	Impacts of Biological Invasions (3)		**Optional field trip**
15:00										
15:30			**Registration**							
16:00										
16:30	COST meeting	COST meeting		**Break**		**Break**		**Break**		
17:00										
17:30			Opening Ceremony	Mitigation and Control of Biological Invasions		Drivers and Pathways of Invasions (4)	Impacts of Biological Invasions (1)	Impacts of Biological Invasions (4)	**FIELD TRIP**	
18:00										
18:30			ESENIAS round table				Biological Invasions Under Climate Change			
19:00										
19:30	**Turkish Music with Ahmet**	**Welcome Cocktail**		**Neobiota Editors's meeting**	**Turkish Music with Ahmet**	**Neobiota Board meeting**				
20:00						**Gala Dinner**				

ORAL PRESENTATIONS

Sessions and Moderators	**Presentations**	**Corresponding/First author**
INVITED TALK 08:30-09:00 @ 4 Nov Ingo KOWARIK	Ecological impacts of novel chemicals on aboveground patterns and belowground processes	Inderjit
Temporal and Spatial Trends (1) 09:00-10:30 @ 4 Nov Petr PYSEK	Rapid physiological adaptation to low oxygen in invasive populations of both quagga and zebra mussels?	Lukas De Ventura
	The big picture: insights into vascular plant invasions worldwide	Franz Essl
	Beyond climate: Disturbance niche shifts in invasive species	Pablo González-Moreno
	Predicting invasions in novel climates: A case study of exotic Crassulaceae in New Zealand	Jennifer Pannell
Temporal and Spatial Trends (2) 11:00-13:00 @ 4 Nov Franz ESSL Bruce OSBORN	Identifying the signal of environmental filtering and competition in invasion patterns – a contest of approaches from community ecology	Laure Gallien
	Community structure, succession and invasibility in a seasonal deciduous forest in southern Brazil	Michele de Sá Dechoum
	Using historic botanical literature to chart the geography, habitats and pathways of invasive species	Quentin Groom
	(What) can we learn about ecology of invasive plants from unsystematically collected data?	Sven D. Jelaska
	Implications for invasion resulting from phylogeographically based variation in nuclear genome size and plant defense in Phragmites	Laura A. Meyerson
	Naturalization of central European plants in North America: disentangling the roles of species traits, habitat legacy, propagule pressure and residence time	Petr Pysek
EWRS-EPPO-NEOBIOTA SESSION: Alien plants in agricultural areas 14:00- 16:30 @ 4 Nov Christian BOHREN Sarah BRUNEL	Fertile Crescent: A Cradle of Crops is A Cradle of Weeds?	Makihiko Ikegami
	Approach to a control strategy against Cyperus esculentus	Christian Bohren
	Can the invasion of common ragweed be halted? New insights from an international project	Uwe Starfinger
	Management of Parthenium hysterophorus L. in Israel	Tuvia Yaacoby
	Managing Littleseed Canarygrass – An Invasive Weed through Wheat Allelopathy	Zahid Ata Cheema
	The invasion and allelopathic effect of Artemisia vulgaris L. in the different agricultural crops in Lithuania	Zita Kriaučiūnienė
	Dealing with risks to agriculture from invasive alien plants : EPPO's role	Sarah Brunel
Mitigation and Control of Biological Invasions 17:00- 19:00 @ 4 Nov	Ambrosia confertiflora in Israel – weed invasion and possible management	Baruch Rubin & Yifat Yair
	A framework for priority setting in management of widespread invasive plant species	Ingo Kowarik
	Integrated management of invasive Canada geese populations in an international	Tim Adriaens

Darren J. KRITICOS Vania PIVELLO	context: a case study	
	"Better never than late" or "better late than never"? Science-based management strategy to control invasive oxeye daisy	Kateřina Štajerová
	A First for New Zealand: Eradicating the European Alpine Newt	Edwin Ainley
	International management of the chestnut gall wasp invasion : anthropological and biological perspectives	Alexandre Aebi
	Predictive modelling of suitability and susceptibility of areas for the European wild rabbit in the Queensland Murray Darling Basin, Australia	Vanessa Macdonald
INVITED TALK 08:30-09:00 @ 5 Nov Alain ROQUES	Old vs. new associations: impact of invasive alien species revisited	Yan SUN
Drivers and Pathways of Invasions (1) 09:00-10:30 @ 5 Nov Jan PERGL	The pathways of introduction of alien cactus species to South Africa: lessons for risk assessment	Ana Novoa
	Do native and exotic species differ in how they perform following wildfire? Revealing patterns and mechanisms via analysis of a global database	Christina Alba
	Spatial and temporal variation in introduction risk determine inspection priorities	Katelyn T. Faulkner
	Species traits and introduction history: important introduction bias contributes to the establishment success and spread of ornamental alien plants	Noëlie Maurel
	Tracing a fast European invasion: the case of the Western conifer seed bug, Leptoglossus occidentalis	Marie-Anne Auger Rozenberg & Lesieur Vincent
Drivers and Pathways of Invasions (2) 11:00-13:00 @ 5 Nov Phil HULME Gordon COPP	Ecological restraints to jumping the garden fence; a case study of an invasive street tree	Melinda S. Trudgen
	The composition, impact and pathways of introduction of non-native species in Great Britain	Olaf Booy
	Taking Advantage of a Window of Opportunity: The Significance of Early Establishment and Growth of Invasive Plant Species	Bruce Osborne
	Pathway analysis and impact assessment	Hans Peter Ravn
	From behind the fence: how private gardens support the spread of alien plants?	Jan Pergl
	Distribution and habitat-association of a potentially spreading native marine macrophyte	Sofie Emma Voerman
	The times they are a-changin´: impact of Acacia dealbata Link on soil chemistry and microbial community over a chronological sequence	Pablo Souza-Alonso
Drivers and Pathways of Invasions (3) 14:00-16:30 @ 5 Nov Hans Peter RAVN Josef SOUKUP	Comparative assessment of the soil seed bank of invasive and non-invasive congeners in their native and alien range	Margherita Gioria
	A meta-analysis: Non-native plant species benefit from disturbance, natives do not	Miia Jauni
	Host resources of freshwater bivalve Anodonta woodiana in its native and non-native range: consequences for invasion success	Douda, K.
	Is Acacia dealbata using different growth patterns to colonize distinct ecosystems?	Luís González & Jonatan Rodrígue

	When invasibility blocks invasiveness: Harmonia axyridis Pallas (Coleoptera: Coccinellidae) in the Azores as a case study	Isabel Borges
	The human footprint shapes the global distribution of terrestrial, freshwater and marine invaders	Belinda Gallardo
	Landscape Genetics of Monochamus galloprovincialis, Vector of the Pine Wood Nematode in Europe	Julien HARAN
	Invasiveness and population ecology of tropical crayfish, the Redclaw (Cherax quadricarinatus), in a temperate climate in Europe	Martina Jaklič
	Pre-adaptation or genetic shift after introduction in invasive species? A study on Impatiens glandulifera	Evelyne Elst
Drivers and Pathways of Invasions (4) 17:00-19:00 @ 5 Nov Wolfgang NENTWIG Sava VRBNICANIN Romain ROUCHET	Re-assessing the host range of the crayfish plague pathogen by DNA-based approaches: Implications for disease dynamics and spread	Adam Petrusek
	Quarantine arthropod invasions in Europe: Climate, host plants, propagule pressure, and border controls	Sven Bacher & Steven James Bacon
	Combining two major databases to assess taxonomic and habitat-related patterns in introduction pathways of alien species	Wolf-Christian Saul
	The global network of plant invasion caused by international trade	Hanno Seebens
	The role of humans in the dispersal of pumpkinseed (Lepomis gibbosus)	Grzegorz Zięba
	The invasion of an American boatman Trichocorixa verticalis verticalis in Europe, consequences for native species, and the role of the salinity gradient	Andy J. Green
	The silent invasion of native species in Brazil	Dalva M. Silva Matos
	Predicting the potential distribution of Amorpha fruticosa invasive plant species in the Mureş Floodplain Natural Park using bivariate analysis	Ines Grigorescu & Gheorghe Kucsicsa
	Invasive knotweed (*Fallopia × bohemica* (Chrtek & Chrtková) J. P. Bailey) is allelopathic only in artificial substrates	Madalin Parepa
Prevention and Early Detection of Biological Invasions 09:00-10:30 @ 5 Nov Ingolf KUHN	Horizon-scanning and surveillance: invasive alien species in Great Britain	Helen Roy
	EDDMAPS & Bugwood Apps: Using Information Technology & partnerships to collect data and map invasive species across the U.S.	G. Keith Douce
	Assessing the threat and potential for management of Berberis spp. (Berberidaceae) in South Africa	Jan-Hendrik Keet
	A European Early Warning and Rapid Response System of invasive alien species	Ana Cristina Cardoso
	WRASP: A spatial weed risk assessment tool reveals important sub-national variations in weed risks	Darren J. Kriticos & Josef R. Beautrais
ESENIAS-NEOBIOTA SESSION: Alien species in South and East Europe 11:00-13:00 @ 5 Nov	Invasive alien plants in Croatia – distributional patterns and range size	Božena Mitić
	Feeding Habits of the invasive Topmouth Gudgeon, Pseudorasbora parva (Temminck & Schlegel, 1846), population in Hirfanlı Reservoir, Central Anatolia, Turkey	Şerife G. Kırankaya & Şükran Yalçın Özdilek
	The exotic flora of Turkey and Preliminary Check-list of Invasive Alien Plant Species (IAS) in Turkey	Necmi Aksoy

Teodora TRICHKOVA Rumen TOMOV	Tree plantations in Southern Europe and the risk of invasion to neighbouring ecosystems	Patrícia Fernandes
	Seed bank of Amorpha fruticosa L. on some ruderal sites in Serbia	Bojan Konstantinovic & Milan Blagojević
	Sunflower Broomrape (Orobanche cumana Wallr.): An invasive parasitic plant in sunflower production areas in Turkey and in the World	Yalcin KAYA
	The Black Sea highway: the route of common ragweed invasion in Turkey	Hüseyin Önen
Evolution of biological invasions 14:00-16:30 @ 5 Nov Emili GARCIA-BERTHOU Antonio SOARES	Genetic diversity facilitates the establishment of a perennial invader but is not associated with population growth rate	Satu Ramula & Shou-Li Li
	Genetic differentiation between native and invasive populations of *Quercus rubra*	Nastasia Merceron
	Comparison of molecular diversity of three Impatiens species from Central Europe and Baltic region	Eugenija Kupcinskiene
	Evolutionary analysis of seed size variation and its contribution to non-native invasion	Özkan Eren/José L. Hierro
	"American" and "European" Douglas-fir	Marcela van Loo
	The lime leafminer Phyllonorycter issikii, a highly invasive pest in Europe: genetics of invasion and systematic	Natalia Kirichenko
Impacts of Biological Invasions (1) 17:00-18:00 @ 5 Nov F Guler EKMEKCI	Pan-European evaluation of impact assessment protocols for invasive alien species	Marc Kenis
	New kids on the block: a case study of how invasives can alter early-life stage fish-mussel interactions	Luděk Šlapanský
	Parasite spill-over, spill-back and dilution effects of invasive oysters in the Wadden Sea	M.A. Goedknegt & Anouk Goedknegt
	Can Corbicula fluminea (Bivalvia: Corbiculidae) exert a significant top-down regulation on estuarine phytoplankton?	Pedro Morais
Biological Invasions Under Climate Change 18:00-19:00 @ 5 Nov Giuseppe BRUNDU	Predicting invasiveness of a freshwater fish under conditions of climate warming using a life-history model	Gordon H. Copp
	Will climate change and water restriction drive the arrival of new pests and pathogens?	Alberto Santini
	The impact of forest management and climate change on the reproductive investment and physiological performance of an invasive acacia: Potential consequences in the invasive pattern	Cristina Máguas & Patrícia Fernandes
INVITED TALK 08:30-09:00 @ 6 Nov Uwe STARFINGER	Threats posed by non-native freshwater fish introductions to biodiversity in the Mediterranean Basin region: a case study from Turkey	Ali Serhan TARKAN
Impacts of Biological Invasions (2) 09:00-10:30 @ 6 Nov Baruch RUBIN	Everything you always wanted to know about impact but were afraid to ask	Sabrina Kumschick
	Alien and native plant species play different roles in plant community structure	Philip Hulme
	Environmental Risk Assessment of the Emerald Ash Borer, Agrilus planipennis	Gritta Schrader
	Competition for a shelter among invasive Ponto-Caspian gobies and native European bullhead Cottus gobio	Dagmara Rachalewska

	Interaction Rewiring in Plant-Pollinator Networks Invaded by a Non-Native Plant	Ana Montero-CASTAÑO & Montserrat VILÀ
Biotic and Abiotic Control of Alien Species 11:00-13:00 @ 6 Nov Wolfgang RABITSCH Eugenija KUPCINSKAS	Why is species richness a poor predictor of invasion success?	Anna Henriksson
	The role of hydrological alteration in explaining invasiveness of two North American fish species introduced to the Iberian Peninsula	Emili García-Berthou
	A SMARTER approach to assess the impact of an established, exotic leaf beetle on invasive ragweed Europe	Suzanne Lommen
	The ragweed leaf beetle landed in Europe: fortunate introduction or threat?	Heinz Müller-Schärer
	Landscapes of biotic resistance: context-dependencies restructure the allometric scaling of predator-prey interactions	Daniel Barrios-O'Neill
	Limiting similarity by functional group resemblance: Preventing plant invasion during grassland restoration	Florencia Yannelli
	Adaptation of native hyperparasitoids to the invasive aphid parasitoid Lysiphlebus testaceipes (Hymenoptera, Braconidae, Aphidiinae) in Benin, West Africa	May-Guri Sæthre
Impacts of Biological Invasions (3) 14:00-16:30 @ 6 Nov Montserrat VILÀ Laura MEYERSON	Can the functional traits of introduced plants be used to estimate impact to ecosystem services?	Ryan Blanchard
	The combined effects of invasive species in riparian and lotic communities on leaf litter breakdown	Helene C. Bovy
	Invasive Species in a Changing World; can we predict new invaders and their ecological impacts?	Jaimie Dick
	Invaders under threat: how alien Ponto-Caspian gammarids respond to their potential predators and competitors	Jarosław Kobak
	The impact of biological invasions on reciprocal relationships in biological communities	Romain Rouchet
	Impacts of invasive alien marine species on ecosystem services and biodiversity: a pan-European review	Ana Cristina Cardoso & Stelios Katsanevakis
	Human health impacts of alien species in Europe: a scoping review	Stefan Schindler
	Effect of invasive species Urochloa decumbens on carbon stocks in Cerrado (Brazilian savanna)	Vania Pivello
Impacts of Biological Invasions (4) 17:00-19:00 @ 6 Nov Marc KENIS Bozena MITIC	Alien and translocated fish species: Bridging the gap between economics and ecology	F Güler Ekmekçi
	The impact of a predator on competitive interactions between two Ponto-Caspian gammarids: Dikerogammarus villosus and Pontogammarus robustoides	Anna Dzierżyńska
	Fourteen years later and there remains a poor understanding of the invasional meltdown; A new framework and a way forward	Sidinei Magela Thomaz
	Are water quality and invasive alien species important drivers of macroinvertebrate diversity?	Pieter Boets
	Blackberry invasion threatening unique Scalesia forest on Santa Cruz Island,	Heinke Jäger

	Galápagos	
	From impact to damage: a review of different approaches to assess non-native species	Robert BARTZ
	The effect of flow on the competition between the alien racer goby and native European bullhead	Łukasz Jermacz
INVITED TALK 08:30-09:00 @ 7 Nov Melanie JOSEFSSON	The EU IAS Regulation – policy and implementation	Niall MOORE
Policy and legislation 09:00-10:30 @ 7 Nov Helen ROY	Biocontrol - a tool not to be ignored when drafting the list of invasive species for the new EU Regulation	Richard Shaw & Rob Tanner
	Can Europe unite to tackle Invasive Alien Species?	Anne Turbé
	The ISEIA and Harmonia+ protocols : five years of prioritization practice in Belgium	Sonia Vanderhoeven
	Biological Control of Invasive Plants: the need for free exchange of genetic resources	Massimo Cristofaro
Public Perceptions and Communication of Invasion Risks 11:00-13:00 @ 7 Nov Heinz MÜLLER-SCHÄRER	Invasive Species Survey in Koh Chang, Thailand	Pongthep Suwanwaree & Kawisara Seheng
	Freshwater Invasives Networking for Strategy - Tackling Invasive Alien Species in Europe: the Top 20 Issues	Frances Lucy
	Public Outreach and Recording of Invasive Alien Species in the UK.	Peter M.J. Brown
	Recommendations for the management of invasive species	Doreen Schmiedel
	Biosecurity in Ireland – Averting the Threat of Aquatic & Riparian Invasive Species	M Millane, P McLoone& J. M. Caffrey
	An International Plant Sentinel Network	Ellie Barham

POSTER PRESENTATIONS

Sessions and Titles	**Corresponding/First author**
Temporal and Spatial Trends	
The Distribution of the Eastern Mosquitofish (Gambusia holbrooki) and endemic Aphanius villwocki in the Upper Sakarya River Basin (Turkey)	Yoğurtçuoğlu et al.
Reconstructing the invasion of Cyperus esculentus in Central Europe	Follak et al.
Feral occurrence of arable crops and vegetables along the Vltava River - the influence of floods	Holec et al.
Downstream drift of early life stages – an important means of dispersal for invasive gobiid fishes?	Janáč et al.
Rapid colonization of *Arcuatula senhousia* in a Northern Adriatic lagoon	Mavrič et al.
Invasive Plant Species in Suranaree University of Technology Campus, Thailand	Muangsan et al.
Prediction of invasive species spread using selected distribution models	Pěknicová et al.
Neophytes in restored post-mining areas	Pusch et al.
Distribution of Exotic Invasive Plant Species in Waterways and Wetlands in Korea	Pyon & Park
Invasion of racoon dog in Europe: the dynamics of spread, factors promoting successful establishment and the assessment of impact	Pyšková et.al.

The invasive weeds of Iran	SohrabiKertabad et al.
Disentangling the worldwide distribution and introduction correlates of invasive mosquitofishes	Srean et al.
Distribution of invasive plants in urban environment is driven by habitat availability and urban structure	Štajerová et. al.
Non-native ichthyofauna in the Bulgarian stretch of the Danube River	Trichkova et al.
Micromorphology of achenes in Asteraceae genera: *Conyza, Bidens & Solidago*	Vinogradova et al.
A Decade of Invasion: Ecology, Spread and Impacts of Harmonia axyridis (Coleoptera: Coccinellidae) in the UK	Peter M.J. Brown
EWRS-EPPO-NEOBIOTA Session: Alien Plants in Agricultural Areas	
Alien Plant Species in Citrus Orchards in the Antalya Province of Turkey	Arıkan et al.
Dispersal potential of spotted spurge seed by soil and water	Asgarpour
Spotted spurge and wild poinsettia growth as affected by Intraspecific plant density	Asgarpour
Experiences with Ambrosia in Switzerland	Bohren
Breaking dormancy of wild oat (Avena fatua L.) seeds	Dragosavac et al.
Occurrence of archaeophytes on arable land in the Czech Republic - field survey in 2006-2008	Kolářová et al.
Long-term Artemisia vulgaris (Mugwort) Control Strategies on Hazelnut (Corylus avellana)	Mennan et al.
Parthenium weed invasion in crops: a new emerging threat to agricultural lands in Pakistan	Shabbir et al.
Reproduction ability and control of Velvetleaf (Abutilon theophrasti Medic.) in sugar beet	Soukup et al.
Molecular and classical identification of wild oat (Avena spp.) species which are economically important in wheat areas in Turkey	Türkseven et al.
A review on allelopathy studies to control Physalis spp. in Turkey	Üremiş et al.
New alien plant species in Turkey: *Ipomoea triloba* L.	Yazlık et al.
Mitigation and Control of Biological Invasions	
Management trials and demonstrations for invasive Mahonia in coastal dunes	Adriaens et al.
A First for New Zealand: Eradicating the European Alpine Newt	Ainley
Attempts to control invasive aquatic Crassula helmsii with special reference to dye treatment	Denys et al.
Best practice in management of Rosa rugosa	Isermann et al.
Effect of essential oils on germinated seeds of ragweed	Matkovic et al.
EU-COST Action on „Sustainable management of Ambrosia artemisiifolia in Europe“ (COST FA1203-SMARTER): opportunities and challenges	Müller-Schärer & Lommen
Management Of Oxalis pes-caprae L. in North Cyprus cereals fields	Turkseven et al.
Response of ragweed to herbicides: imazamox, tribenuron-methyl and glyphosate	Vrbnicanin et al.
Drivers and pathways of invasions	
Exotic dominance of ruderal communities depends on disturbance type	Chiuffo & Hierro
Functional and phylogenetic distances between a successful invader and experimental native communities under different stress levels	Conti et al.
Which traits are associated with invasiveness in the genus Impatiens?	Čuda et al.

Dispersal restrictions may explain differences in colonization by an invasive tree in Southern Brazil	Dechoum et al.
Invasive terrestrial plant species and climate - related variables in the Romanian protected areas. Selected case-studies	Dumitraşcu et al.
Looking for potential woody plant invaders in upper Žitava region (Slovakia). Part 1: An old parks survey	Ferus et al.
Tolerance to environmental stress - an important component of invasion success	Jaklič et al.
Anthropogenically impacted arborescent habitats as main drivers of introduced species distribution on insular agro-natural landscapes	Marcelino
Invasiveness of three species of Pinus in Cerrado (São Paulo State, Brazil)	Miashike & Pivello
Can reproductive and dispersal characteristics explain the naturalization of garden plants?	Perglová et al.
How the yellowhammer became a kiwi: using bioacoustics to understand invasion history	Pipek et al.
Carpobrotus edulis: physiological integration as key to invade stressful ecosystems	Sixto et al.
Factors shaping the distribution of Ambrosia artemisiifolia in the Czech Republic	Skálová et al.
Biomorphology of Caragana arborescens Lam. – an invasive species for European Russia	Vinogradova & Kuklina
Invasion of *Lupinus arboreus* and *L. polyphyllus* in native ecosystems of New Zealand	Vinogradova & Mayorov
Prevention and Early Detection of Biological Invasions	
Early warning in Belgium - waarnemingen.be as an early-detection tool	Adriaens & Casaer
Alpha-shapes: a flexible profile-type technique for delimiting climatic suitability for non-native species	Capinha & Pateiro-López
Traits of European terrestrial gastropods are correlated to the climates occupied in non-native ranges	Capinha et al.
GLOBAL WARNING: A new COST Action about tree nurseries as early warning system against alien pests	Eschen & Vannini
Risk analysis invasion of ten alien species in Venezuela	Lozano et al.
Seed morphology: useful character for screening for invasive cacti?	Rodríguez et al.
Sentinel' plants to prevent biological invasions	Vannini & Vettraino
ESENIAS-NEOBIOTA Session: Alien Species in South and East Europe	
Riparian invasion by Japanese Knotweed s.l. – preliminary findings for Serbia	Anđelković et al.
A catalogue of non-native plants for the island of Rhodes (Greece)	Brundu et al.
First record of Drosophila suzukii (Matsumura) (Diptera: Drosophilidae) in Romania	Chireceanu & Chiriloaie
New potential pest species previously considered rare in the Romanian fauna: Semanotus russicus (Coleoptera, Cerambycidae) and Ovalisia festiva (Coleoptera, Buprestidae)	Dobrin & Nitzu
Does heterogeneity of habitats/landcover reflects on the composition of Grime CSR strategies of invasive plants across different landscape scales?	Jelaska et al.
Potential distribution of the invasive weed (Oxalis pes-caprae L.) Bermuda buttercup in İzmir	Kaçan & Özkul
The status of some alien plant species and invertebrates in Romania	Manole et al.
North-American alien invasive insect species – case study of distribution, impact and risk management in Romania for Metcalfa pruinosa Say (Homoptera:Flatidae)	Manole et al.
Alien plants of the city of Zadar (Dalmatia, Croatia)	Milović et al.
Biological characteristics of common ragweed (Ambrosia artemisiifolia) – the most dangerous weed in Hungary	Nadasy et al.

Common millet (Panicum miliaceum)-a new weed problem in maize in Hungary	Pazstor et al.
Reproductive capacity of invasive weed species Asclepias syriaca L. in Serbia, Bačka region	Popov et al.
Temporal and spatial scales of impacts of alien species on the zoobenthos in the Black Sea	Shalovenkov
Galinsoga ciliata (raf.) S.f. blake invasion in arable areas in Bozdağ District (Izmir, Turkey)	Sokat & Seçmen
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The invasion history, distribution and colour pattern forms of the harlequin ladybird beetle Harmonia axyridis (Pall.) (Coleoptera, Coccinellidae) in Slovakia, Central Europe	Viglášová et al.
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Soil microarthropod communities in monospecific Fallopia japonica stands: unveiling another aspect of knotweed invasion	Mincheva & Conti
Saprotrophic fungal diversity and abundance during litter decomposition of Fallopia japonica and native grassland species	Mincheva et al.
Zebra mussel Dreissena polymorpha as the feeding ground and substratum for a Ponto-Caspian fish Babka gymnotrachelus	Poznańska et al.
Ranking Invasive Alien Species in Romania	Preda et al.
Comparison of the condition of fish fauna communities between the Oder and Vistula drainage basins using the Zoogeographic Integrity Coefficient	Rachalewska et al.
Lysiphlebus testaceipes: a globally introduced biological control agent and an invasive species	Sæthre et al.
What do we know about non-native fishes? The perspective from Florida, USA	Schofield & Loftus

Habitat preferences and impacts of the highly invasive Poaceae Urochloa arrecta in Brazilian inland waters	Thomaz & Michelan
Acacia dealbata in Mediterranean shrubland: soil and plant changes after invasion	Luís González & Souza-Alonso Pablo
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Does plant activator application help to antioxidant defense of tomato plants during broomrape infection?	Acar & Ozkal
Ragweed leaf beetle: a friend or a foe?	Toth et al.
Occurrence of Dreissena polymorpha in Bulgarian inland waters in relation to calcium concentration	Trichkova et al.
Policy and Legislation	
The Invasive Species Compendium: information for assessing invasive species threats	Charles et al.
Priority Invasive Alien Plants in Natura 2000 sites in Greece	Galanidis et al.
Alien species in the Czech Republic: Black, Grey and Watch List with recommended management action for state authorities	Pergl et al.

ORAL PRESENTATIONS

Ecological Impacts of Novel Chemicals on Aboveground Patterns and Belowground Processes

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Some exotic plants do bring chemicals novel for the invaded ranges, which can suppress the establishment and growth of local species, the process is known as allelopathy. The chances of allelopathy as a potential driver of the invasion success are higher in invaded ranges due to naïve soil communities and sensitive neighbors, at least in the early phases of invasion. Novel chemicals influence plant growth, soil communities, soil fertility, litter decomposition and native herbivores. The production of novel chemicals is linked to enemy release, evolution of increased competitive abilities and soil microbial communities. I will talk about ecological impacts of novel chemicals and their interactions with invaded environment in contexts of ecosystem processes and coevolutionary relationships. The ecological roles of novel chemicals in exotic plant invasion will be discussed by taking examples of *Ageratina adenophora*, *Chromolaena odorata*, *Prosopis juliflora* and *Eucalyptus globulus*.

Rapid Physiological Adaptation to Low Oxygen in Invasive Populations of Both Quagga and Zebra Mussels?

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Both ecological and evolutionary processes are expected to be important in predicting the future range and impact of non-native species. The zebra mussel, *Dreissena polymorpha* (Pallas, 1771), and the quagga mussel, *Dreissena rostriformis bugensis* (Andrusov, 1897), are among the most prominent and most detrimental aquatic invasive species in Europe and North America. The zebra mussel has a relatively long invasion history in Western Europe. In contrast, the quagga mussel invasion to the lowland rivers and lakes in Western Europe started only a decade ago and its further spread to deep alpine lakes is expected in the near future. The degree of tolerance to low oxygen and low temperature might be an important niche shaping factor for both zebra and quagga mussels, limiting their colonization potential in the deep zones of lakes with pronounced stratification and hypolimneal oxygen depletion. In this study, we compared differences in tolerance to low-oxygen conditions among invasive populations of zebra and quagga mussels. We exposed quagga and zebra mussels of three different populations from Western Europe to four oxygen levels (7%, 33%, 66% and 90%) and two temperature (11°C and 18°C) regimes. We found that the differences in survival among oxygen and temperature treatments depended more on the population origin than on the species identity. This finding suggests that populations had gone through rapid and convergent processes to adapt to local conditions after invasion, in particular to low oxygen conditions, which is especially relevant for colonization of deep alpine lakes of Europe. We therefore suggest that potential evolutionary processes need to be taken into account when predicting the further spread of zebra and quagga mussels in Western Europe in the future.

Keywords: Physiological adaptation, *Dreissena polymorpha*, *Dreissena rostriformis bugensis*, oxygen limitation, survival analysis

The Big Picture: Insights into Vascular Plant Invasions Worldwide

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The factors that determine variation in plant invasions world-wide are still poorly understood due to the lack of rigorous data. Here, we introduce the first comprehensive global database of alien vascular plant species distributions in regions throughout the world – the GloNAF (Global Naturalized Alien Flora) database, which has been compiled by a core group of invasion ecologists. This database currently contains occurrence data > 10,000 naturalized vascular plant species in around 400 regions of the world (covering c. 80% of the Earth's land area).
This data set offers *inter alia* unique possibilities to assess the state of research, the level of invasions across biogeographic and climatic regions and regions shaped by highly different levels of human impact. In our talk, we will present the key features of GloNAF, present first results on the biogeography and macroecology of global plant invasions, and will outline on-going and planned research activities.

Keywords: biogeography, distribution, diversity, macroecology

Beyond Climate: Disturbance Niche Shifts in Invasive Species

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Analyzing how species' niches shift between native and introduced ranges is a powerful tool for understanding the determinants of species distributions and for anticipating range expansions by invasive species. Most studies only consider the climatic niche, by correlating widely available presence-only data with regional climate. However, habitat characteristics and disturbance also shape species niches, thereby potentially confounding shifts attributed only to differences in climate. Here, we used *Oxalis pes-caprae* L., a species native to South Africa and invading areas globally, as a case study to understand how niche shifts based on abundance data may be influenced by disturbance at habitat and landscape scales in addition to climate. We used available presence-only data and also conducted extensive surveys of the abundance of *O. pes-caprae* (~11,000 plots) across different habitats in the native range and the introduced range in the Mediterranean Basin. We extended PCA methods for measuring niche shifts with Bayesian GLMs to identify climatic and disturbance niche shifts. We found a large climatic niche expansion towards higher seasonality and lower temperature in the introduced range, but this expansion was greatly reduced when considering only conditions available in both ranges. *O. pes-caprae* occupied more natural landscapes in the native range that remained unoccupied in the introduced range ("niche unfilling"). In contrast to the even abundance across natural and disturbed habitats in its native range, *O. pes-caprae* was more abundant in disturbed habitats in the introduced range. The large climatic niche expansion suggests significant plasticity of *O. pes-caprae* rather than rapid evolution. Furthermore, the unfilling of its disturbance niche in the introduced range suggests high potential for further invasion of natural areas. Together, these findings suggest that characterizations of invasive species' niches based only on climate or partial information of their distribution, risk underestimating their potential for future spread.

Keywords: biological invasions; non-native species; Bayesian; invasion risk; niche conservatism

Predicting Invasions in Novel Climates: A Case Study of Exotic Crassulaceae in New Zealand

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Predicting the spread of alien plants is critical for risk assessment, but there is no consensus on best practice in distribution modelling. Studies often derive predictions by pooling data from the native and invaded ranges under the assumption of niche stability, although the frequency of niche shifts in invasions is unclear. Despite recommendations to test these assumptions prior to modelling, and tools to do so, this is not common practice.

We use alien plants in New Zealand to demonstrate how prior niche analysis complements the modelling process and informs methodological decisions, and that niche stability cannot be assumed. We show how model predictions using pooled data can be misleading in such cases.

We examine the native and invaded climatic niches of *Aeonium arboreum* (L.) Webb & Berth., *A. haworthii* (L.) Webb & Berth., and *Cotyledon orbiculata* (L.). Each showcases a different scenario; non-analog climates, niche expansion in the invaded range, and possible niche shift. We model suitable climate in New Zealand using MaxEnt via native, invaded and combined ranges. Using established niche analysis methods, we explain why each species must be modelled using New Zealand data only.

We show that the New Zealand niches overlap considerably between species, and that much of the coastline is climatically suitable. They appear to be limited by seasonal precipitation and temperature, and spread is likely to continue.

We strongly advise examining the niche before modelling invasions, and comparing predictions from multiple ranges. Where only native range data are available, quantifying niche characteristics will be crucial for confidence in our predictions.

Species distribution models are a powerful tool for invasion ecology, but searching for a "one-size-fits-all" method has led to confusion. Instead, studies such as this can contribute to developing a niche-based framework, leading to more accurate predictions of invasion risk.

Keywords: Niche; SDM; Crassulaceae; New Zealand

Identifying the Signal of Environmental Filtering and Competition in Invasion Patterns
A Contest of Approaches from Community Ecology

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In 1859, Darwin had identified environmental constraints and competition with the native community as major drivers of invasion success. Since then, a toolbox of indices and statistical approaches has been developed and commonly applied to test for the relative importance of these drivers. This toolbox is largely based on community ecology theory with the underlying hypothesis that patterns of trait (or phylogenetic) similarities between invaders and native species permit to disentangle the signatures of competition and environmental filtering. However, so far the performance of the indices and statistical approaches has not been thoroughly evaluated and there exists no study exploring the sensitivity of the different methods given common biases in field data. This severely hampers inter-comparisons of invasion studies, and ultimately prevents the elaboration of general conclusions.

In this work, we developed a *mechanistic community assembly model* to simulate invasion patterns across a range of communities (available on R-forge: *VirtualCom*), and tested the performance of four different indices aiming at disentangling environmental filtering *vs.* competition from these patterns. Furthermore, we evaluated the sensitivity of the statistical methods to biases in the data (resulting from non-equilibrium dynamics or observation errors).

Our results indicated that the best performing index was MDNS, or the average functional distance between the invader and all the species of the community, especially in heterogeneous landscapes. Further, we demonstrated that the detection of competition was more sensitive to the presence of biases in the data than was the detection of environmental filtering.

In conclusion, studying invasion mechanisms based on community patterns is possible when employing the appropriate statistical method, but it is highly sensitive to the quality of the dataset used.

Keywords: Community assembly rules, Darwin's naturalization, (dis)similarity indices, virtual ecology

Community Structure, Succession and Invasibility in a Seasonal Deciduous Forest in Southern Brazil

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Most trees are considered invasive in grasslands, shrublands, and temperate forests. *Hovenia dulcis* is an exception, being one of the most pervasive invaders in Brazilian subtropical forests, apparently competing with native plants for resources and reducing their populations. This study was aimed to identify the clues for success of *H. dulcis* by defining the structural and functional characteristics of plant communities in different stages of succession with and without *H. dulcis*. Following the general assumptions of invasion ecology, we expected that *H. dulcis* establishment and invasion success would be significantly higher in early successional communities, with high resource availability and low species richness and diversity, as well as low functional diversity. Contrary to this hypothesis, no differences were found between plant communities invaded and non-invaded by *H. dulcis* at three different succession stages. No relationship was found between species richness and diversity and functional diversity, with respect to invasibility along the successional gradient. *H. dulcis* is strongly associated with the semi-open vegetation type, where the species was found in higher density. The invasion of the open vegetation type is more recent, providing evidence of the species' ability to invade plant communities in early successional stages. In conclusion, colonization by *H. dulcis* seems to be associated with forest openness but the species is able to persist in the successionally more advanced communities.

Keywords: invasive trees, *Hovenia dulcis*, functional diversity, biotic resistance, disturbance.

Using Historic Botanical Literature to Chart the Geography, Habitats and Pathways of Invasive Species

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Scientists can observe current biological invasions; however, it is difficult to understand the whole invasion process due to unavailability of long-term data. We frequently lack data covering more than a few decades, yet historical biodiversity literature is a potential mine of useful information on all aspects of biogeography and biological invasions. It spans more than 400 years of history and is a rich source of information, particularly over the past 200 years. We have demonstrated how useful information found in botanical literature can be obtained and combined with data from specimens to provide useful scientific information.
Here, we use the example of *Chenopodium vulvaria* L., a small insignificant weed that, on the one hand, is an endangered species in parts of Northern Europe and on the other hand is an alien weed in Australia, California and elsewhere. By combining data from hundreds of sources it is possible to chart changes in the introduction routes and vectors, changes in the distribution and changes to the habitat. This approach has a great potential for many other species to document their introduction and provide a long term perspective of the invasion process.

Keywords: invasion history; Chenopodium vulvaria; text mining; text analysis

What We Can Learn About Ecology of Invasive Plants from Unsystematically Collected Data?

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Chorological data can differ by various criteria (origin, age, format etc.). Here, we were interested in various spatial accuracy of chorological data on invasive plants in Croatia, and how this difference affects environmental data which can be attributed to recorded localities. Chorological data in Flora Croatica Database originate from various sources (literature, herbarium, field data) and are associated with one of the 11 levels of spatial precision. Latter are ranging from least accurate that corresponds to whole region (e.g. Dalmatia) to the most accurate level corresponding to coordinates obtained by GPS devices. More than 11000 chorological data were joined with environmental data (topography: elevation, slope, aspect; climate: yearly precipitation, mean and minimum temperature; distance from settlements; human population density) within the frame of Geographical Information Systems. Descriptive statistics for environmental data were calculated for different subsets that were separated based on their spatial accuracy (e.g. all data, highest precision data, upper half precision data, least precise data etc.). This was done for individual plant invasive species and for set containing data on all species. Results have shown that data with less spatial accuracy do not have substantial effect on the information about environmental conditions in which a certain invasive plant occurs, when they are analysed together with data with higher spatial accuracy. However, this is not the case when we use imprecise data solely, whereas such analyses provide significantly different information than those obtained with spatially more precise data. Still, some relevant information about the ecology of species could be acquired even with less precise data, with some help of spatial analyses (creating buffer zones and employing neighbourhood statistics) prior to joining environmental data to such localities.

Keywords: GIS; spatial precision; environment; invasive plants

Implications for Invasion Resulting from Phylogeographically Based Variation in Nuclear Genome Size and Plant Defense in *Phragmites*

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Phragmites is among the most widespread and successful plants globally and is of note because it is both an invasive species and provides valuable habitat and ecoservices across its range. *Phragmites* is also recognized as an important model genus in ecology and invasion science because of its broad distribution and high genetic and karyological diversity. In a common garden in Denmark containing plantings from over 200 *Phragmites* populations collected globally, we tested the following. 1) Populations with larger genomes are less common in extreme environments; i.e., genome size decreases with increasing latitude. 2) Plant nutritional condition (%C, %N, CN ratio, %water), biomass and herbivore defense (leaf toughness, total phenolics) vary with phylogeographic group, genome size (GS), ploidy level, and geographic origin (latitude and longitude). 3) Palatability to the widespread and common herbivore, the aphid *Hyalopterus pruni* (Geoffroy, 1762) varies with *Phragmites* nutritional condition, defense levels, GS, and phylogeographic group. We made separate comparisons for the entire collection of populations and for three phylogeographic groups in North America (native, invasive, Atlantic invasive). *Phragmites* GS was nonlinearly related to latitude but this was driven by populations with large genome sizes. Plants with large GS were most common at intermediate latitudes (~35-45^0). Across all groups, we found significant negative correlations of GS with N and aphid mass, positive relationships between GS, phenolics, and %water, and weak relationships between phylogeographic group and biomass and toughness. Finally, comparing only NA groups, we found no significant relationships between GS and N, phenolics, and aphid colony size but did find significance for C, %water, toughness and aphid abundance. These data suggest that phylogeographic group and GS (irrespective of ploidy level) are important in invasion success and merit further attention. Furthermore, the data also suggest that global change may play a key role in the future phylogeographic distribution of *Phragmites*

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Keywords: Plant-insect interactions, Polyploidy, *Hyalopterus pruni*, latitude, invasive species

Naturalization of Central European Plants in North America: Disentangling the Roles of Species Traits, Habitat Legacy, Propagule Pressure and Residence Time

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The factors that promote invasive behaviour in introduced plant species occur across many scales of biological and ecological organization. Those acting at relatively small scales, for example biological traits associated with invasiveness, scale up to shape species distributions amongst different climates and habitats, together with other characteristics linked to invasion, such as attractiveness for cultivation (determining the propagule pressure). To identify the drivers of invasion, it is necessary to disentangle the contribution of multiple factors that are interdependent. Using path analysis, we describe how species traits, habitat affinity in the native range, propagule pressure in both ranges and residence time interacted in the process of invasion of 466 central-European plant species into North America. The invasion success, in terms of the number of North American regions invaded, most strongly depends on the minimum residence time in the invaded range, and the number of habitats occupied by species in their native range. The effects of biological traits on invasion success were mainly indirect, via their effect on the number of native range habitats occupied and propagule pressure in the native range. Persistent seed banks, long flowering period and stress-tolerant life strategy were among the traits with strongest influence. Yet, the importance of the biological traits was nearly an order of magnitude less than that of the larger-scale drivers, and

highly dependent on the invasion stage (traits were associated only with native-range drivers). Our results suggest that future research should explicitly link biological traits to the different stages of invasion, and that a failure to consider minimum residence time or characteristics of the native range may seriously overestimate the role of biological traits, which in turn may result in spurious predictions of plant invasiveness.

Keywords: biological traits; habitat; native range; propagule pressure; residence time

Fertile Crescent: A Cradle of Crops is A Cradle of Weeds?

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Where do alien weeds come from? When did they become weeds? The arable weeds of crops provide a unique system for studying invasions at a global scale. The widespread prevalence of crop fields has resulted in essentially the same habitat being replicated in different parts of the world with well documented records of species distributions. Here we present the results of a global literature survey documenting the weeds found in wheat fields in different countries. We hypothesize: (1) countries with a greater area in wheat cultivation and with a longer history of wheat cultivation will have more weed species associated with wheat fields; (2) countries with a longer history of wheat cultivation and higher native plant diversity will have a greater proportion of native species in the weed flora associated with wheat fields.

Using Web of Knowledge, Google and Google Scholar, we found 582 papers from 41 countries with data on the weed species found in wheat fields. These papers listed about 1,500 weed species. The number of weed species in each country was strongly and positively correlated with the harvested area of wheat but weakly correlated with the length of wheat cultivation history. The proportion of native species in the weed flora increased with the length of wheat cultivation history but was not correlated with local native plant diversity.

Our results suggest that weed species adapted to crop fields tend to colonize new regions over time but that adaptation of local native plants to crop fields may take longer perhaps due to the often marked habitat differences between crop fields and their surrounding native environments. The Fertile Crescent and surrounding areas, where wheat originated, appear not only to be the cradle of this cultivated crop but also of its weeds.

Keywords: wheat, arable weeds, weed flora, literature survey, meta-analysis

Approach to a Control Strategy Against *Cyperus esculentus*

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Cyperus esculentus L. (yellow nutsedge) is one of the most problematic weeds in many crop production systems in subtropical and temperate zones around the world. The species was found in 1989 as a troublesome weed in the Swiss Ticino region, belonging geographically to the North Italian range. Locations in the Swiss Mittelland region north of the Alps were reported for the first time in 1992. Since 1998 the Central Office for Horticulture mentioned regularly yellow nutsedge in their annual reports as a troublesome weed invading several locations in western Switzerland. New locations were registered in several Cantonal Plant Protection Services in the last five years. In general an exponential increase of registered infestations was observed since 2010. *C. esculentus* is listed in Switzerland on the so called 'watch list' of Infoflora as a plant species which needs to be surveyed because it has the potential to harm. *C. esculentus* is characterized as: an invasive weed in agricultural zones; propagating at the expense of indigenous species; belonging to the ecological group of weeds and ruderals; invading plantation, crop and field habitats.
C. esculentus is a C_4 plant with a perennial nature. It has the ability to form underground tubers that makes it highly competitive and a difficult weed to control. The tubers are produced on rhizomatous tissue from the beginning of May until early October. The germination of a second generation of tubers was not observed in Switzerland north of the Alps. Tubers are effective means of spread inside and between agricultural fields. Numbers of seedlings above ground and numbers of tubers in the ground are often weakly related; therefore reducing the number of tubers is the only way for successfully breaking the invasion. An important factor for non-timely information about newly infested fields is the lack of knowledge of the farmer about the appearance and the biology of this new weed.

Keywords: soil cultivation, tuber count, herbicide, correlation of tubers and seedlings

Can the Invasion of Common Ragweed be Halted? New Insights from an International Project

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The European Commission, DG Environment, has funded the research project 'Complex research on methods to halt the Ambrosia invasion in Europe - HALT AMBROSIA' (07.0322/2010/58340/SUB/B2) as a pilot study for the development of control measures against invasive species. Research has been executed from Feb. 2011 till Feb. 2014.

The overall aim of the project was to contribute to the reduction of the prevalence of the invasive alien plant Ambrosia artemisiifolia in European countries in order to reduce the burden on public health, agriculture and biodiversity.

The research focussed on the following fields:

- Biological fundamentals:

We studied biological characters of ragweed necessary for a better planning of control and eradication, in particular the conditions for germination and for the survival of seeds in the soil.

- Non-chemical and integrated control strategies

We ran experiments in order to improve and adapt physical methods for ragweed control, such as hot water or steam treatments.

- Best use of herbicides

We studied optimal timing, dosage and technology of herbicide application.

- Impact on non-target species and biodiversity

We analysed the impact of common ragweed on the biological diversity of invaded vegetation and reviewed the effects of different control measures on co-occurring plant species.

Following these studies we give recommendations:
Be informed

– countries should conduct programmes to assess the frequency and distribution of ragweed, the concentration of pollen in the air and the extent of damage to agriculture and human health.

Prevent further introduction

– countries should apply measures that reduce the transport of ragweed seeds into and within the country.

Organise control

– countries should set up management strategies and legal instruments that make prevention of spread, control and eradication obligatory.

Raise awareness

– countries should run campaigns to inform the public about the plant, its negative impacts and ways to control it

Keywords: ragweed, control strategies, European Commission

Management of *Parthenium hysterophorus* L. in Israel

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Parthenium hysterophorus (Asteraceae) is an annual plant native to the subtropics of North and South America. The plant has been introduced accidentally to Israel (the only country within the EPPO region) during the late 70's of the 20th century. The initial introduction site was a palm date (*Phoenix dactylifera*) orchard in kibbutz Tirat Zev, the Jordan valley. *P. hysterophorus* could survive growth conditions of 210 m below sea level and air temperatures approaching ~50°C which occur during the summer in the Jordan valley. Since two decades, *P. hysterophorus* is rapidly spreading from the initial establishment towards north (Lake of Galilee) and west (Jezreel valley) and is found in orchards, chickpea, cotton and tomato fields. The management of such aggressive weed is rather complicated, especially due to the need of hormone-like herbicides (e.g., 2,4-D) that should be applied before weed flowering. Field experiment conducted in chickpea (*Cicer arietinum*) and alfalfa (*Medicago sativa*) showed that some herbicide tank mixtures applied PRE and EARLY POST applied herbicides were effective against the weed. Fluroxypyr and triclopyr applied POST effectively control *P. hysterophorus* in range land and roadsides. Special management program are needed in order to contain the weed and limit its fast spread in Israel.

Keywords: *Parthenium hysterophorus,* herbicides, management

Managing Invasive Littleseed Canarygrass Through Wheat Allelopathy

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Littleseed canarygrass (*Phalaris minor* Retz.) is one of the most troublesome invasive weed of wheat in South Asia. In a set of laboratory and field experiments, the allelopathic potential of wheat was evaluated to manage canarygrass. In initial laboratory experiment, using ECAM (Equal Compartment agar method), different wheat genotypes were screened for their allelopathic potential against *P. minor*. All wheat cultivars (*i.e.* Faisalabad-08, Sehar-06, Shafaq-06) differed significantly in suppressing the growth of *P. minor* and also in producing total soluble phenolics in their root and shoot tissues. Shafaq-06 showed maximum inhibition in root and shoot (length and dry weight) with maximum total soluble phenolics in its root and shoot tissues. It was followed by Faisalabad-08 for inhibition of all growth indices of *P. minor* and in production of total soluble phenolics. Minimum inhibition was observed by Sehar-06. In second experiment, the wheat genotypes (selected from initial trial), were grown in hydroponic culture. Shafaq-06 had maximum number and amount of allelochemicals in its root exudates and it was followed by Faisalabad-08. Minimum number and amount of allelochemicals were found in root exudates of Sehar-06. In the third experiment, synthetic analogs of identified allelochemicals (gallic acid, *p*-coumaric acid, *p*-hydroxy benzoic acid, m-coumaric acid and vanillic acid) were applied to sand grown seedlings of *P. minor* at two different concentrations alone and in combinations. Inhibition in root and shoot (length and dry weight) was recorded and it showed that inhibition was concentration dependent. Moreover, allelochemicals applied in combinations were more effective than applied alone. The selected cultivars were also grown with different density levels of *P. minor* under field conditions for two consecutive years. All three cultivars differed significantly in inhibiting *P. minor*. Shafaq-06 was better in its suppression ability than Faisalabad-08 and Sehar-06. Shafaq-06 and Sehar-06 were also grown in different row spacing. The density and dry weight of *P. minor* increased with increase in row spacings for both cultivars during both years. Shafaq-06 and Faisalabad-08 proved better than all other cultivars in managing *P. minor* under field conditions due to their strong allelopathic and competitive ability, whereas, Sehar-06 showed weak allelopathic potential against *P. minor*.

Keywords: *Phalaris minor*, allelopathic potential, wheat cultivars

"NOT ATTENDED"

"**NOT ATTENDED**"

The Invasion and Allelopathic Effect of *Artemisia vulgaris* L. in the Different Agricultural Crops in Lithuania

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In recent years, the increased invasion of *Artemisia vulgaris* L. in agricultural crops has gained attention in Lithuania. *A. vulgaris* is an herbaceous, perennial plant belonging to the *Asteraceae* family which typically grows in weedy and uncultivated areas, such as waste areas and roadsides. *A. vulgaris* contains biologically active compounds such as sterols, terpenes, flavonoids, saponins and tannins. The objective of this investigation was to compare the invasion and allelopathic effect of *A. vulgaris* in the following agricultural crops: winter wheat (*Triticum aestivum* L.), a mixture of oats (*Avena sativa* L.) and peas (*Pisum sativum* L.); and early potatoes (*Solanum tuberosum* L.) (Experiment I). The investigations were carried out in 2011 at the Experimental Station of Aleksandras Stulginskis University. The influence of different concentrations of *A. vulgaris* biomass water extract (distilled water (control); and ratios of *A. vulgaris* biomass and distilled water were 1:6250; 1:1250, 1:250, 1:50, and 1:10) on winter wheat and spring barley grain germination and early growth was also investigated in the laboratory (Experiment II). The highest above-ground and root dry biomass of *A. vulgaris* were established in the early potato crop and the lowest indices were found in the mixture of oats and peas. The different concentrations of water extract from *A. vulgaris* had no significant effect on winter wheat germination. The highest concentration of water extract significantly inhibited germination (48.1%) of spring barley compared with the distilled water. Water extracts of higher concentrations (1:250, 1:50 and 1:10) inhibited the growth of winter wheat shoots (from 23.5 to 48.0%) and winter wheat roots (from 18.5 to 55.0%). The growth of spring barley shoots (from 12.2 to 43.9%) and roots (48.8%) were inhibited by the 1:50 and 1:10 concentrations. Overall, the most favourable conditions for *A. vulgaris* growth were in the potato crop. *A. vulgaris* had no significant allelopathic effect on the germination of winter wheat, but the growth of shoots and roots was inhibited more compared with spring barley.

Keywords: common mugwort; *Artemisia vulgaris*; biometrical indices; chemical composition; invasion

Dealing With Risks to Agriculture from Invasive Alien Plants : Eppo's Role

Sarah Brunel

EPPO

The European and Mediterranean Plant Protection Organization (EPPO) provides recommendations and information to its 50 member countries contributing to an early warning on invasive alien plants. EPPO's objective is to identify and to implement preventive measures on new emerging pests (including invasive alien plants) which could cause detrimental agricultural, ecological and other impacts in the EPPO region.

The tools in place for organizing this early warning and spreading information are:

- lists of invasive alien plants: the Alert List, the A1 List is composed of species not present in the EPPO region, the A2 List is composed of species present but not widely distributed in the EPPO region, for example *Heracleum* spp., *Parthenium hysterophorus, Polygonum perfoliatum, Solanum elaeagnifolium* which have mainly agricultural impacts.
- Pest Risk Analysis for species proposed to be recommended for regulation (and therefore registered to the A1 and A2 Lists);
- a monthly Reporting Service focusing on new geographical records, new host plants, new pests, pests to be added to the EPPO Alert List, detection and identification methods, etc.;
- Management measures (e.g. on *Ambrosia artemisiifolia*, *Heracleum* spp., *Parthenium hysterophorus, Sicyos angulatus*).

Once the risk of an emergent invasive alien plant has been identified, analysed and that the information has been officially transmitted by EPPO to its Member Countries, the alert still needs to be spread to persons that may detect and manage the species in the field. Awareness raising, citizen sciences and communication actions are increasingly considered as indispensable steps for the establishment of an efficient early warning system. Work on emerging invasive alien plants represents a fantastic opportunity for cooperation between various institutions and for communication on pests including invasive alien plants with farmers, civil servants and the general public.

Ambrosia confertiflora in Israel – Weed Invasion and Possible Management

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The genus *Ambrosia* (Ragweed, *Asteraceae*) includes more than 40 species. In the past few decades, *Ambrosia confertiflora* DC. has invaded large areas in Israel, moving along roadsides, streams and railway tracks and by soil movement. From river banks/roadsides, it rapidly invaded nearby perennial orchards and annual crops. It is an aggressive and competitive perennial weed, forming large stands reaching heights above 3 m with a very dense underground rhizomes and roots. The invasion probably originated from shipments of contaminated grains from the USA. Experiments were conducted under controlled environment which showed that the seed germination rate of *A. confertiflora* exceeds 50% (N>1000). Seeds germinate in light and emerge only from the upper soil level. *A. confertiflora* also spreads by rhizome sprouting: a single plant forms an average of 45 sprouts within a period of 4 months without apex dominance. *Ambrosia* spp. is wind pollinated, producing large quantities of highly allergenic pollen. *A. confertiflora* flowering season is between August and December, however, in recent years, flowering was observed as earlier as midwinter (January/February). Greenhouse and field experiments have shown that in spite of the vigorous growth habit of *A. confertiflora*, selective management is possible in crops and orchards. However, timing of herbicide application is important for effective ragweed management.

Keywords: Ragweed; germination; vegetative reproduction; weed management;

A Framework for Priority Setting in Management of Widespread Invasive Plant Species

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Invasive plant species can be a threat to biodiversity. Hence, in many countries, legal regulations are in place in order to manage invasive species. Yet ecological impacts of the same species can be multidirectional and vary significantly across ecosystems or biogeographic regions. Additionally, limited funds make it difficult to select suitable management strategies. Thus, priorities need to be set, in particular for managing invasive species that have already spread widely and are difficult to control. We here propose a framework that aims at guiding decisions on prioritizing management strategies for widespread invasive plant species at a regional scale. This framework is operationalized by an assessment approach that allows determining (i) the ecological impact of invasive species in terms of environmental damage (effect size of ecological impact x conservation value of affected species/habitats) and (ii) the management prospects based on management efforts (feasibility) and management success.
We illustrate the application of this assessment approach in a model region in southeast Germany. We refer to major invasive species belonging to *Fallopia*, *Heracleum*, *Solidago*, and *Impatiens* taxa and combine data on ecological impacts, feasibility of management strategies as well as the monitored success of these strategies. This approach helps identify populations of invasive species that should be managed selectively with different levels of priority. Overall, the proposed framework enables managers to allocate limited funds efficiently and to respond adequately to legal regulations that call for differentiated responses to widespread invasive species.

Keywords: Ecological impacts, impact assessment, invasive plant species

Integrated Management of Invasive Canada Geese Populations in an International Context: a Case Study

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Impact scoring for established non-native birds in Europe has shown Canada goose *Branta canadensis* L. (CG) to have the highest environmental, economic and social impact. Among the ecological effects are grazing and trampling of reed beds or meadows, as well as bioturbation of oligotrophic fens. Management of CG was mainly performed by egg pricking and hunting. Since 2010, the coordination of these efforts was enhanced and additional moult captures (n=180) were performed on a cross-border scale. These were successful for CG, with over 10.500 birds caught between 2010 and 2014. Reported numbers of CG culled by hunters increased in the same period with over 7000 birds shot per season. The overall impact of the combined management efforts was assessed by annual counts of the geese populations in a fixed sample of counting areas. Trends in the average number of geese per municipality and per year were modeled using gee-GLMs. This showed a significant decrease in the number of Canada and feral goose since the beginning of the project. The modeled decline was in line with the trend in the absolute numbers of CG which showed a 40% reduction since 2010. For the species caught in high numbers, the impact was significant over four years, and related to catch effort. This suggests a link between captures and population numbers. However, this would assume other management efforts to be evenly applied over the area, which was not the case. Research indicates CG can disperse over large distances within Europe, blurring effects of a local action over years. Captures were performed within the EU co-funded Interreg projects Invexo (2010-2012) and RINSE (www.rinse-europe.eu) (2012-2014). Future work will be needed to upscale management and implement adaptive management backed by population models and thorough monitoring. This requires continued investment in prevention, awareness raising and generating public support.

Keywords: wildlife management; invasive birds; captures; control; adaptive management

"Better Never than Late" or "Better Late than Never"? Science-Based Management Strategy to Control Invasive Oxeye Daisy

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Oxeye daisy (*Leucanthemum vulgare* agg.) is a pretty plant native to Europe, which was introduced to the North America by 1800, both intentionally as an ornamental and accidentally as a contaminant of imported hay. Soon after introduction it escaped from cultivation and now it is reported from all Canadian provinces and states in the US and listed at the federal and/or state level as a noxious weed in Colorado, Montana, Ohio, Washington and Wyoming.

In Montana, oxeye daisy was first reported in 1890 and has become an aggressive invader of pastures, meadows, open forests and roadside verges where it used to be intentionally seeded until quite recently, it still is offered for sale in wildflower seed mixtures. The species rapidly builds dense stands in invaded sites and decreases native plant diversity and forage production. In addition, the proportion of bare soil increases compared to uninvaded sites. This promotes the persistence of oxeye daisy, which is rather weak competitor, and opens way to the invasion of other species (i.e. invasional meltdown). The invasion of oxeye daisy is also accelerated by extensive grazing as livestock avoid the plant and prefer to

feed on grass. The plants also produce a great amount of seed (up to 400 per a flower head) of a long viability (up to 40 years).
Within our project aimed at a transcontinental comparison of native and invasive dominants, we studied the population dynamics of *L. vulgare* agg. in Swan Valley, MT since 2010, and assessed the effect of management, especially the application of herbicides which is a commonly used action against the oxeye daisy in the study area. In our paper, we point to the crucial role of the proper timing of herbicide application and demonstrate that this factor, in combination with the effect of dosage, can dramatically affect the outcome of management effort. Our results emphasize that management action based on scientific data is the best way to allocate resources most effectively.

Keywords: herbicide, invasive, management, oxeye daisy

A First for New Zealand: Eradicating the European Alpine Newt

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A self-sustaining population of *Icthyosaura alpestris* (European alpine newt) was discovered in New Zealand in late 2013, in close proximity to the already endangered native frogs *Leiopelma archeyi* and *L. hochstetteri*. *I. alpestris* poses a significant threat to New Zealand's rare and endemic native fish and amphibians. It is a voracious predator that eats small vertebrates and amphibian eggs, and carries chytridiomycosis, a fungal pathogen causing global amphibian decline. As there are no native newts in New Zealand, *I. alpestris* also has the potential to occupy habitats here with little competition. The Ministry for Primary Industries (MPI) is attempting to eradicate *I. alpestris*, using a variety of methods including; fyke and box nets, dip nets, drift fences, pitfall traps, detector dogs and manual searches in and around water bodies and high risk areas. Detector dogs have been used very rarely in responses here and have the potential to be a valuable tool. To date, *I. alpestris* has been found only within 350 m of the initial incursion site, presenting an opportunity for successful eradication. This is the first time that eradication of an amphibian has been attempted in New Zealand. Continued collaboration with scientists and experts will be vital as we continue to progress this response.

Keywords: European alpine newt; Amphibian; Eradication; New Zealand.

International Management of the Chestnut Gall Wasp Invasion : Anthropological and Biological Perspectives

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The chestnut gall wasp (*Droycosmus kuriphilus* Yasumatsu) is a severe pest of chestnut trees. High infestation by this pest causes dramatic yield losses and infested trees are severely weakened during the first years after an infestation. Classical biological control, using the Chinese parasitoid (*Torymus sinensis* Kamijo) is considered to be the most sustainable solution to keep the population density of the pest under its damage threshold. The beneficial insect was released in Italy and France under the pressure of chestnut growers who faced severe economic losses, despite evidence of environmental risk.
We investigated biosafety concerns associated with the potential release of *T. sinensis* in Switzerland. The host-specificity of *T. sinensis* was evaluated by collecting oak galls in the vicinity of Italian *T. sinensis* release points. No evidence of non-target attack was reported. The risk of hybridisation between *T. sinensis* and native *Torymus* species was evaluated by molecularly analysing *Torymus* specimens reared from oak and chestnut galls, collected in Switzerland and in Italy. Three specimens, identified as *Torymus cyaneus,* were shown to be genetically close to *T. sinensis*. Evidence of hybridisation was found even if the biology of the hybrid is not known. Further work will be necessary to verify that the hybrids are fertile and to evaluate their potential impacts on the environment.
By following chestnut producers, biosafety regulators, foresters and amateur naturalists, we documented the social dimensions of this environmental problem. Semi-directive interviews and participatory observations revealed the importance of the traditions associated with this emblematic tree. Environmental risk assessment schemes often propose to take into account the socio-economic aspects to evaluate such situation. We here describe the international situation and how biosafety regulations or socio-economic aspects were mobilized by these actors to justify their decisions to release or not to release *T. sinensis*.

Keywords: biological control; environmental risk assessment; anthropology; *Torymus sinensis*; chestnut gall wasp

Predictive Modelling of Suitability and Susceptibility of Areas for the European Wild Rabbit in the Queensland Murray Darling Basin, Australia

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Rabbit *(Oryctolagus cuniculus)* invasions are continuing to occur across the Queensland Murray Darling Basin (QMDB), despite years of rabbit management and the success of myxomatosis and rabbit haemorrhagic disease (RHD). With recovery from RHD rabbit populations are increasing and expanding their range into new areas and returning to historic areas. Tools for identification of these potential areas will help target control activities where they will be most effective. This project aims to inform land managers at a local and regional scale where the rabbit will most likely invade or re-invade in the QMDB.The Queensland Murray Darling Committee (QMDC) and CSIRO have combined expert knowledge and spatial data to produce a tool identifying 'hot spot' areas (highly suitable areas where rabbits breed and survive best). By identifying these areas where rabbits are most likely to invade, we can target management and control, providing education and awareness, early detection and rapid response to reduce the ecological and economic impact on the Australian landscape.

The model was developed using a participatory modelling approach. It involves combining ecological concepts with knowledge from research experts, management solutions with input from land managers with hands on experience in managing rabbits and spatial context in the form of spatial modelling. The model output is a series of maps of habitat suitability (ability to support high rabbit populations) and habitat susceptibility (suitable areas at risk of invasion within dispersal distance of known populations). The model shows highly suitable country across the QMDB.

One of the strengths of this model is the ability to run different scenarios to show the impact of management and soil type on the potential for rabbits to spread. The results assist land managers to plan their investment in prevention and eradication. The model is an evolving tool that can be consistently updated with new spatial data and new ecological information.

Monitoring population densities is pivotal to a successful pest management plan. Predictive modelling provides a basis for this to be successfully achieved across large catchments effectively and efficiently. Population densities are determined by ground truthing the maps, identifying the population size in certain areas. Extrapolation across the catchment provides estimation of economic damage caused and allows prediction of the value of rabbit control using the most appropriate management strategy.

Keywords: European wild rabbit, modelling, containment, training

Old vs. New Associations: İmpact of Invasive Alien Species Revisited

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Evidence is increasing that the level of impact of invasive alien species (IAS) assessed in the native range does not necessarily help predicting impact in a new environment. This suggests that the often observed high impact of IAS on resident plant communities in the invaded range is not simply a matter of different densities, but is also affected by different ecological settings and different mechanisms operating in the two ranges, which has important consequences for the management of IAS.
Using the invasive forb *Centaurea stoebe* as a model system, we explored context dependency of impact with regard to the recent debate on whether origin matters. With the help of a conceptual framework, we aimed at identifying the relationship between invader biomass and impact in the invasive *C. stoebe* by conducting a series of greenhouse and field experiments. We further disentangle the factors of relevant biotic contexts in the home vs. the introduced range. The framework was then applied to a comparison between the impact of several native and invasive alien species on the same ecosystem.
Not only is strength and type of impact of an IAS context specific, but also its direction. The concept of old vs. new associations has also been explored previously with regard to selecting effective biological control organisms and more recently in the context of assisted migration. The new associations approach is intended to find a high capacity of biological control agents to suppress the target invasive or native pest population due to “new” attack strategies and “new” biotic community. The assisted migration debate focuses on the benefit vs. impact on the receiving community. We will link these issues in our framework in order to explore efficient management strategies when dealing with IAS in a new environment.

The Pathways of Introduction of Alien Cactus Species to South Africa: Lessons For Risk Assessment

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The global pool of alien plant species is strongly shaped by trends in human trade and transport. Pathways are defined as a suite of processes that result in the introduction of an alien species from one geographical location to another. Pathways are now considered as a powerful instrument of alien species management and biosecurity. In this study, we examine the pathways of introduction of cactus species (1846 species native to North and South America) in South Africa as an example. Scientific papers and grey literature were scrutinized, expert knowledge was consulted, and a survey of all businesses involved in the cactus trade in South Africa was performed. Our results show that until the 20th century, the dominant pathway for cactus establishment in South Africa was deliberate planting done by farmers for economic reasons - for forage, fences or human consumption. In recent times, horticulture has increased greatly in importance and is now only pathway of introduction for new cactus species. We found 70 nurseries as well as supermarkets, unofficial markets, and small illegal retails involved in this trade. Despite this large commercial network, we found that all imports came from the same source. Many imported cactus species were sold under incorrect scientific names, making effective regulation of the ornamental cactus industry in South Africa impossible. We ordered seeds of every imported species and variety. Seeds were germinated and DNA barcoding techniques were applied. We then compiled a precise list of imported cactus species. Finally, we developed a risk assessment protocol for the listed species with the purpose of informing policy and regulating the cactus trade. This study provides an interesting example of how complete and accurate listing information is a fundamental ingredient for an effective strategy for managing invasive alien species.

Keywords: Cactus; Pathways of introduction; Ornamental trade; Barcoding; Risk assessment

Do Native And Exotic Species Differ In How They Perform Following Wildfire? Revealing Patterns and Mechanisms Via Analysis of a Global Database

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Wildfire is a natural disturbance that shapes vegetation structure and function in many of the world's ecosystems. However, fires now often occur on landscapes harboring exotic invasive species that may respond positively to post-fire conditions. We have recently confirmed, using meta-analysis of plant community response to fire, that exotic species groups are facilitated by wildfire in terms of both richness and performance. In contrast, native species groups exhibit a neutral response in terms of richness and a significantly negative response in terms of performance. However, the species-specific mechanisms that underlie these differences remain unclear, because response metrics were at the community scale, reported as, for example, "native richness" or "exotic cover". We have now extended the data set to include the responses of 281 native and exotic species to wildfire, and have assigned each species an array of variables which are likely to influence their performance in a post-fire environment. These include both species traits (growth form, life history, regeneration strategy, level of invasiveness, region of origin) and external factors that may mediate plant response to fire (ecosystem type, time since fire, fire season, latitude of the study location, pre-fire annual precipitation). We will first conduct a meta-analysis to generally assess whether the performance of native and exotic species increases or decreases following fire, and which moderator variables explain the direction and magnitude of the responses. Additionally, given the interactive nature of the many variables that shape species responses to fire, we will use path analysis to build a synthetic model that includes the direct and indirect contributions of each variable to post-fire performance. This will provide a robust understanding of the conditions that benefit native versus exotic species in post-fire environments and reveal which regions are particularly vulnerable to invasion following fire.

Keywords: post-fire invasion; plant performance; disturbance; regeneration strategy

Spatial and Temporal Variation in Introduction Risk Determine Inspection Priorities

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The rapid and increasing movement of goods and people around the world is facilitating the unintentional introduction of organisms. As a consequence of this phenomenon, the limited resources available for border control and a lack of optimal inspection strategies, the number of these introductions is increasing. However, whether these organisms can survive and establish will depend on the suitability of the recipient climate. Using tourism and trade data and climate matching techniques, we assessed the invasion risk posed to South Africa by other nations, and determined whether this risk varies seasonally. Our results show that many of the nations that have good tourism and trade links to South Africa are not climatically similar, and as a consequence few nations pose a high risk. The risk posed to South Africa does vary seasonally, however, as tourism and trade vary little across the seasons this variation is largely driven by seasonal changes in climate. For instance, South Africa is at the greatest risk when there is an increase in climatic similarity with nations to which there are strong, consistent trade and tourism links (e.g. European countries). We argue that the spatial and temporal variation in the risk of successful introduction has consequences for the development of optimal inspection strategies. In particular, we propose that for a more efficient allocation of resources, these strategies should be based on the number of organisms that are likely to survive introduction and establish.

Keywords: biological invasions; biosecurity; pathways of introduction; pre-border control

Species Traits and Introduction History: Important Introduction Bias Contributes To the Establishment Success and Spread of Ornamental Alien Plants

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A big part of research in invasion ecology has been aimed to identify traits that promote alien plant invasion. However, the importance of introduction bias has been so far overlooked. Whether species with specific trait values were introduced earlier vs. later, or in greater vs. smaller numbers, and whether such a bias changed over time, may be critical to the success of alien plants in their new range. To avoid spurious relationships, it is necessary to consider introduction bias, and to distinguish between direct and indirect (i.e. through introduction bias) effects of plant traits on invasion success. Here, we focused on ornamental plants introduced in central Europe and in Great Britain. For both regions, we aimed to assess (1) the determinants of establishment success among aliens, and (2) the determinants of spread in the wild among established aliens. We combined data on introduction history (year of introduction, planting frequency), species characteristics (native range, plant traits) and success in the new range (establishment status, current distribution). We analysed the two datasets using path analysis. We considered the year of introduction and planting frequency as both response (to native range and plant traits) and predictor (of establishment or spread) variables. Furthermore, we could estimate total, direct and indirect effects of species characteristics on establishment and spread. For both datasets, we detected strong introduction biases. We found that both the year of introduction and planting frequency significantly affected establishment and spread. On the other hand, most species characteristics included in our analysis had strikingly little direct effect on establishment success and spread. For several of them, the indirect effect accounted for an important part of the total effect. Overall, our results suggest that introduction bias matters even more than commonly acknowledged.

Keywords: introduction bias, ornamental, traits, indirect effect, path analysis

Tracing a Fast European Invasion: The Case of the Western Conifer Seed Bug (*Leptoglossus occidentalis*)

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The Western conifer seed bug, *Leptoglossus occidentalis* Heidemann (Heteroptera, Coreidae), is considered as a major pest of cones and seeds in conifer seed orchards of its native western North American range. It was unintentionally introduced in the Eastern part of the USA during the 1950s and then spread eastwards to reach the Atlantic coast in the 1990s. Then, it was introduced in Europe during the late 1990s and first reported in Italy in 1999. The bug expanded its range very quickly and colonized most of Europe within just a decade. Recent studies indicated that it can be considered as a serious threat for seed production not only in seed orchards but also in natural stands.
In order to implement successful management program and understand the reasons underlying the invasive success of *L. occidentalis* in Europe, it is important to characterize the routes of its fast expansion, assessing if it has proceeded from a unique or several different introductions. We used mitochondrial gene sequence data and a set of microsatellites loci on bugs sampled across the three main areas, i.e. western North America, eastern North America and Europe. Both markers indicate that *L. occidentalis* presents a largely homogeneous population through its entire native area. The invasive samples (European and eastern North American ones) compared to the native ones showed a lower genetic diversity, traducing a bottleneck often characteristic of invasive populations. Moreover, all analyses showed a stronger genetic affinity of European invasive samples with the eastern North American populations than with those of native range. That demonstrates that European populations share a common origin with eastern North America. This suggests that the populations having invaded eastern North America may have acted as a bridgehead for the European invasion. Moreover, as suggested by the historical and biological data, the molecular data confirmed multiple introductions in different parts of Europe.

Keywords: Western conifer seed bug, microsatellite, mitochondrial DNA, multiple introductions, source population

Ecological Restraints to Jumping the Garden Fence; a Case Study of an Invasive Street Tree

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Non-native plants are a major threat to biodiversity, with many weedy species arriving via the horticultural trade. To limit the negative impacts of these species, the processes allowing them to 'jump the garden fence' and establish invasive populations are needed to be understood. The distribution of a species has three driving forces: biotic interactions, abiotic factors and the movement of individuals. We used this framework to investigate the invasive potential of a South American tree species, rosewood (*Tipuana tipu* (Benth.) Kuntze). It is an attractive street tree, commonly planted in gardens and streetscapes, and shares many traits with other popular cultivated trees. In Australia, rosewood is a national environmental alert weed. We tested if this status was appropriate across the broad range of Australian climates. We found that rosewood is a highly invasive weed in subtropical areas of the east coast, but has not naturalised in temperate Western Australia or tropical Queensland. Biotic factors impact on plant fitness, but do not cause any noticeable impact on reproductive output. Abiotic factors, including climate extremes and phosphorus availability (tested in field and controlled environments) play a major role in limiting naturalisation. The urban environment presents considerable opportunity for movement of rosewood seeds, and post-cultivation dispersal does not limit invasion success. Mechanistically modelling climatically suitable regions for the tree suggests focal areas of high risk, with seasonal precipitation patterns likely to limit the overall risk of invasion. These results provide guidance on the selection and management of urban trees, improving prioritisation and management of urban escapees.

Keywords: Non-native plants, Urban, Naturalisation, Invasion pathway

The Composition, Impact and Pathways of Introduction of Non-native Species in Great Britain

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Policy makers require evidence to underpin their decisions; however data on non-native species (NNS) in Great Britain (GB) is often patchy and distributed across a range of organisations. The Non-native Species Information Portal (NNSIP) was established to provide a central place for the collation, collection and analysis of NNS data and now allows for a comprehensive overview of NNS in GB. Of the 1919 established NNS 1494 are plants, while 420 are animals. The majority of established species are terrestrial with only about 80 freshwater and 80 marine species represented, although aquatic NNS are more likely to become invasive. The rate of new NNS arriving and establishing in GB over the past 400 years has been rapid. Indeed, new NNS are now establishing at a rate of approximately 12 per year, compared to 0.9 per year in the period 1600-1799. Europe has historically been a major donor of NNS; however this trend has declined in the past 50 years with temperate Asia and North America becoming more important. An unexpected result is that while the number of new NNS establishing in GB has been increasing rapidly, the number of new *invasive* NNS establishing has been relatively slow. This suggests a lag between the arrival of a non-native species and the recording of impact. If so, the implication may be that we are soon to see a dramatic increase in the number of harmful non-native species recorded in GB. With prevention a key aim of the GB Non-native Species Strategy, a major role for the NNSIP is to now analyse where future threats are likely to be coming from, how they will get here and what impact they may have. This will form the basis of a pathway prioritisation process and a model to predict likely invasion scenarios.

Keywords: Great Britain, invasive non-native species, trends, impacts, pathways, modelling

Taking Advantage of a Window of Opportunity: The Significance of Early Establishment and Growth of Invasive Plant Species

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Over the years, extensive research effort has been placed on identifying plant traits that contribute to successful invasions, although definitive conclusions have not been reached, given the strong context-dependent nature of each invasion. It has been known for some time that plant invaders are often characterised by early growth and development, initiating growth more than two weeks earlier than native species. However it is only recently that the significance of this has been examined in any detail. Although most recent analyses have focussed on reproductive phenology, early vegetative establishment and growth could confer a number of advantages. This includes the rapid development of a canopy that physically shades out co-occurring species, reducing resource availability and available space. This will be dependent on the introduced species having features that enable early growth, including enhanced abiotic resistance, as well as being photoperiod insensitive, with little chilling requirement. Early growth could reduce the effects of resource competition, indicating that invasive plant species do not necessarily have to be good competitors. In contrast they would need to be able to take advantage of a window of opportunity that is delineated by growth-limiting environmental constraints on the one hand and competitive exclusion by resident species on the other. High growth rates would only be important during the early developmental phase and, coupled with a persistent canopy, would ensure little opportunity for late season growth or recruitment by native species. In this presentation we assess the significance of phenological differences in growth and establishment in determining successful plant invasions and identify areas requiring further research.

Keywords: Early establishment, phenology, window of opportunity

Pathway Analysis and Impact Assessment

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An analysis of pathways of introduction of non-native species in Denmark was hold against an impact analysis of negative effects on the environment and human interests such as the economy and public health. The European Network on Invasive Alien Species (NOBANIS) includes 2690 species, and an additional 109 species are not yet present but with a reputed potential of invasiveness were added. A comprehensive literature search was completed for 2079 of these species. For each of these, the adverse effects on four environmental categories were evaluated based on the Belgian non-native species assessment protocol named HARMONIA after the invasive ladybird species *Harmonia axyridis*. Evaluation of effects on health and economics were added. The analysis pointed out the most frequent pathways for introduced, exotic organisms and it pointed out the pathways from which the organisms that turns out have the most severe impacts are introduced. Across taxonomic groups and habitat choice the method makes it possible to rank the organisms and identify the most important pathways for the organisms with the most severe impacts. We believe this assessment method and system provides an objective method that provides a framework for future decisions on which species should be targeted with management plans.

Keywords: Pathway analysis; impact assessment; order of priority

From Behind the Fence: How Private Gardens Support the Spread of Alien Plants?

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High levels of propagule pressure or mass effect were shown to overcome both biotic and abiotic barriers to invasion of individual species. Still, although propagule pressure represents one of the most important factors determining the successful naturalization of introduced species, rigorous data for plants are largely missing and plant studies commonly rely on proxies for propagule pressure rarely rather than using direct quantitative assessments.

Human settlements are a major source of the spread of alien species, which makes this environment suitable for studying the role of propagule pressure in plant invasions. However, the flora of private gardens, which serve as important primary source of propagules of alien species, has never been taken into account quantitatively at a large scale. Furthermore, studies on alien species are biased towards observations of the most successful invaders, while failed introductions (including intentional) are rarely recorded.

In our paper, we focused on collecting quantitative data about the diversity of plants grown in private gardens in the Czech Republic. We covered a wide range of urban and countryside settlements types (large cities, villages, old urban city parts and new urban sprawl) as well as of climatic conditions. Sampling of all plant species, excluding conifers, intentionally planted in gardens in ~200 of cities/villages with estimate of the local abundance yielded information on the frequency of planting for ~1500 taxa. Among the most frequently planted species are shrubs (*Buxus sempervirens* L., *Syringa vulgaris* L.) but also herbaceous plants (*Sedum spurium* M. Bieb., *Phlox paniculata* L., *Tagetes patula* L.). However, only a few species known to be invasive in the Czech Republic are cultivated with a high frequency: *Lysimachia punctata* L., *Rhus typhina* L., *Solidago canadensis* L., *Lupinus polyphylus* Lindl., and *Aster* sp. This points to the important role of other factors as well, such as the time of introduction and

escape from cultivation, species reproductive and dispersal traits, or ability to establish in a range of habitats and climates.
The data on current frequency of planting will be compared with information from historical catalogues of garden centres, to provide insights into how well the recent data reflect the propagule pressure from earlier periods of species invasions in the Czech Republic.

Keywords: horticulture, naturalization process, plant inventory, propagule pressure, residence time

Distribution and Habitat-Association of a Potentially Spreading Native Marine Macrophyte

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Invasive macrophytes often spread rapidly because they are highly adaptive to changing environmental conditions. A growing phenomenon is the rapid spread of some native species, whose impacts rival those of non-native invaders. Examples include fish and several bird species. However, we know little about the potential for native macrophytes to undergo rapid range expansion or increases in abundance, or their potential impacts on associated communities. We may predict that these native species exhibit similar traits to non-native invasive species. The marine alga *Caulerpa filiformis* (Suhr) Hering, native to south eastern Australia, is thought to be becoming more abundant and spreading outside what is considered its natural distribution. Interestingly, several species from the genus *Caulerpa* are notorious invaders. Here we tested the following hypotheses 1) *C. filiformis* is present outside its known historical range, 2) *C. filiformis* is associated with a wide range of abiotic characteristics, and 3) macrophyte community composition is different in presence of *C. filiformis*. We found the species to be present >500 km away from its known historical distribution. When present, it often formed very large dense beds with a surface area close to 100.000 m^2. The species was associated with a wide variety of substrata, and wide range of depth. Presence of the species altered community composition drastically by reducing the main habitat forming algae's abundances and homogenising macrophyte assemblages. By its spread, high tolerance to a wide range of environmental conditions and large impacts, we show that this native *Caulerpa* species holds the traits of a true invader.

Keywords: *Caulerpa;* seaweed; ecosystem engineer; marine; habitat forming species

The Times They are a-changin´: Impact of *Acacia dealbata* Link on Soil Chemistry and Microbial Community Over a Chronological Sequence

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Acacia dealbata Link, a leguminous tree native to Australia, has become a major problem due to its invasiveness throughout the world. However, little is known about its long-term impact. In this study, we examined the impact of the invasive *A. dealbata* on soil chemistry and microbial community function and structure in 16 invaded forest sites in NW Spain. These invaded sites were identified in a chronosequence of invasion: (1) a minimum of 25 years of *A. dealbata* presence; (2) an average of 15 years of invasion; (3) an average of 7 years and (4) less than 3 years.

In general, pH significantly decreased over time as organic matter increased. Soil nutrients were progressively altered under *A. dealbata*; the content of main chemical elements such as C, N and P increased as different periods of invasion time also increased, whilst total Ca, K and Mg remain slightly influenced. In addition, soil enzymatic activities of acid phosphatase, β-glucosidase, urease, N-acetyl glucosaminidase increased significantly. Global soil microbial activity, measured as soil basal respiration, was enhanced over the sequence of the invasion. The structure of the soil microbial community was significantly influenced by *A. dealbata* and the time of invasion. DGGE analyses provide us with evidence of a consistent trend of variation in the structure of bacterial and fungal communities over the entire examined period.

This is the first time that chronological sequences have been examined to assess the impact of *A. dealbata* invasion on soil processes. Our results indicate that the impact of *A. dealbata* on soil chemistry and microbial community is related to the age of invasion. Additionally, the initial dominance of *A. dealbata,* and its negative impact, is not reversed by stabilizing processes over time.

Keywords: Chronosequence of invasion, soil nutrients, plant invasion, soil enzymatic activities, microbial diversity and function

Comparative Assessment of The Soil Seed Bank of Invasive and Non-Invasive Congeners in Their Native and Alien Range

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In recent years, there has been an increasing interest in examining the characteristics of the soil seed bank of invasive species, as they act as a source of propagules and as a form of dispersal in time, thus affecting the probability of successful recruitment and the persistence of a species in invaded communities. To improve our understanding of the role of soil seed banks in determining species' invasiveness, we will test whether the seed bank of global invasive species differs in their native and non-native range, across habitat types, and whether invasive and non-invasive congeners possess different seed bank characteristics. To address these research questions, we will use data from a seed bank database currently under construction and made of 16142 records for 2075 species, of which 146 are listed in the Global Invasive Species Database, while additional 179 are naturalized or invasive at the sites where the original data were collected from. Specifically, (1) we will compare the characteristics of the seed bank of 225 invasive species that are globally or locally invasive, for which seed bank data (type: transient vs. persistent; size: density) are available in both their native and non-native range, and (2) we will compare the seed bank of local or global invasive species vs. that of non-invasive congeners, for 20 genera. This study will also generate extensive information on the type and size of seed bank formed by invasive species across habitat types, in different regions.

Keywords: alien plant species; congeneric comparisons; invasiveness; persistence

A Meta-Analysis: Non-Native Plant Species Benefit from Disturbance Natives Do Not

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Disturbances, such as fire and grazing, are often claimed to facilitate plant species richness and plant invasions in particular, although empirical evidence is contradictory. We conducted a meta-analysis to synthesize the literature on how disturbances influence the diversity and abundance of non-native plant species. We explored whether the observed impact of disturbance on non-native plant communities is related to disturbance type (fire, plant removal, grazing, soil disturbance, nutrient addition, and anthropogenic) and frequency (disturbance once prior to the observation or multiple times), to habitat type (grassland, forest, and man-made habitats), study approach (observational or experimental study), and to the temporal and spatial scales of the study. To put the results in a broader context, we also conducted a set of parallel analyses on a data set involving native plant species. The diversity and abundance of non-native plant species were significantly higher at disturbed sites than at undisturbed sites, while the diversity and abundance of native plant species did not differ between the two types of sites. The effect of disturbance on non-native plant species depended on the measure used to evaluate the impact (species diversity or abundance) and on disturbance type, with grazing and anthropogenic disturbances leading to higher diversity and abundance of non-native plant species than other disturbance types examined. The impact of disturbance on non-natives was also associated with study approach**,** habitat type and temporal scale, but these factors co-varied with disturbance type, complicating the interpretation of the results. Overall, our results indicate that disturbance has a positive impact particularly on non-native plant species (at least when they are already present in the community), and that the strength of this impact depends primarily on the disturbance type.

Keywords: disturbance type; meta-analysis; plant invasions; species diversity

Host Resources of Freshwater Bivalve *Anodonta woodiana* in its Native and Non-native Range: Consequences for Invasion Success

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Invasions of several freshwater bivalve species (e.g. *Dreissena polymorpha*) have considerably altered ecosystems worldwide. The invasion potential of these species has been particularly attributed to the existence of their free-living larvae having high dispersal capabilities. Nevertheless, other freshwater mussel species may be similarly amendable to rapid invasions, despite having more complex life cycles. We investigated freshwater bivalve *Anodonta woodiana*, a species with complex life cycle, which include obligatory parasitic stage developing on fishes. The geographic range extensions expose *A. woodiana* to novel hosts, which has direct consequences for establishment success of its new populations, their population dynamics and potential for further spreading. Our study focused on the role of the short-term fish-parasitizing larval stage in explaining the dispersal of this species throughout freshwaters worldwide. We experimentally tested the host-parasite compatibility of *A. woodiana* with several potential host fish species in its native (Yangtze River basin, China) and non-native (Danube River basin, Czech Republic) range and evaluated the relative quality of host resources in both areas. We compared the dynamics of initial glochidia attachment, the length of the parasitic period and the transformation success of *A. woodiana* glochidia among particular host species. The results provide novel insights on the evolution of host specificity in unionid bivalves and clarify the role of broad host generalism (unique among unionid bivalves) on invasion potential of *A. woodiana*. We discuss our outcomes with an emphasis on the global patterns and consequences of *A. woodiana* invasion.

Keywords: China; Europe; glochidia; host resources; *Sinanodonta woodiana*

Acknowledgement: Study was supported by the Czech Science Foundation (13-05872S) and ESF/MŠMT (CZ.1.07/2.3.00/30.0040).

Is *Acacia dealbata* Link. Using Different Growth Patterns To Colonize Distinct Ecosystems?

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The leguminous tree *Acacia dealbata* is one of the most widespread invasive species of Australian Acacia around the world, reducing plant biodiversity and altering soil microorganisms. The invasion success of *A. dealbata* was partially related to the release of chemical compounds which interfere with native plants and soil microorganisms and promote the growth of its own seedlings. However, this positive autoallelopathic effect was reduced in the presence of field soils. Therefore, other factors appear to be influencing the colonization of *A. dealbata* in non-native ranges and the role of allelopathy remains unclear. Recent studies have shown that the establishment of *A. dealbata* seems to be promoted by high irradiance and environmental disturbances. Nevertheless, this species is also capable of invading communities where no obvious alterations were observed. Therefore these factors seem important but not determinant. Although, there is abundant literature compiling the impacts of *A. dealbata*, however, studies assessing and quantifying environmental colonization by *A. dealbata* to find a field colonization pattern are unknown. This study is part of a large project to determine whether *A. dealbata* equally colonizes different environments, or contrarily, the colonization process depends on the environmental conditions. Samplings for assessing *A. dealbata* growth are being conducted firstly in shrublands and pine forests in North West of the Iberian Peninsula. Our preliminary results have shown that *A. dealbata* individuals located in pine forests are taller than those in shrublands. However, the basal diameter of exotic plants was the same in both ecosystems. The *A. dealbata* growth was recorded along its whole phenological cycle, but development of individuals was highly and positively related to summer time. Moreover, the number of new individuals was significantly higher in pine forests than in shrublands. These results suggest that the colonization pattern of *A. dealbata* varies among threatened plant communities and is dependent on environmental conditions.

Keywords: invasive plants, native ecosystems, height growth, diameter growth, seasonal growth

When Invasibility Blocks Invasiveness: *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae) in the Azores as a Case Study

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Harmonia axyridis invasion is considered an extreme case of successful adaptation of an alien insect to a new area. Despite being several times released into the Azores archipelago (Portugal) in the 1980s' and 1990's, however, it has never been found in systematic samplings. This is the first documented case of *H. axyridis* failing to invade and it affords therefore a crucial opportunity to look for factors promoting and preventing the invasion process.
This predator is a large generalist species, able to survive at low levels of a limiting resource, producing a strong propagule pressure and, having a high capacity of dispersion. It should therefore be able to quickly react to the increment of prey population abundance, a scenario typically found in agrosystems. However, we hypothesize that the particular characteristics of the Azorean habitats played a key role in preventing the establishment of this invader. Field work was performed in the Azores to identify the preferred habitats of coccinellids. These habitats were then characterized according to their suitability in terms of prey productivity and their cartography was carried out. Results indicated that there is a low diversity of preferred habitats. The most suitable habitat is composed by a reduced number of small fragments. In S. Miguel Island, suitable habitats account for 7.8% of the total island area, where the preferred habitat of the largest species present in the Azores, the medium sized *Coccinella undecimpunctata* Linnaeus, totals only 0.5%. The present ladybird community species composition in the Azores seems well related to this profile of the islands: the small species are dominant (species from the *Scymnus* and *Nephus* genera) and large species are no longer present (*C. septempunctata* Linnaeus).

Keywords: Invasibility; invasiveness; Propagule pressure; *Harmonia axyridis*

The Human Footprint Shapes the Global Distribution of Terrestrial, Freshwater and Marine Invaders

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Human activities such as trade and tourism are likely to influence the spatial distribution of non-native species. However, Species Distribution Models (SDMs) that aim to predict the future broad scale distribution of invaders often rely on environmental (e.g. climatic) information only. This study investigates the role of the human footprint in the global distribution of invasive species in terrestrial, freshwater and marine ecosystems. We used as reference 100 of the worst invasive species, a list collated by DAISIE (2009) that includes a representation of terrestrial plants, terrestrial animals, freshwater and marine invasive species. Species Distribution Models were calibrated with the global occurrence of species and three sets of predictors: 1) climatic variables (e.g. temperature and precipitation), 2) human footprint proxies (e.g. population density, road proximity), and 3) a combination of both. We expected climatic variables to set the basic limits for the global distribution of species, and human footprint to promote the dispersal and establishment of invasive species in suitable geographic areas. By using geographical information at a relatively high resolution (ca. 10 km) and broad scale, this study provides accurate insights into the spatial correlation between invasive species occurrence and multiple environmental and human related indicators at a global scale. Furthermore, the multispecies approach enabled the comparison of patterns between habitats and species groups that are otherwise difficult to contrast when modelling habitats separately.

Keywords: Europe, MaxEnt, risk assessment, ecological niche model, human influence index

Landscape Genetics of Monochamus galloprovincialis, Vector of the Pine Wood Nematode in Europe.

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The pine wood nematode (PWN), Bursaphelenchus xylophilus (Steiner & Burher) Nickle (Nematoda, Aphelenchoididae) is the causal agent of the pine wilt disease (PWD), a virulent syndrome killing susceptible pines trees within few months. From its native area in North America, it has been introduced in several Asian and European countries causing considerable damages to native pine forests. The PWN was detected for the first time in Europe in Portugal 15 years ago. From its introduction site, it rapidly expanded its range to a large part of the country and entered into Spain. In Europe, the native longhorn beetle Monochamus galloprovincialis (Olivier) is the only known vector for this nematode. This beetle performs its larval development in the wood of declining pine trees and spread the PWN when it emerges from infected wood. Thus, natural dispersal of the PWN is highly depending on beetle dispersal. Given the rapid range expansion of this pest and the threat to forests involved, it is crucial to identify potential barriers to dispersal of M. galloprovincialis to define suitable pest management strategies.
Based on 1043 individuals from Iberian Peninsula, genotyped at 13 microsatellites loci, we conducted a landscape genetic analysis to uncover the landscape features affecting dispersal of M. galloprovincialis. To avoid confounding effect of evolutionary history of this species in the area of study, we used a nested sampling design and assessed population genetic structure in order to select the appropriate populations and the optimal scale for correlation analysis.
Our results show that mountain ranges represent a break to dispersal of M. galloprovincialis, and subsequently potential barriers to the spread of the PWN.

Keywords: Alien spread, dispersal, Coleoptera, Cerambycidae.

Invasiveness and Population Ecology of Tropical Crayfish, the Redclaw (*Cherax quadricarinatus*), in a Temperate Climate in Europe

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The Redclaw (*Cherax quadricarinatus* Von Martens, 1868) is a tropical crayfish, for which an established introduced population was found in Europe for the first time in 2009. The population was found in the thermal oxbow lake in temperate climate zone of Eastern Slovenia. The development and growth of the *C. quadricarinauts* population was monitored at different temperature zones (mean water temperature from 15 °C to 35 °C) in the oxbow from 2010 to 2013. At first, the population was low until mid of 2011, and then it started to increase including first occurrence of pregnant females. From July 2011 to the June of 2013, high increase in the population was taken place. In late 2013, the population size was stabilized with low increase rate, and the population most probably reached carrying capacity of the environment and started to naturalize. Condition indices (CI) indicated that adult *C. quadricarinauts* had higher CI at introduction phase compared to naturalisation stage, while no differences was observed among seasons. Under appropriate conditions with typically tropical r-selected growth characteristics of the Redclaw, the fast establishment and increase of the population were possible in just 15 months. Currently, the Redclaw population is restricted only to suitable warm water conditions while only a few individuals were found in zones with lower mean water temperature conditions. However, due to high selection pressure in temperate aquatic environment, a subsequent secondary spread cannot be excluded in the future and this could lead to climate niche shift. Besides the *C. quadricarinauts,* some other tropical invaders also occur in the studied thermal oxbow, e.g. Nile Tilapia (*Oreochromis niloticus* Linnaeus, 1758) and Water Lettuce (*Pistia stratiotes* L.). The occurrence of these species increases the needs for future eradication and monitoring plans. *Cherax* sp., tropical crayfish, are widely available in the aquarium trade in Europe. This is because; it is generally accepted opinion that tropical species do not survive in temperate climate in the wild. However, we have shown that aquatic tropical species have potential of at least establishing wild population in Europe, at least in southern parts of Europe and in warm water bodies. According to the results of our study, the improvement of regulations and monitoring of trade with aquatic tropical species is needed in Europe.

Keywords: *Cherax quadricarinatus*, invasive processes, growth, condition indices

Pre-Adaptation or Genetic Shift After Introduction in Invasive Species? A Study on *Impatiens glandulifera*

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Invasive plants often display high competitiveness, reproductive output and phenotypic plasticity in their invasive range. Such characters may be essential for successful invasion. However, it remains unclear whether these characteristics are already present in native populations (pre-adaptation hypothesis) or evolve after introduction (genetic shift hypothesis).
We compared means and phenotypic plasticity of vegetative and reproductive traits between four populations of *Impatiens glandulifera* (Royle) collected from two sites in the invasive range and two in the native range. Additionally, we tested whether trait's mean and reaction norm harbored genetic variation. Seeds collected in the field were sown and the resulting plants were exposed to three different experimental environments in a glasshouse.
Plants from populations in the invasive range produced less seeds per capsule and had lower total reproductive output than those from the native range. Furthermore, phenotypic plasticity did not differ between the native and invasive range, except for the number of nodes, where plasticity was higher in the invasive range. Finally, we found no evidence of genetic variation in phenotypic plasticity.
These results suggest that post-introduction evolution of traits did not boost the invasiveness of *I. glandulifera*. Instead, this species seems pre-adapted for invasion. Differences in habitat are probably the main factor in driving the invasibility of this species.

Keywords: biological invasion, genetic shift hypothesis, *Impatiens*, pre-adaptation, phenotypic plasticity

Alien and Translocated Fish Species: Bridging the Gap Between Economics and Ecology

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Turkey has many rivers, natural and dam lakes with different ecological properties and hosts a rich biodiversity with approximately 320 fish species. There are some serious threats to biodiversity. For example, as pollution over abstraction of ground water, invasive species, dams other constructions, floods and droughts, fishing and harvesting aquatic resources.

According to the statistics, two native species (*Alburnus tarichi*-tarek and *Cyprinus carpio*-carp) a non-native (*Carassius gibelio*- gibel carp), and a translocated marine fish (*Atherina boyeri*-sand smelt) were the mostly caught species from inlands. In 2013, the total catch (tons) of these species were: tarek 8,600, carp 8,276.6, gibel carp 5494.7, sand smelt 5,012.3. These four species constitutes 84.83% of the total catch from inlands in Turkey. Although gibel carp, an alien fish have been considered as an invasive in recent years, it has an increasing commercial importance. Similarly, sand smelt, a sea originated fish which has become a widespread species in inland waters of Turkey became an important product for export. The rapid and wider distribution of sand smelt in Anatolia exhibits a unique case in world. There are still some ongoing arguments about these two species that they have adverse impacts on the ecosystem and fishery.

Keeping the economic importance of these species for locals in mind, the impacts on the ecosystems need to be discussed at a platform where all stakeholders such as scientists, governmental organizations, NGO's, and local people meet. Discussions on the possibility of making advantage of these alien and translocated species in terms of economic development while keeping its adverse impacts on the ecosystem under control has a vital importance for the future of the biodiversity and the socio-economic status particularly under the projected climate change.

Keywords: Gibel carp, sand smelt, biodiversity, fishery, Turkey

The Impact of a Predator on Competitive Interactions Between Two Ponto-Caspian Gammarids: *Dikerogammarus villosus* and *Pontogammarus robustoides*

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Ponto-Caspian gammarids *Pontogammarus robustoides* (G.O. Sars, 1894) and *Dikerogammarus villosus* (Sovinsky, 1894), invasive in Europe, are relatively large, highly motile, tolerant to variable habitats and predatory.
We studied their substratum preferences in 24-h pairwise-choice tests in darkened 3-L tanks with bottoms covered in half by stones (diameter:ca. 3 cm) and in half by sand, at two different densities (12 or 24 individuals per tank).
Both species tested separately preferred stones, the selectivity of *D. villosus* (95%) being stronger that of *P. robustoides* (74%).
P. robustoides in the presence of *D. villosus* occupied its preferred substratum less often (52 and 29%, at higher and lower density, respectively). Thus, it selected less suitable substratum to avoid the impact of a stronger competitor, *D. villosus*.
D. villosus responded to the presence of *P. robustoides* by increasing its occurrence in stony substratum to 99%.
We also studied the effect of a fish predator *Babka gymnotrachelus* (Kessler, 1857) on the outcome of the competition between both gammarids. When the gammarids were exposed to fish separately, *D. villosus* increased its occurrence in the stony substratum (99%), whereas *P. robustoides* did not respond to the predator. *P. robustoides* in the presence of *D. villosus* and fish chose stones more often than in the presence of *D. villosus* alone, probably taking advantage of the lower activity of its competitor. Nevertheless, in a foraging experiment, the presence of *D. villosus* significantly increased the predation of fish on *P. robustoide* indicating an overall negative effect of the competition.
The presence of a predator clearly modified relationships between both gammarid species, allowing a weaker competitor to utilize more suitable substratum. Such multi-level interactions including predatory pressure should be taken into account when considering the impact of alien species on communities.

Keywords: gammarids, invasive species, competition

Acknowledgement: Our research was supported by the National Science Centre grants 2012/05/B/NZ8/00479 and 2013/09/N/NZ8/03191.

Invasional Meltdown 14 Years Later is Still Poorly Understood

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The invasional meltdown hypothesis is one of the main hypotheses in ecology; however, it is often tangentially or inaccurately cited and/or tested in the scientific literature. We systematically reviewed the invasional meltdown hypothesis by analyzing all citations of the original paper that first defined the process throughout the ISI Web of Science database. Our analysis of 320 publications indicated that the term *invasional meltdown* was tested, even tangentially, in only 2% of the papers analyzed. Although beginning with facilitation between invasive species and invasional meltdown is a phenomenon that propagates to communities and ecosystems. Accordingly, we separated the hypothesis into four parts: the first part involves the prevalence of negative impacts on native biota owing to the net effect of facilitations or mutualisms between non-native species with consequences detected at the community level. In the second part, populations of co-existing invasive species grow and establish at higher rates than when they occur individually. The third part involves the spread of co-occurring invasive species at faster rates than when they occur alone. The fourth part regards impacts at the community or ecosystem level. The impact of the interacting non-natives must be higher than what the sum of their impacts would have been in isolation. Establishment, spread, and impact aspects of meltdown do not all need to happen for a meltdown to have occurred, but at least one of them must be present together with community-level responses in order for a case to be considered an invasional meltdown. Our literature review showed that fourteen years following the proposal of invasional meltdown, this hypothesis still remains poorly tested. We believe our framework will provide a more practical and accurate way to test the invasional meltdown hypothesis.

Keywords: facilitation, positive interactions, impact.

Are Water Quality and Invasive Alien Species Important Drivers of Macroinvertebrate Diversity?

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In this study, we investigated the reciprocal link between water quality and invasive alien species (IAS) as well as their combined effects on diversity of macroinvertebrate communities. In total, 575 samples were collected in 1999, 2004 and 2009 in five different river types located in the northern part of Belgium. Between 1999 and 2009, up to 4-fold decreases of nutrient concentrations indicated water quality improvement. A decrease of within river type similarity, calculated based on six water quality variables, revealed an increase in habitat heterogeneity. Despite the high pollution tolerance and the high dispersal rates in homogeneous habitats of IAS, the proportion of alien taxa in the macroinvertebrate community was lower in 1999 than in the 2000s. Based on statistical models, it was found that poor water quality negatively affected the proportion of aliens in macroinvertebrate communities. The number of native taxa in large and small rivers was higher in the 2000s than in 1999, demonstrating a net positive effect of water quality improvement on IAS and macroinvertebrate diversity in general. Because water quality improvements promoted both native and alien taxa, no biotic homogenization at the river basin scale was observed, despite very high proportions of alien macroinvertebrates present in large rivers. Multiple-site similarities of community composition indicated more heterogeneity in the 2000s than in 1999. This study shows that due to water quality improvement and alien species establishment macroinvertebrate diversity increased in lowland rivers, both at the local and regional scale.

Keywords: water quality, biotic similarity, ecological models

"NOT ATTENDED"

Blackberry Invasion Threatening Unique *Scalesia* Forest on Santa Cruz Island, Galápagos

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The Galapagos Archipelago is renowned for its unique plant and animal species; however these are threatened due to land use change and invasive species. One of the threatened species is *Scalesia pedunculata* Hook. f., an endemic 'sunflower tree' that forms a forest on the island of Santa Cruz, which is a key habitat for Darwin's finches. The extension of the forest has been severely reduced by agriculture and the remaining area is now adversely impacted by an invasion of *Rubus niveus* Thunb. (blackberry). While *R. niveus* and other invasive plant species in the *Scalesia* forest are currently manually and chemically controlled by the Galapagos National Park, the effects of *R. niveus* dominance and the control programme on the *Scalesia* forest ecosystem are presently unknown. Consequently, we initiated a community level study to determine the direct and indirect effects that *R. niveus* and the other invasive plants have on the *Scalesia* forest community. This involved quantifying plant community structure in 34 plots (10×10 m) using the line-intercept method in two areas of varying *R. niveus* abundance. Preliminary results suggest that *R. niveus* is severely reducing the cover of *Scalesia*, while covers of the invasive *Tradescantia fluminensis* Vell. and *Cestrum auriculatum* L'Her. are apparently inversely related to *R. niveus* cover. It seems that endemic species are able to coexist with some invaders (like *T. fluminensis* and *C. auriculatum*) but not with *R. niveus*. Uncovering these species interactions has implications for management: removing these less invasive plant species may facilitate the spread of *R. niveus*. Therefore, a focused *R. niveus* control programme may be the best practice. This study provides evidence-based technical assistance to the Galápagos National Park Directorate in order to improve the effectiveness of ecological restoration of the *Scalesia* forest on Santa Cruz Island, Galápagos.

Keywords: *Rubus niveus*, ecological restoration, invasion impacts, invasive species interactions

From Impact to Damage: A Review of Different Approaches to Assess Non-Native Species

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As non-native species can considerably threaten biodiversity and other resources of interest, the prevention and management of biological invasions is a major task on scientific and political agendas. Direction and magnitude of impacts caused by non-native species at first vary depending on the context of the respected species and the environmental context within its actual or potential distribution. However, the question of which of these impacts are adverse, i.e. threaten biodiversity, strongly refers to underlying human values and should be addressed in appropriate assessment approaches. We have reviewed a set of 22 approaches analysing whether these meet the following challenges in supporting decisions on the prevention of entry and on the management of non-native species: (i) operationalization of relevant impact types and attributes, (ii) consideration of their context dependence, (iii) inclusion of human values, (iv) assessment of the feasibility of management and (v) verification of transparency and traceability of operationalization, underlying values and definitions. Though nearly all analysed approaches refer to ecological impacts the consideration of impacts on the gene or ecosystem level or the operationalization of relevant impact attributes fall short. In terms of context dependence approaches throughout refer to the species context and predominantly include information about actual or potential spread of non-native species. However, only few approaches go further identifying actual or potential exposure of relevant resources (e.g. species, habitats) towards non-native species impacts. Above this the operationalization of underlying values by differing negative impacts from benefits or adverse impacts with regard to the conservational value of (potentially) affected resources is underrepresented. Several approaches directly address the feasibility of management. Yet, it is striking that relevant factors such as “availability of suitable management methods” or “unwanted effects of management” are rarely considered. Finally, disclosure of underlying values and definition of value laden or controversial terms clearly misses out.

Keywords: non-native species, damage, assessment, context dependence

The Effect of Flow on The Competition Between the Alien Racer Goby and Native European Bullhead

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The racer goby *Babka gymnotrachelus* (Kessler) is an invasive Ponto-Caspian fish spreading throughout Europe. They threaten a native species of similar biology, the European bullhead *Cottus gobio* L., by displacing them from shelters. These shelters are necessary for reproduction as well as for protection against predators and hydrodynamic forces. However, abiotic conditions may strongly modify the outcome of an interspecific competition in the wild. Nevertheless, little is known about the effect of flow velocity on the competition between these rheophilic species, although this factor is crucial for their distribution in the field. We video-recorded fish behaviour for 2 h in single-species and mixed-species pairs in the presence of single shelters at three flow velocities: 0, 10 (a velocity preferred by the racer goby) and 30 cm/s (a velocity greater than preferred by the racer goby) to determine whether the invader can deprive the native species of its shelter. At the flow of 0 and 10 cm/s, the racer goby exhibited aggressive behaviour towards bullhead and this restricted the time spent by the bullhead in the shelter. Moreover, although the flow of 30 cm/s inhibited racer goby aggression, the time spent by the bullhead in the shelter in interspecific competition was still reduced when compared to intraspecific controls. Our results suggest that under natural conditions, the racer goby displace bullheads from their shelters even at flow velocities greater than optimal for the racer goby.

Keywords: interspecific aggression; flow velocity; biological invasion; shelter

Horizon-Scanning and Surveillance: Invasive Alien Species in Great Britain

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Horizon-scanning, the systematic examination of future potential threats and opportunities, leading to prioritisation of invasive alien species (IAS) threats is seen as an essential component of IAS management. We developed a horizon scanning approach (including consensus methods and rapid risk assessment) to consider IAS that were likely to impact on native

biodiversity but were not yet established in the wild in Great Britain. The process involved two distinct phases:
Preliminary consultation (to derive ranked lists of potential IAS) between experts allocated to five distinct groups (plants, terrestrial invertebrates, freshwater invertebrates, vertebrates and marine species);
Consensus-building across groups to review and rank the entire list of potential IAS.
We considered 591 species not currently established in Great Britain and derived a list of 93 species which were agreed to constitute at least a medium risk (based on score and consensus) with respect to arrival, establishment and threat to native biodiversity. Thirty species were considered to constitute a high risk and were grouped according to their ranked risk while the remaining 63 species were considered as medium risk, and included in an unranked long list. Our study focused on Great Britain but we suggest that the methods have global application for horizon-scanning to provide evidence for underpinning and prioritising management both for the species and, perhaps more importantly, their pathways of arrival. We conclude with an outline of the on-line surveillance system implemented in Great Britain for early-warning and linked to the horizon scanning.

Keywords: Invasive Alien Species, horizon-scanning, consensus approach, biodiversity impacts

EDDMAPS & Bugwood Apps: Using Information Technology & Partnerships to Collect Data and Map Invasive Species Across the U.S.

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Invasive species are increasingly a priority in environmental monitoring programs worldwide. In the U.S., many federal and state agencies and organizations have programs that collect data about invasive species of concern to their agency/organizational objectives and clientele. Unfortunately, many of these databases were for internal agency/organization use and because they contained codes and data elements unique to the database, it has been difficult to aggregate data to identify the distribution and spread of invasive species over large areas.

In 2005, the University of Georgia Center for Invasive Species and Ecosystem Health www.bugwood.org (The Center) developed protocols that enabled exchange and aggregation of data from multiple databases and made standardized data collection protocols available in the web-based EDDMapS - Early Detection and Distribution Mapping System (www.eddmaps.org). With funding from several federal and state agencies, The Center continues to improve EDDMapS and has been aggregating invasive species data from federal, state, and regional agencies, organizations, and groups across the U.S. The resulting database is freely available for use (with some restrictions on species of regulatory or endangered status) and enables sharing of data subsets from the many databases and provides geospatial display (Google Maps) of data.

EDDMapS has been incorporated into a number of Smartphone Apps (http://apps.bugwood.org/) that are available for iPhone and Android systems that are being used in survey and detection programs being implemented by federal and state agencies, NGO's and citizen scientists programs in 40 U.S. states and 4 Canadian provinces.

This presentation will provide an overview of programs being implemented using resources developed by The Center, provide examples of how they are being used to compile & aggregate data on invasive species and as tools to enhance survey and detection and educational programs dealing with invasive species.

Keywords: Invasive species, using technology, distribution mapping, data collection, data aggregation

Assessing the Threat and Potential for Management of *Berberis* spp. (Berberidaceae) in South Africa

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The genus *Berberis* L. contains approximately 500 species and has been distributed all over the world for their horticultural uses. This has resulted in several species escaping from cultivation, and about 7 species are known to be invasive. Invasive *Berberis* can have considerable negative environmental impacts, such as altering soil chemistry, lowering land carrying capacity, preventing access to watercourses when occurring in dense stands, and replacing indigenous vegetation. Several species also serve as alternate hosts for the destructive black stem rust disease of wheat. Here we report two newly detected invasive populations in South Africa. These include populations of *Berberis julianae* C.K. Schneid. in a National Park [28.504960°S 28.618736°E] and *Berberis aristata* D.C. in a State Forest [23.819227°S 29.960837°E]. The former species has recently been listed as invasive in the USA and this is one of the first global records of invasiveness; the latter species is already invasive in Australia. The main population of *B. julianae* has approximately 380 individuals (0.41 ha) while that of *B. aristata* has approximately 5500 individuals (115 ha). Bioclimatic modelling indicated a moderate climatic suitability for *B. julianae*, but a high suitability for *B. aristata*. Seeds of both species yielded a high germination success, with up to 100% for *B. julianae*. Fruits and seeds of *Berberis* are spread primarily by birds, but also by humans, therefore the two species have the potential to become widespread invasives. Weed risk assessments were also conducted together with analyses of population characteristics. Upon completion of this study, the potential for eradication will be assessed with the aim of starting eradication campaigns against both species in 2015.

Keywords: Risk assessment, early detection, distribution modelling, *Berberis*

A European Early Warning and Rapid Response System of Invasive Alien Species

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An Early Warning and Rapid Response System (EWRRS) has been designed by the European Alien Species Information Network (EASIN) and is now under development. This system will support the new European Regulation on prevention and management of introduction and spread of invasive alien species (IAS). According to this EWRRS, member states (MS) should report new populations of IAS of mutual concern detected on their territory directly to EASIN through a notification protocol for early detection, which includes contact details, information on the detection (species, date, type of detection, confirming authority, related surveillance system, number of individuals, invaded area, assessment of establishment status, pathway information), and geographical information. This will lead to an Early Warning of the Commission and other MS by EASIN through a notification protocol for early warning. Once an early warning has been issued, the affected MS needs to establish eradication measures which should be notified to EASIN through a notification protocol for eradication measures. Through EASIN, this notification will be forwarded to the Commission, and will also be made publicly available. Finally, MS should also submit to EASIN a notification when the eradication programme has been successfully completed through a notification protocol on the completion of eradication. Through EASIN, such notifications will be forwarded to the Commission and the information will be made publicly available. It should also be possible for MS to share through EASIN information about the effectiveness of the measures taken. All information gathered by EASIN will be included in species-specific factsheets created by EASIN and made publicly available.

Keywords: early detection; EASIN; EU Regulation; prevention; European Commission

WRASP: A Spatial Weed Risk Assessment Tool Reveals Important Sub-National Variations in Weed Risks

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The number and diversity of introduced invasive plants, coupled with limited weed management budgets requires biosecurity managers to employ systems to prioritise weeds for management attention. To assist this process, an analytical protocol and spreadsheet tool has been developed for post-border weed risk management (PBWRM), and published as an Australian and New Zealand standard. It is an important and widely-used tool which has been adapted and applied in many parts of the world. The PBWRM tool utilises a framework that ignores spatial variation in risk factors within the geographical area of concern of the risk assessor. However, invasive plants vary in risk factors such as invasiveness, potential impacts, and feasibility of control as a function of spatially variable factors. Logically, the assessment of weed risks should also be spatially explicit in order to best understand risks and to target management concern. In order to use the current PBWRM, the risk assessor has to firstly define their area of concern and then make subjective judgements that distil the spatial variation within that area into a single answer to each of the questions in the tool. At the national level, this method is wasteful, requiring each Regional Council to repeat an analysis, tailoring it to their own environmental conditions, or perhaps worse simply applying the results of analyses conducted in different jurisdictions without considering the different environmental conditions. To address these concerns we took the PBRWM logic and spatialised it, to allow weed managers to assess weed risks and management across geographical space. We illustrate this new spatial system using a case study of *Senecio glastifolius* in New Zealand, comparing the results of a spatial and an aspatial analysis. The spatial view of risks revealed locations of higher and lower risk and suitability for management attention that were hidden by blanket, aspatial weed risk scores of the current PBWRM system. The national level risk was also significantly higher when considered in the light of the results from the spatial tool. Answering the risk factor questions using the spatial system involved far less subjectivity, and hence the resulting risks and management classifications are likely more robust and usable to Regional Councils and the National Government. The spatial tool, WRASP, is presently being packaged for general use, and will shortly become available for testing by Regional Councils and interested individuals.

Keywords: sub-national, post border, weed risk assessment

Invasive Alien Plants in Croatia–Distributional Patterns and Range Size

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Invasive alien Croatian flora has never been studied systematically until the year 2006 when a national survey was started. We present the first overall insight into the spatial distribution of invasive plants in Croatia and their relation to the human population density, longitude/latitude ratio, altitude, meteorological factors and habitat types. Invasive alien plants were detected on 49% of the state territory (57,000 km^2), averaging five taxa per 35 km^2. At least half of the area of Croatia contains some invasive plants, and the most occurring are *Ambrosia artemisiifolia* L., *Ailanthus altissima* (Mill.) Swingle and *Erigeron anuus* (L.) Pers.. Anthropogenic influence is confirmed by the positive correlation between the population in the 6749 settlements and the number of invasive species in that urban areas.The greatest number of invasive plants (> 30 per grid cell) was recorded in the major urban centres located at the intersection of main continental transport corridors and seaports. We have presented the alien plants of Zadar as a case study. The most widespread invasive taxa on this area are *Amaranthus retroflexus* L., *Conyza ssp.*, *Bidens subalternans* DC. etc. Number of invasive plants is increasing in the south-east direction and reflecting positive correlation with temperature and negative with altitude. Invasive alien plants occurred in a relatively wide altitude range, but mostly no higher than 1100 m a.s.l. The largest proportion of recorded introductions and naturalization in the last 20 years has occurred in the Mediterranean region of Croatia, especially on islands. The number of invasive plants increased with habitat diversity, but almost 75% of all sites with invasive plants are located within a few habitats with direct anthropogenic influence. The most invaded habitats are agricultural areas, artificial surfaces, and affected forests. Results should provide a reliable basis for strategic planning regarding invasive plants management and biodiversity conservation.

Keywords: Croatia, invasive alien plants, distributional patterns, city of Zadar

Feeding Habits of Invasive Topmouth Gudgeon, *Pseudorasbora parva* (Temminck & Schlegel, 1846), Population in Hirfanlı Reservoir, Central Anatolia, Turkey

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The small cyprinid fish *Pseudorasbora parva* (topmouth gudgeon) is originally distributed in East Asia. It was unintentionally introduced into freshwater ecosystems in Europe and has established successful populations in Europe, North Africa and Central Asia during the last 50 years. The species was first recorded in 1982 from Thrace part of Turkey and it has widely distributed in freshwater systems throughout Anatolia. *P. parva* is regarded as a pest by some authors due to its competition with native species for food and space. It is also host of deadly pathogen. Therefore, *P. parva* can be considered as a threat to the rich native ichthyofauna in Turkey. Although *P. parva* has rapidly invaded both many natural and artificial freshwater environments in Turkey, information about biology and ecology of this species is very scarce. The present study is the first detailed research on feeding biology of invasive *P. parva* in Turkey. Foregut contents of 672 *P. parva* specimens caught from Hirfanlı Reservoir between April 2008 and June 2009 were examined. The proportion of the filled foreguts was 68% in the sample. The vacuity index was higher during summer months. Zooplanktonic organisms, especially representatives of Cladocera, Insecta and Copepoda, were predominant both in terms of abundance and frequency. Phytoplanktonic organisms such as representatives of Bacillariophycea and Cyanophycea were also determined in the foregut contents. According to our data, *P. parva* fed throughout the year. A positive correlation was found between lenght of *P. parva* and frequency of zoobenthos and insects in the foregut contents. The results revealed that juveniles of *P. parva* fed mainly on zooplankton, but the food preference changed with age. We conclude that *P. parva* may have a competitive pressure on the native fish fauna in Hirfanlı Resorvoir due to its high feeding intensity and wide food preference.

Keywords: Stone moroko, invasion, Kızılırmak River Basin, alien species, diet

The Exotic Flora of Turkey and Preliminary Check-list of Invasive Alien Plant Species (IAS) in Turkey

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In this study a list of exotic flora of Turkey and preliminary check-list of invasive alien plant species (IAS) in Turkey are presented. They have been created on the basis of literature and field observations. The number of exotic taxa occurring in the Flora of Turkey and the last Checklist of Vascular Plants of Turkey are 242, which includes 171 alien and 71 cultivated taxa. Out of 44 families the majority (42 families) belong to Angiospermae. The list of invasive alien plants consists of 64 taxa, with family, life-form and geographic origin assigned to each IAS. The most numerous family is Compositae (Asteraceae) and the genera with the highest number of IAS are *Bidens, Conyza* and *Ambrosia*. It has been compiled using historical data (e.g. local floras, bibliographic records, and herbarium specimens) and oriented field GPS surveys and collections. The total number includes all alien species ever recorded or surveyed in the phytogeographically of the Region, including most commonly cultivated species (e.g. in urban parks, garden centres, forest nurseries, and botanical gardens) and short-lived species. Analyses according to family affiliation, life-form and origin were made. Life-form analysis showed the predominance of hemicryptophytes but also presence of phanaerophytes and therophytes. Based on origin, IAS from the Americas predominate, followed by those from Asia and Africa.

Keywords: Exotic, Invasive Alien Plants (IAS), Check-List, Turkey.

Tree Plantations in Southern Europe and the Risk of Invasion to Neighbouring Ecosystems

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In many areas, the introductions of exotic forest species are the best choice to achieve high production levels. The planted forest species are selected on the basis of their ability to adapt to local conditions and of their rapid growth. These characteristics also contribute to the ability of these species to colonize outside their planted areas.
In Southern Europe, specifically in Portugal, the large growth of forest is the result of voluntary plantations, most often through commercial plantations, of *Pinus pinaster* and *Eucalyptus globulus.*
In this study we measure the natural regeneration of *P. pinaster* and *E. globulus* in the surrounding areas of commercial plantations through a distance transect design, in order to evaluate the invasive risk, as well as to identify the main factors that promote natural establishment of these species, and identify the implications for forest management.
The survey of 75 planted sites in Portugal resulted in a detection of 11 wildlings/ha of *E. globulus* and 92 wildlings of *P. pinaster*. Of these, 60% *E. globulus* were established within the boundaries of the planted stands and the rest were observed at a maximum distance of 60 m away. For *P. pinaster* the wildlings were mostly observed outside (75%) of the stands as far as 100 m away. Open areas (grasslands and shrublands) were the most susceptible habitats for establishment of these tree species. In these areas, the vegetation density, the presence of bare ground and the disturbance level were the most significant factors determining the presence of tree wildlings.
These two species have very different seed dispersal capabilities and the results showed that these differences are reflected in their spread pattern from plantations. In comparison to *P. pinaster*, the intensive short-rotation of *E. globulus* stands also contributes to controlling the natural expansion of this species.

Keywords: planted forest; tree invasions, *Eucalyptus globulus*, *Pinus pinaster*, Portugal

Seed Bank of *Amorpha fruticosa* L. on Some Ruderal Sites in Serbia

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Amorpha fruticosa L. (Fabaceae), known as Indigo bush, False indigo bush, False indigo, and Desert false indigo, is deciduous shrubs, 1-6 m tall. The violet flowers are in upright narrow racemes that can be clustered or solitary. The woody weed species *A. fruticosa* has a high environmental adaptability, and is present in different environmental conditions. In Vojvodina region (Northern Serbia) is mostly present near irrigation channels and river banks, especially in alluvial or marshy areas. The species is also present in forest communities, from the lowest elevations at the timber line to the highest elevations, where the periods of underground and flood waters are the shortest, or where they are absent.
Since *A. Fruticosa* is continually spreading near river banks, the aim of research was determination of seed bank composition near Danube river . In 2014, soil sampling was perfomed at localities with high population of *A. fruticosa* (3-4 plants at age over 2 years and 10-14 plants at age 1-2 years). Soil samples were taken from two localities with alluvial loam-clayish soil and chernozem near Danube river: Futog and Šangaj. Each sample was sieved through a system of copper sieves of various diameters. After separation of seeds from samples they were identified. Significant presence of *A. fruticosa* seeds (1914 seeds per m²) was established in layer 0-10 cm. In the same soil layer, significant presence of seeds of *Stellaria media* (L.) Vill. and *Urtica dioica* L. was also established. Seeds of *A. fruticosa* were not found in soil layers 10-20 cm and 20-30 cm. The invasive weed species *A. fruticosa* produces a large number of seeds, in two cycles. Majority of the seeds stays in the upper soil layer, being dispersed by water (hydrochory).

Keywords: *Amorpha fruticosa* L., soil seed bank, invasive species, seed dispersion

Sunflower Broomrape (*Orobanche cumana* Wallr.): An Invasive Parasitic Plant in Sunflower Production Areas in Turkey and in the World

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Sunflower (*Helianthus annuus* L.) is one of the important oil crops in the world, while sunflower broomrape (*Orobanche cumana* Wallr.) is a dangerous holoparasitic plant in sunflower production areas in Turkey and also in many other parts of the world. Broomrape attacks the plant roots after germination and results in severe yield and quality reduction in cultivated sunflower up to 100%. Broomrape progressively develops races against sunflower resistant genotypes, and invades sunflower production areas in Europe as well as in Asia and Africa. Interestingly, here is no broomrape in North America, where sunflower and sunflower wild types originate. *O. cumana* was firstly detected in wormwood (*Artemisia maritima incana* Schm. and *A. austriaca* Jacq.) at gardens with sunflower in the mid 18th century and then spread in sunflower fields in Russia in the beginning of the 19th century. By the late 19th and early 20th centuries, *O. cumana* expanded its invasive range largely and threatened seriously the sunflower planted areas in Russia. In the mid 20th century broomrape invaded large areas starting from Russia, then Ukraine, Moldova and Bulgaria. Broomrape developed new races every twenty years period starting from A to E which are known as old races and could be encountered in many part of the world. Recently, it developed new races (called F, G and H), mostly in Spain, Turkey, Bulgaria, Romania, Ukraine and again in Russia. However, genetically tolerant cultivars have been developed by sunflower breeders and also chemical control is possible with IMI (Imidazolinone) herbicides with post application overcoming both broomrape problems and key broad leave weeds.

Keywords: Sunflower, Broomrape, Invasion, Races, Resistance

The Black Sea highway: The Route of Common Ragweed (*Ambrosia artemisiifolia* L.) Invasion in Turkey

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Common ragweed (*Ambrosia artemisiifolia* L.) is an invasive annual plant native to North America that has spread to the Europe, and other continents. After the first report of the plant in 1998, no further study was conducted on *A. artemisiifolia* in Turkey. We aimed to demonstrate the present invasion status of *A. artemisiifolia* in Turkey. The research area of the surveys was Black Sea Region of Turkey. The survey was conducted in 2012 and 2013. The frequency of occurrence and density of ragweed increased gradually from western to the eastern parts in the surveyed area. The weed was first encountered in the Samsun province. Ragweed was rarely observed between Samsun and Trabzon provinces, but it was extensively populated in areas between Rize and the Georgia border. Common ragweed was found in highly perturbed habitats such as roadsides and waste areas in the region. Observations indicate that common ragweed has already settled in the Black Sea Region of Turkey and probably introduced from one of our northern neighbors (Georgia). It is also speculated that the ragweed expansion in Turkey was probably associated with the construction of the Black Sea Highway, since the highway construction cleared the land from all native plants and created conditions suitable for the *A. artemisiifolia* invasion.

Keywords: Common ragweed; *A. artemisiifolia*; Invasion; Turkey; Black Sea Region

Acknowledgements: This study was implemented within a project funded by the Gaziosmanpasa University (BAP Grant Number: 2012/106).

Genetic Diversity Facilitates the Establishment of a Perennial Invader But is not Associated with Population Growth Rate

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Genetic variability enables populations to adapt to new environments and may therefore determine their invasion success. Exploring whether genetically diverse populations of invasive species have higher population growth rate than populations with lower genetic diversity is highly relevant for invasion control, and will also increase our understanding of species invasiveness. We investigated the role of genetic diversity in the fitness of individuals and populations of a perennial, invasive herb (*Lupinus polyphyllus* Lindl.) by combining genetics, demographic data over the whole life cycle of individuals and controlled greenhouse experiments. We collected genetic and demographic data from 37 *L. polyphyllus* populations covering a latitudinal gradient in a part of the invaded range in Finland, and defined genetic diversity based on 13 microsatellite loci. Genetic diversity differed among habitat types and increased with population size. Seedling establishment in the field increased with genetic diversity, whereas the survival, growth and seed production of *L. polyphyllus* individuals were not associated with it. There was no relationship between the long-term population growth rate and genetic diversity. Overall, our results suggest that genetic diversity may facilitate the establishment of plant invasions by improving the fitness at the seedling stage, but plays a negligible role in more established invasions.

Keywords: demography; fitness; genetic diversity; population dynamics; vital rates

"NOT ATTENDED"

Genetic Differentiation Between Native and Invasive Populations of *Quercus rubra* L.

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We investigated the role of interaction between environmental conditions and genetics in the success of tree invasion. Indeed, invasiveness is expressed only under certain environments: for example, European populations of *Acer negundo* L. present higher growth and a longer growing season length explained by earlier budburst compared to that of U.S. populations of *A. negundo*. This may be related to rapid changes in introduced populations. Provenance tests are appropriate tools for studying genetic differentiation by comparing populations of different origins under several environmental conditions.
Northern Red Oak (*Quercus rubra*) which was first introduced from USA to France as an ornamental species has received a strong interest in forestry since the late 19th century. This interest prompted the installation of comparative trials to establish a breeding program during the 80s-90s at the demand of forest managers. Recently, European forest managers seek to evaluate its invasiveness and to limit its natural expansion that impedes the regeneration of sessile or pedunculate oaks. Two provenance trials have been settled in South-West and North-East of France, containing 66 American and 60 European provenances, corresponding to 40000 trees per trial, which were followed between 1982 and 2012 on traits related to fitness.
Within each trial, differences between ranges would reflect the existence of genetic differentiation between populations, while differences between trials would indicate the existence of phenotypic plasticity. Statistical analyses showed the existence of genetic differentiation, invasive European populations demonstrating superior growth compared to native populations. Regarding phenology, the results are inconclusive, probably due to the strong inter-annual variability of these traits and the availability of a single measurement. A monitoring of leaf and fruiting phenology, traits heavily involved in the determination of fitness, are thus required. On the other hand, in order to evaluate the adaptive nature of these differentiations, analyses of diversity molecular markers will also be undertaken.

Keywords: genetic differentiation, phenotypic plasticity, northern red oak

Comparison of molecular diversity of three *Impatiens* species from Central Europe and Baltic region

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Invasion studies are often performed employing methods of population biology. In most cases, populations differing in geography, ecology and invasion history are compared inside areal occupied by alien species. The other group of analyses represents comparison of populations growing in natural and invaded areas, in such cases, populations belonging either to very distinct corners of the same continent or even different continents are compared. In many regions of the world, some genera are represented by both natural and alien species, as a samples of such genus might be *Solidago*, *Heracleum*, *Erigeron*, *Rumex*, *Acer*, *Eucalyptus*, etc. *Impatiens* from Europe represent a unique opportunity to study gradients of invasion process due to very special set of the species: the first one – *Impatiens noli-tangere* L., growing naturally, the second one – *Impatiens parviflora* DC. – widely spread alien with very high degree of naturalization, and the third one – *Impatiens glandulifera* Royle – an alien, very actively spreading nowadays and least adapted to the novel areas according to phenology and other physiological traits (further in the text species were abbreviated, respectively IN, IP and IG). Despite Impatiens species slightly differ in microhabitats owing to their requirements for light, soil and moisture, however, under certain cases; they might grow besides each other or in a short distance with similar microclimate. Such circumstances provide opportunity to employ 3 *Impatiens* model for invasion research. Aliens from different regions of Europe underwent distinct histories of invasions in terms of arrival, spread and social media. Present study was aimed at evaluation of 3 *Impatiens* species of Europe according to multilocus molecular markers of two types. Totally, 24 populations belonging to three *Impatiens* species from two different Europe countries (Czech Republic and Lithuania) were examined. Percentage of polymorphic loci depended on marker type and species: the highest mean values were documented for IG at RAPD loci, and the lowest for IN at ISSR loci. Nei's genetic

distances defined by ISSR and RAPD markers, were significantly related: medium correlation was found for IN, strong correlations were observed in case of IP and IG. Both molecular markers showed very well expressed geographical differences between populations in case of all three *Impatiens* species, and it might due to the differences in climate conditions and/or life histories.

Keywords: balsams, *Balsaminaceae*, invasions, alien species, genetic diversity

Acknowledgements: The work was sponsored by Lithuania Research Council, project No LEK-07/2012

"NOT ATTENDED"

Evolutionary Analysis Of Seed Size Variation And Its Contribution To Non-Native Invasion

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Differences in phenotypic traits between native and non-native populations may explain how some species succeed in non-native ranges. Based on recent findings suggesting that larger seeds in non-native than native populations of the worldwide distributed *Centaurea solstitialis* L. favor seedling establishment under non-native conditions, we initiated an evolutionary analysis of seed size variation in the species. In the current work, we addressed three inquiry lines. First, we conducted extensive field samplings in what is considered the ancestral range of the species, Turkey and Georgia, and in one non-native region, central and southern Argentina, to better estimate the mean and the variation of the trait in populations from both ranges. Second, we related seed size to environmental gradients in both ranges to explore for clinal variations in the trait. Lastly, we assessed survival in seedling emerged from small and large seeds in a field experiment in the non-native region to assess whether the environment in that region selects for larger seeds. We found that seed mass in non-native populations exhibited a larger mean and a smaller variance than those in native populations. Also, seed size related negatively to precipitation in the non-native range and positively to elevation in the native range. Finally, seedlings emerging from larger seeds exhibited higher survival than those emerging from smaller seeds in the non-native region. Although the influence of founder and maternal effects remains to be assessed, these results suggest that selection on pre-adapted genotypes could contribute to seed size increase in non-native populations. Larger seeds may, in turn, be central for the demographic success of these populations.

Keywords: *Centaurea solstitialis*, clinal variation, geographic range expansion, population differentiation, selection of pre-adapted genotypes

"American" and "European" Douglas-fir

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Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is one of numerous naturally wide-distributed and economically important forest tree species with extensive introductions outside their native ranges, where these species sometimes naturalized or even become invasive. Outside its native range in western North America, *Pseudotsuga menziesii* was introduced in numerous countries worldwide (e.g. New Zealand, Chile, Argentina, Australia, France) promoted by the tree's stable growth potential, the robustness and the timber quality. Within the broad native range, two varieties are commonly recognized: the coastal variety (*P. menziesii* var. *menziesii*) and the interior variety (*P. menziesii* var. *glauca*). These hybridize in zones of contact. Both varieties differ morphologically and ecologically. The interior variety is more shade tolerant, more cold hardy and more drought resistant than the coastal variety, however more susceptible to a specific fungal agent under humid conditions. In Europe this conifer was introduced some 190 years ago. In general, European Douglas-fir populations cultivated up to the 1980s are of unknown geographic origin including variety identification. Nevertheless, knowledge of the genetic structure, hybridisation/introgression patterns of this conifer in the Northern America as well as in Europe is crucial to understand how this species may evolve outside its native range where existence of artificial variety-mixed stands have been reported. In the presentation, we will show results on these patterns and processes (genetic structure and hybridisation/introgression) as revealed by genotyping Douglas-fir populations from America (Canada, USA) and Europe (Germany, Austria) with 13 nuclear microsatellites.

Keywords: Douglas-fir, genetic structure, hybridization, variety, *Pseudotsuga menziesii*

The Lime Leaf Miner *Phyllonorycter issikii* (Kumata, 1963), a Highly Invasive Pest in Europe: Genetics of Invasion and Systematic

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Herbivore insects are one the most numerous invaders at many locations around the world, representing an economic threat, causing serious impacts on communities of native species, and disturbing natural ecosystem processes. Among those invasive plant-feeding pests, leaf mining insects (larvae developed within leaves) represent an important group of herbivores that threaten crops, parks and gardens. Some leaf mining micromoths provide extraordinary examples of rapid expansion, particularly the lime leaf miner *Phyllonorycter issikii*, a *Tilia*-feeder. A native of Eastern Asia, in the last few decades, this tiny moth has spread westwards over the whole of Russia and has invaded several European countries, becoming a serious ornamental pest of lime trees.
Within a project supported by LE STUDIUM® Loire Valley Institute for Advanced Studies (France), we are analyzing the genetics of the invasion of *P. issikii* across its distribution range using mitochondrial (COI) and nuclear (28S and Histone3) gene fragments. In addition, the morphology of barcoded adult moths is being compared between native and invaded areas. Preliminary results indicate a loss of genetic diversity in *P. issikii* populations, following the range spread from East to West. Both genetic and morphometric data support the existence of a new undescribed non-invasive cryptic species that occurs sympatrically with *P. issikii* in the Russian Far East.

Keywords:*Phyllonorycter issikii*, invasion, Europe, genetics, systematics

Pan-European Evaluation of İmpact Assessment Protocols for Invasive Alien Species

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In recent years, many national or regional organisations and research groups have developed various protocols for assessing the impact of invasive alien species in Europe. These protocols are diverse in their objectives (black list, prioritization for management, integration into full risk assessments, etc.) but also in their content and methodology. In the framework of the COST Action ALIEN CHALLENGE, more than 120 European invasive species specialists are presently testing 17 protocols using 72 species belonging to all taxonomic groups of invasive species. The aim is not to compare and rank the quality of the protocols but rather to identify their strengths and weaknesses, taking into account their main utilisation, test their consistency and suggest improvements. The final objective will be, at a later stage, to use the strengths of the different methodologies to propose pan-European standardised methods to estimate the magnitude of actual and potential environmental and socio-economic impacts of invasive alien species in Europe. The species assessments by various protocols and assessors will also be analysed to propose a preliminary ranking of invasive alien species impacts in Europe. This ranking will have to be validated and supplemented with other species using the standardised methods developed in the project. The testing exercise and the first results will be presented at the conference.

Key words: Impact assessment, alienchallange, assessment protocols, IAS

New Kids on The Block: A Case Study of How Invasives Can Alter Early-Life Stage Fish-Mussel Interactions

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The arrival of exotic (non-native) fish species often results in alterations in fish-bivalve interactions; however, our knowledge in this field is limited as studies on fish-bivalve interactions have tended not to consider early life stages (ELSs) of fish. In this study we, examine ELS bivalve (glochidia) infection of drifting ELS fish assemblages in the River Dyje (Czech Republic), a system recently colonised by two exotic gobiid species (round goby *Neogobius melanostomus* and tubenose goby *Proterorhinus semilunaris*) and the non-native Chinese pond mussel *Anodonta woodiana*, thereby revealing previously unconsidered effects of invasive species.
While ELSs of native fish (mostly Cyprinidae) were only rarely infected by native bivalve ELSs (represented mostly by the swollen river mussel *Unio tumidus*), they were more prone to infection by ELSs of exotic *A. woodiana*. Exotic gobiids displayed significantly higher prevalence (25% vs. 8%) and mean intensity of infection (3.0 vs. 1.2 glochidia) than native fish, being more prone to infection by ELSs of both native and exotic bivalves. Compared to native fish, presence of exotic gobiids (i) changed the proportion of native/exotic bivalve glochidia transported downstream on fish ELSs, (ii) increased the total number of glochidia transported, and (iii) prolonged the period during which glochidia were transported.
We suggest that interactions between gobiids and unionids are more complex than previously considered, with effects on dispersal pattern, assemblage composition and population dynamics in both fish and bivalves.
The addition of exotic components into native ELS-level fish-bivalve interactions introduced completely new dynamics into the system. Such effects will have been missed when studying older life stages only, thus stressing the importance of studying ELS-level interactions when assessing the impacts of invasive species.

Keywords: host-parasite interactions, dispersal, glochidia, fish larvae, Gobiidae

Parasite spill-over, spill-back and dilution effects of invasive oysters

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Invaders are able to affect native parasite-host dynamics via a variety of ways. New established hosts can act as reservoirs by co-introducing a parasite that also infects native hosts (*spill-over effect*). In addition, invaders may act as an alternative host for native parasites, thus increasing the parasites' population sizes and subsequently intensifying parasite burdens in native hosts (*spill-back effect*). Alternatively, invasive species can reduce the disease risk for native hosts, e.g. by preying on infective stages *(dilution effect)*. Here, we present the results of observational and experimental studies that show evidence for these three effects in the intertidal of the Wadden Sea, in which the Pacific oyster, *Crassostrea gigas*, is one of the most prominent invaders that interacts with native blue mussels, *Mytilus edulis*. In the field, we found evidence for a spill-over effect of the parasitic copepod *Mytilicola orientalis* from oyster to mussels, however, evidence for spill-back and dilution effects on shell-boring polychaetes and trematodes were less apparent. In addition, we found the infection levels of parasites in both mussel and oyster hosts to be more similar within beds than among beds, indicating that the effect of the invader on native-parasite host systems mainly acts on local spatial scales. The implications of this invader for native host systems are further illustrated with preliminary results of effect studies.

Keywords: parasite spill-over; parasite spill-back; marine invasion; parasite-mediated indirect effects; co-introduction

Can *Corbicula fluminea* (Bivalvia: Corbiculidae) (Müller, 1774) Exert a Significant Top-Down Regulation on Estuarine Phytoplankton?

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One of the most interesting ecological characteristics of certain invasive species is their capability to alter ecosystems' functioning. The Asian clam *Corbicula fluminea* (Müller, 1774) is a good representative of such a species, being well known their impacts at multiple compartments in brackish and freshwater ecosystems. For example, *C. fluminea* is both a filter and a pedal-feeder, so one of our goals was to investigate if this species can exert a significant top-down pressure on estuarine phytoplankton, and inherently cause a major impact on estuarine primary productivity. We conducted two experiments, during phytoplankton blooming and non-blooming periods, in Minho estuary (Portugal). We used nine one m^3 tanks, paved with estuarine sediment, arranged in a Latin square reduced form design- 1 treatment (*C. fluminea* density) with 3 levels (0 individuals m^{-2}, 100 individuals m^{-2}, 2000 individuals m^{-2}). The experiment lasted for 48 h, and phytoplankton samples were collected every hour during the first 12 hours, and then at every 12 hours. Data showed that *C. fluminea* exerts a significant top-down control on estuarine phytoplankton and similar grazing pressure upon all phytoplankton taxa, during blooming and non-blooming periods. During the blooming period, only 1% of initial phytoplankton abundance remained in the 2000 individuals m^{-2} treatment tanks only 8 hours after the beginning of the experiment. Minho estuary is a shallow ecosystem (average depth- 4 m) and *C. fluminea* reach high densities throughout the estuary (average minimum and maximum densities- 80 and 4000 ind. m^{-2}), so the low phytoplankton biomass registered in this estuary might also be due to *C. fluminea* top-down control. Thus, this work contributes to explain why allochthonous sources of organic matter and pedal-feeding are used by *C. fluminea* as alternative or complementary sources of energy to autochthonous phytoplankton in Minho estuary.

Keywords: biological invasions, ecosystem functioning, bivalve, phytoplankton, estuary

Predicting the Invasiveness of Introduced Freshwater Fishes Under Conditions of Climate Warming Using a Life-History Model

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North American nest-guarding fishes are amongst the most successful introduced species in Europe. For example, the pumpkinseed *Lepomis gibbosus* Linnaeus 1758 and the black bullhead *Ameiurus melas* (Rafinesque, 1820), from the families Centarchidae and Ictaluridae respectively, have established invasive populations in many parts of Europe, though mainly in the warmer (middle and southern) regions and where human disturbances have undermined freshwater ecosystem resilience. Extensive studies of growth and life-history traits in native *L. gibbosus* populations have confirmed a relationship of decreasing age at maturity (AaM) with increasing juvenile growth (JuvG). Application of this model to *L. gibbosus* populations introduced to Europe revealed is a potentially useful tool for predicting the species' likelihood of being invasive under conditions of climate warming. Current forecasting models predict warmer climates (by 2–5°C) and more variable hydrological regimes for water courses in many parts of Europe. The warmer conditions are predicted to benefit some species (e.g. pumpkinseed), especially those that have easily established populations in the southern parts of Europe. This communication will review applications of the AaM–JuvG model to assess its potential usefulness for predicting the invasiveness, under future (warmer) climatic conditions, of these two North American species and also the crucian carp *Carassius carassius* (Linnaeus, 1758), a cyprinid species native to the middle and northern parts of Europe but introduced in the south. The greater hydrological variability predicted to accompany the warmer climatic conditions is expected to increase fish dispersal, so wider

establishment of non-native fishes is likely to enhance the risks of adverse consequences for native species and ecosystems. However, existing evidence for adverse impacts remains equivocal or lacking for many non-native fishes.

Keywords: *Lepomis gibbosus*, *Ameiurus melas, age at maturity, juvenile growth, Carassius carassius*

Will Climate Change and Water Restriction Drive The Arrival Of New Pests and Pathogens?

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Forests and woodlands harbor a great part of the World's biological diversity, provide long-term carbon storage, and regulate biogeochemical cycles and erosion. During the last 30 years, these ecosystems have been exposed to the increasing pressure of globalization, which amplified frequency and effects of biological invasions. The downfall of physical and/or political barriers resulting in the opening of new trade routes increased both the speed and magnitude of invasions. Invasive species modify forest ecosystem dynamics at different levels, progressively reduce genetic diversity and, together with other human-mediated stress factors, may ultimately lead certain species or entire communities to extinction.
In addiction to trade, changes in land-use and climate may increase the spread and impact of existing invasive species, favor the establishment of new invasive species, and impair the effectiveness of control strategies. As a matter of fact, altered weather patterns can increase vulnerability of forest ecosystems to infestation by native and introduced pests and pathogens. Indirect evidence of this phenomenon is the increasing number (more than 5-fold in average from the beginning of the 20th century) of pests on tropical and subtropical trees used as forest and amenity trees in Southern Europe. The economical consequences are heavy since these trees are used in specialized plantation for wood production and as ornamentals. Climate change and water restrictions increase the demand for new plants adapted to the new conditions, but new sources of plants will bring along new invasive pests and pathogens, because trade of live plants is the main pathway of introduction.

Keywords: climate change, forest pests, forest pathogens, drought, pathways

The Impact of Climate and Forest Management on the Physiological Performance and Reproductive Investment of an Invasive Plant Species

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In Portugal, *Acacia longifolia* is one of the most aggressive invasive plant species and causing major ecological problems. In contrast to native species, *A. longifolia* reveals lower investment in adaptive traits; it exhibits a high resource allocation and a constant allocation pattern under different conditions. The objective of this study was to understand the physiological response, vegetative growth and reproductive output of *A.longifolia* to different climatic conditions and forest structure.

The study was conducted at two different sites, Osso da Baleia (northern of Portugal) and Pinheiro da Cruz (southern of Portugal), where we have different climate conditions, being mesic conditions in the northern site and xeric conditions in the southern site. Both sites are occupied by *Pinus pinaster* plantation. The pine forest is approximately 2 times denser and has higher canopy cover in the northern site than in the southern site. We compared the physiological performance, vegetative growth and reproductive output of *A. longifolia* between both sites in plots with a *P. pinaster* forest canopy and open areas. In each plot were performed leaf water potential (Ψw) and gas exchanges measurements in three occasions: March, June and July (2010). Vegetative growth of selected *A. longifolia* trees was monitored by measuring shoot elongation and by counting leaves and reproductive investment by counting flowers and fruits.

The results showed that, although the higher precipitation registered in the northern site, the Ψw values of understory *A. longifolia* was as negative as in the southern site. But the Ψw values of *A. longifolia* under *P. pinaster* over story were significantly lower compared with *A. longifolia* in the open plot. Carbon assimilation (A) and stomatal conductance (gs) decreased with increasing drought in *A. longifolia* in all study plots but the understory *A. longifolia* in the north site were the most affected by drought showing the strongest decrease in *A* and *gs* values. In the northern forest understory *A. longifolia* showed highest reproductive investment and lowest growth rate comparatively with open areas and southern forest.

We can conclude that forest systems in the north of Portugal, with mesic conditions but relative higher biomass and higher resources competition

(such as water and sunlight) might be more stressful for understory *A. longifolia*, displaying a lower physiological performance and higher reproductive costs than in the south forests systems. These results are especially important for the understanding of the factors that can determine the reproductive costs in *A. longifolia*, emphasizing potential differences in the invasive pattern according to forest management and climate change. Moreover, this study may contribute for a future model that will account climate change scenarios and invasiveness patterns in the Mediterranean region.

Keywords: *Acacia longifolia*; Portugal; plant phenology; maritime pine Forest

Threats Posed by Non-Native Freshwater Fish Introductions to Biodiversity in The Mediterranean Basin Region: A Case Study from Turkey

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Biological invasions by non-native species represent one of the major threats to biodiversity conservation. The southern part of the Mediterranean region, including Turkey, is regarded as one of the six global invasion hotspots. This area is characterized by a high level of endemism, hence vulnerability to species invasions including non-native fishes. Introduction of the latter can occur either intentionally (i.e. aquarium trade, sport fishing, food industry, biological control) or accidentally (i.e. contamination from scientific experiments and stockings). The impacts resulting from these introductions are mostly predation, competition, hybridisation, habitat modification, and transmission of novel diseases and may ultimately involve economic costs and risks posed to public health. The present contribution reviews the main pathways, drivers and associated impacts of non-native freshwater fish introductions in the Mediterranean region, using as a case study the freshwater ecosystems of Turkey—a country that hosts the largest number of freshwater fish species (310, of which ≈25% endemic) in the Mediterranean region. Introduction of freshwater fish in Turkish inland waters has occurred via fisheries and aquaculture practices, and has involved 33 species in total including species translocated within the country. Some of these non-native species have been reported to cause declines in native fish communities through reproductive interference, predation, competition, habitat degradation and dramatic changes in ecosystem processes. A recent risk assessment using the Fish Invasiveness Screening Kit (FISK) has demonstrated the usefulness and viability of the tool for identifying potentially invasive non-native fish in Turkey. Public awareness and scientific knowledge are essential to prevent further introductions and spread of non-native fish across the country.

Keywords: Invasive species, drivers of use, pathways, legislation, endemism.

Everything You Always Wanted to Know about Impact *But were Afraid to Ask

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Despite intensive research on the effects of alien species during the past decade, invasion science still lacks the capacity to predict impacts and thus provide timely advice to managers on where limited resources should be

allocated. This capacity has been limited in part by the context-dependent nature of impacts and the lack of standardized methods for observing and quantifying impact. We review different strategies, including specific experimental approaches and observational methods, for detecting and quantifying the ecological impacts of alien species. Our synthesis points out that different experimental methodologies are appropriate for different taxa due to particular properties of the species and ecosystems involved, even though most methods are theoretically possible for most organismal groups. Our recommendations to conduct experiments on impact include a four-way-plot experimental design (uninvaded, invaded, removal of natives, removal of aliens) – not only to reveal ecological and potentially irreversible impacts, but also to determine the potential success of restoration efforts. We also present other strategies for recognizing high-impact species, for example to identify specific combinations of species traits, ecosystem characteristics and impacts with a high probability of causing irreversible changes in recipient system. Furthermore, we identify hypothesis-driven parameters that should be measured at invaded sites to maximize insights into the nature of impact. Our recommendations aim to provide a basis for developing systematic quantitative measurements to allow comparisons of impact across alien species, sites and time, and to maximise the usefulness and outcomes of impact studies.

Keywords: biological invasions, context dependence, ecosystem functioning, management, prediction

Alien and Native Plant Species Play Different Roles in Plant Community Structure

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To date, few studies have examined the potential impacts of a wide enough spectrum of native and alien species to address the importance of geographic origin on the structure of plant communities. We investigated how total species richness, as well as its separate alien and native components, varied with the abundance of 115 alien and 146 native species across Banks Peninsula in New Zealand. Using a null model approach, we tested whether significant correlations with species richness were more frequent than expected by chance. Examination of the differences in the relationships with species abundance found for native and alien richness can shed light as to whether alien species might be acting as drivers of change or passengers responding to external environmental factors. Compared to native species, increasing alien abundance was associated with more frequent negative relationships for native richness but positive relationships for alien richness. The relationship with species abundance found for native and alien components of richness differed between vegetation types. While we found support for negative impacts for several alien species in grasslands, the negative correlations with native species richness in woodlands were more likely to reflect community response to external factors such as land-use than being driven by the abundance of aliens. Our analyses reveal that widespread alien and native species play different roles in the plant communities in which they co-occur. By separately analysing the relationship with species abundance for alien and native components of richness can help distinguish situations where aliens may act as drivers in plant community changes or simply passengers. This is an essential first step in designing further experimental studies to determine the underlying ecological processes and potential ecosystem impacts of alien species.

Keywords: abundance, alien species, impacts, species richness

Environmental Risk Assessment of the Emerald Ash Borer *Agrilus planipennis*

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We performed an environmental risk assessment (ERA) of the Emerald Ash Borer (*Agrilus planipennis* Fairmaire, Coleoptera, Buprestidae). For this ERA, we focused on the density of the pest, being the most important driver to describe and foresee the outcome of the trophic relationships between a pest and its host plants. Knowing the population density of an invasive species and its spatial and temporal variation is essential to determine the spatial and temporal pattern of the environmental impact.. The effects of ecosystem resistance and resilience, as well as the outcome of pest management practices on beetle population dynamics in the short (5 years) and the long term (12 years) were estimated. Expert judgment was used to evaluate separately the impacts of the pest on (*a*) ecosystem services and (*b*) biodiversity components in two service-providing units – urban and forest habitats. The impact is assessed under specific assumptions defining the scenarios of the assessment (considering the spatial and temporal scale for the assessment and the values assigned to the resistance, the resilience and the management effects for the different scenarios. The assessment considers the past and current situation in North America (USA and Canada) and Russia, where the pest has been introduced and is spreading. From this, the risk for Europe was estimated for the short and the long term. From experts' judgment three synthetic indexes of the overall risk posed by *A. planipennis* to (i) the provisioning services, (ii) the regulating and supporting services, and (iii) the

biodiversity components were derived. A statistical procedure based on the Shannon entropy measure was applied to compute the uncertainty of the estimated risks. Impacts on biodiversity components and ecosystem services differed partly significantly between short and long term. The approach of combining environmental risk assessments from multiple experts from different regions provided interesting and useful information for the risk organisms can pose to biodiversity and ecosystem services.

Keywords: ERA; ecosystem services; biodiversity; scenario analysis; scaling factors

Competition For Shelter Among Invasive Ponto-Caspian Gobies And Native European Bullhead

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The recent invasion of Ponto-Caspian gobiids can become a real threat for native species, especially when similarities in their habitat requirements and reproductive behaviour are observed. Co-occurrence of the endangered European bullhead *Cottus gobio* and alien gobies (monkey, racer and tubenose goby) was noted in the Vistula catchment, where these species may be involved in competitive interactions. To evaluate if the non-native gobies affect bullhead behavior when potential shelter places are limited, we conducted a series of laboratory experiments in two seasons: spring (regarded as a spawning season) and in autumn. We observed pairs of species consisting of a bullhead resident and goby intruder, and compared time spent in an artificial shelter and frequency of three types of aggressive behavior ('direct aggression' when one fish bites, dart toward or chase another, 'indirect aggression' when one fish seize the shelter, attempt to overtake or move slowly towards the shelter, and 'guarding the shelter' when fish is inside the shelter and lean out to watch). All the goby species competed with bullhead for a shelter, which in consequence led to the alteration of the behavior of the latter. In spring, mokey and racer gobies attempted to take over the shelter (successfully) and displayed aggressive behavior towards bullhead, the racer goby being the most aggressive and influential species. Tubenose goby was the only goby species occupying the shelter in autumn, while racer and monkey goby were less interested in refuges. As a tendency to decline native bullhead populations when they co-occur with alien gobies is noted, the observed negative influence of non-native gobies on European bullhead might diminish their reproductive success, e.g. by limiting their spawning habitats.

Keywords: Ponto- Caspian gobiids, alien species, *Cottus gobio*, aggression

Interaction Rewiring in Plant-Pollinator Networks Invaded by a Non-Native Plant

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Entomophilous non-native plants can get well integrated into plant-pollinator communities by generalist pollinators, affecting native plants through those shared pollinators. The effect on single native plant pollination varies from facilitative to competitive, and might depend on species traits (e.g. flower morphology).
The effects of non-native plant species on native plant-pollinator interactions do not occur in isolation but within complex plant-pollinator interacting networks so that non-native plants can also alter properties of the entire network.
We conducted a flower removal experiment to explore the effect of a non-native entomophilous legume (*Hedysarum coronarirun*) on Mediterranean shrubland plant-pollinator networks. We studied whether the effect of the non-native is influenced by its similarity to the natives in flower morphology (papilionate *vs*. non-papilionate). We did the analysis for the entire pollinator community and for the honeybee exclusively, as it is the main pollinator of *Hedysarum*. *Hedysarum* was well integrated into the resident plant-pollinator networks by interacting with generalist pollinators. Despite that, visitation rate, linkage level, niche overlap and interaction strength of native plant species were not overall affected, and were always lower in natives with restrictive papilionate flowers. Network connectance was neither affected by the integration of *Hedysarum*. However, honeybees visiting natives decreased in invaded communities, irrespectively to flower morphology. Meanwhile, other interactions involving wild pollinators appeared. These changes in the identity of interactions (i.e. interaction rewiring) altered modularity, while nestedness was maintained.
In conclusion, the effect on networks topology of a non-native plant species with restrictive flower morphology seems not to be related to the similarity of natives in flower morphology. With the presence of non-native flowers some topological patters might be maintained (e.g. nestedness), while others might be altered (e.g. modularity). Such effects on network topology are not necessarily accompanied by changes in the number of interactions but just in their identity. Therefore, interaction rewiring must be taken into account in order to predict community responses to the arrival of non-native plants.

Keywords: ecological similarity, pollination networks, papilionate flower, modularity

Why is Species Richness a Poor Predictor of Invasion Success?

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One of the most tested hypotheses within invasion biology is Elton's biotic resistance hypothesis. It states that species-rich communities should be better at resisting invaders than species poor communities. This is because more species should be able to occupy the niche space more fully. Theoretical community ecology provides strong support for this idea, but empirical support from invasion studies is rather weak. Many have even observed a positive relationship with species richness and invasion success. Why? One possible explanation is that species richness and saturation is poorly correlated in natural systems. If so, we should expect invasion success to be related to the degree of saturation rather than species richness. Another possible explanation is that species vary in their contribution to community resistance, depending on their trophic status and competitive abilities. Some species should even be able to resist invasions on their own if they are competitors with the invader or predators of the invading species. Under this hypothesis we should expect that resistance is best explained by the identities of the resident species. To test these hypotheses we analyzed a dataset of 470 successful and failed introductions of four different species of freshwater fish into Swedish lakes. We related the invasion success to species richness, saturation, presence/absence of individual species and a weighted species richness. The weighted species richness describes the different contributions of each species to resistance. We found low support for the species richness and the saturation hypotheses, stronger support for the species identity hypothesis but we found the strongest support for the weighted species richness.

Keywords: Biotic resistance, freshwater fish, species richness, saturation, species identity

The Role of Hydrological Alteration in Explaining Invasiveness of Two North American Fish Species Introduced to The Iberian Peninsula

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Freshwater ecosystems are very rich in biodiversity and among the most threatened worldwide. This is well exemplified by the Iberian Peninsula, where most freshwater native fish being endemics that are declining due to multiple severe environmental pressures. One of these pressures are invasive alien species, which are thought to benefit from hydrological alteration (e.g. dam construction or water abstraction) and other anthropogenic perturbations, although the evidence for this is limited. Using species distribution models as implemented in biomod2, we have tested the role of hydrological alteration in explaining invasiveness of two North American fish species that are among the most introduced worldwide: the eastern mosquitofish (*Gambusia holbrooki*) and the largemouth bass (*Micropterus salmoides*). We found that natural abiotic factors such as temperature, elevation or precipitation are more important than hydrological alteration in explaining the distribution of these two species in the Iberian Peninsula. However, hydrological alteration also seems to play a role particularly for largemouth bass: these species were more frequent in the mainstem of heavily regulated large rivers. Although introduced many decades ago, both species might expand their distribution in the future, particularly with climate change and ongoing hydrological alteration. Preserving and restoring the natural flow regime of Mediterranean rivers might help to reduce the spread and abundance of these and other aquatic invasive species.

Keywords: freshwater fish; rivers; anthropogenic perturbation; *Gambusia holbrooki*; *Micropterus salmoides*

The SMARTER Approach to Assess the Impact of an Accidentally Introduced Exotic Leaf Beetle on Invasive Ragweed in Europe

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The continued spread of common ragweed, *Ambrosia artemisiifolia,* in Europe is a growing problem. Whereas the pollen cause severe health problems, the plant is an agricultural weed, and seed production forms the source for population growth and dispersal. In 2013, large populations of the ragweed leaf beetle, *Ophraella communa* (Coleoptera: Chrysomelidae) were unexpectedly found in Southern Switzerland and Northern Italy. The establishment of this potential biological control agent of ragweed, that is very successful in Asia, demands a rapid investigation of its target impact and host specificity (cf. other contributions on this aspect) in Europe. We address these questions within the European Research network SMARTER "Sustainable Management of Ambrosia artemisiifolia in Europe".
The target impact of *O. communa* depends on the dynamics of both the ragweed and the beetle populations, and their reciprocal interactions. Considering these dynamics, we here present first results of various descriptive and experimental studies manipulating plant and beetle densities, performed in the greenhouse and in the field in 2014. We report the development of several generations of the beetle, and their impact on the progressing phenological stages of the annual ragweed (damage, life-history traits, pollen production). We then present demographic data reflecting the impact on entire ragweed populations, and show how these can be used to assess the long-term effects through a population dynamics modelling approach. We argue that understanding this mechanism is essential to ultimately predict the indirect effects of the beetle on public health

Keywords: Allergenic weed, Classical biological control, Impact studies, Population dynamics, Plant-insect interactions

The Ragweed Leaf Beetle Landed In Europe: Fortunate Introduction or Threat?

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Common ragweed *Ambrosia artemisiifolia* is one of the most problematic invasive plants in Europe, mainly because of its highly allergenic pollen, but also because it is a major crop weed. In the framework of the COST Action FA1203 on "Sustainable management of *Ambrosia artemisiifolia* in Europe ('SMARTER')", biological control solutions are being developed as a long-term management option against this weed in Europe. To our surprise, during the first year of SMARTER the North American leaf beetle *Ophraella communa* was found across northern Italy and southern Switzerland. This beetle, which is a successful biological control agent of common ragweed in China, appears to have been accidentally introduced in Europe, but already prevents flowering of entire common ragweed populations at many sites. While successful biological control of common ragweed may potentially generate huge economic benefits, there is some controversy on the likelihood of attack of sunflower by *O. communa* under field conditions. During summer 2014, we thus performed a series of experiments towards assessing the host specificity of this leaf beetle. We will report results of multiple-choice tests under open-field conditions at three *O. communa* sites in Northern Italy at various relative abundances of the target and test plant species, as well as in the absence of A. *artemisiifolia*, i.e. in no-choice field cage experiments and in multiple-choice open-field experiments in September, when target plants will have been destroyed by the beetle. Closely related Heliantheae species, including sunflower (*Helianthus annuus*) varieties, native (*Inula* spp.) and ornamental species (*Zinnia elegans, Helianthus tuberosus)*, have been tested both for *O. communa* oviposition and larval performance. In combination with surveys of non-target attack in Northern Italy and with field experiments in China, these studies should allow to define a future strategy for handling *O. communa* in Europe.

Keywords: *Ambrosia artemisiifolia*, *Ophraellla communa*, invasive plant, biological control, host-specificity

Landscapes of Biotic Resistance: Context-Dependencies Restructure the Allometric Scaling of Predator-Prey Interactions

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Predator-prey coexistence and the stability of wider communities can depend strongly on the distribution of body masses among species, yet there remains scant understanding of how key traits and environmental contexts might alter predator-prey interactions across body mass distributions. We analysed a large dataset of interactions (i.e. functional responses) between a range of resident aquatic predators and the invasive amphipod *Chelicorophium curvispinum*: we demonstrate that defensive traits can substantially alter the scaling of predator capture rates with body mass, whilst contexts such as the presence of complex habitat structure can collapse their typical hump-shaped distribution. Both aspects have positive consequences for the persistence of *C. curvispinum* populations. These findings provide the first evidence linking the shape of community-level allometric relationships with the persistence of prey populations. Thus, determining how these scaling relationships vary between species and with specific contexts can yield insight into the mechanisms underpinning the persistence and spread of successful invaders.

Keywords: Functional response, biotic resistance, predator-prey interactions, body size, Ponto-Caspian

Limiting Similarity by Functional Group Resemblance: Preventing Plant Invasion During Grassland Restoration

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The invasion of alien species contributes to ecosystem degradation and complicates efforts to restore degraded systems. Thus, designing communities resistant to invasive alien species (IAS) plays a key role for restoration. Biotic resistance can be predicted by the theory of limiting similarity, which states that IAS are unlikely to establish if there are native species sharing similar functional traits, i.e. falling into the same functional groups. However, most studies base functional groups on broad classification of life forms. In this study, we investigate whether we can predict biotic resistance by using functional group identity based on more specific functional traits related to competitive strength. Moreover, we tested if IAS propagule pressure may be decisive in terms of overcoming this resistance, and if this similarity is affected by priority of establishment of the native community. Two greenhouse experiments were devised where three functional groups were clustered according to eight traits, using native grassland species and two invasive alien species (*Ambrosia artemisiifolia, Solidago gigantea*). Results from the first experiment showed that when both IAS and native species are sowed at the same time, functional group identity is not a decisive factor explaining IAS suppression, and no significant differences related to propagule pressure were found. In an ongoing experiment, we expect to find that functional group identity becomes important in terms of biotic resistance when native species are sowed prior to IAS, as found in pre-trials and probably explained by a priority effect. Otherwise, the suppression could be explained by the presence of particular highly competitive species.

Keywords: *Ambrosia artemisiifolia*; *Solidago gigantea*; Biotic resistance; Functional traits

Adaptation of Native Hyperparasitoids to the Invasive Aphid Parasitoid *Lysiphlebus testaceipes* (Hymenoptera, Braconidae, Aphidiinae) in Benin, West Africa

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To what extent will an alien invasive aphid primary parasitoid be attacked by native hyperparasitoids when spreading to a new area? Most case studies of aphid parasitoids in new geographical areas build on experiences from classical biological control (CBC) programs. Poor establishment of primary aphid parasitoids in CBC may be due to competition from native parasitoids, intraguild predation of aphids and mummies, or hyperparasitism.

Most researchers follow careful quarantine procedures to exclude facultative hyperparasitoids in CBS programs, while indigenous hyperparasitoids are usually present in the ecosystem and can interfere with the control of aphids by exotic primary parasitoids. However, many field studies of such programs have shown that primary parasitoids are able to regulate aphid population in spite of high levels of native hyperparasitoids.

With very few exceptions, *Lysiphlebus testaceipes* (Cresson) (Hymenoptera, Braconidae, Aphidiinae) is the only primary parasitoid on aphids in vegetable agroecosystems across Benin, with *Aphis gossypii* Glover and *Aphis crassivora* Koch as common hosts. *Lysiphlebus testaceipes* is native to North America. The species is an invasive species, which can spread rapidly and expand its host range. It is now present on all continents either because it was introduced as a biocontrol agent or as an accidental introduction. The time and origin for its introduction to Benin is unknown.

Here, we studied the aphid-primary parasitoid-hyperparasitoid community on vegetables and weeds at one location in Benin over nearly two years to monitor the species of native hyperparasitoids and to what extent they have really adapted to parasitize the new species. On several occasions, idiobiont hyperparasitoids emerged from more than 90 percent of the mummies collected. The dominating hyperparasitoid was *Syrphophagus africanus* (Gahan). Charipinae hyperparasitoids were lacking, suggesting

that native koinobiont hyperparasitoids have not yet adapted to this aphid community, probably due to a recent introduction of the *L. testaceipes*.

Keywords: *Lysiphlebus testaceipes*, *Syrphophagus africanus*, *Pachyneuron* sp., *Aphanogmus* sp., exotic aphid primary parasitoid and native hyperparasitoids, biotic control

Can the Functional Traits of Introduced Plants be Used to Estimate Impact to Ecosystem Services?

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The impacts of invasive alien plants on ecosystem services are poorly understood. Little is known about the processes by which invasive alien plants affect the delivery of ecosystem services, and the degree to which they do. Given that ecosystem services are largely governed by the combinations of species traits within communities, impacts may be better understood by the relationship between the traits of native and non-native species. In this study, we aimed to understand the impact of alien plants, used for commercial purposes, on ecosystem functioning using plant functional traits. We used three leaf traits (leaf dry matter content, leaf nitrogen content and leaf phosphorous content) to characterise the functional composition of natural communities to determine functional diversity within an ecosystem service hotspot in Eastern Cape, South Africa. These were used to compare changes in species composition across four different land-use types. Each land-use type was characterised by the presence of a single alien species. Results showed that trait diversity and community trait mean values were altered following conversion to different land-use types. There was considerable overlap between native and alien trait values in multi-dimensional space, however, differences could be determined for leaf nitrogen content only. Although, changes in the number of dominant species were observed, differences between native and alien species were based on the traits of individual species as well as the abundance in which they occur. Using this approach for analysing the relationship between native and alien species provides a first step in developing a better understanding of the impacts that alien species have on ecosystem services. This study also provides insight into understanding the per capita effect of alien species. We also discuss the potential to assist decision makers with regards to the propagation or introduction of new species for developing biofuel industries.

Keywords: plant functional traits, land-use, invasive alien plants, biofuels

The Combined Effects of Invasive Species in Riparian and Lotic Communities on Leaf Litter Breakdown

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With the rise of invasive species worldwide, it is necessary to determine their impacts on community structures and, importantly, ecosystem functioning. In freshwater system, the degradation of allochtonous material is an essential energy source, and relies heavily on both the composition of riparian plant and lotic invertebrate communities. With invasive species influencing the composition and functioning of both of e habitats worldwide, it is therefore necessary to determine these species' impacts on leaf degradation. While many studies have looked at the effects of invasive plants or invasive invertebrates in isolation, we investigated both simultaneously in Northern Irish systems; four focal plant species were used: two invasives (*Impatiens glandulifera* and *Fallopia japonica*) and two comparable native competitors (*Urtica diocia* and *Alnus glutinosa*), respectively. We first investigated the individual feeding rates and FPOM production of *Gammarus pulex*, an invasive amphipod in Northern Ireland, and *Gammarus duebeni celticus,* its native counterpart, on the four target plant species. While both native plant species were consumed more readily and efficiently (e.g. FPOM production) than their invasive counterparts, these individual results suggested no significant difference between the two amphipod species. However, as the invasive *G. pulex* is known to decrease the diversity of invertebrates in invaded communities, we furthered our investigation with an *in situ* leaf litter bag experiment to assess if these observed community shifts would modify the degradation pattern of the four target plant species. Our findings suggest that the combined effects of invasive amphipods and invasive riparian plants in Northern Irish waterways could alter detrital dynamics, and therefore availability of resources in lotic environments.

Key words: Detrital dynamics; amphipods; *Fallopia japonica; Impatiens glandulifera*

Invasive Species in a Changing World: Can We Predict New Invaders and Their Ecological Impacts?

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Invasion ecology urgently requires predictive methodologies that can forecast the ecological impacts of existing, emerging and potential invasive species. Ideally, such methods should be applicable across taxonomic/trophic groups, be rapid, reliable and inexpensive, as well as amenable to testing context-dependencies of invader impacts. I argue that many ecologically damaging invaders are characterised by their more efficient use of resources. Consequently, comparison of the classical 'functional response' (relationship between resource use and availability) between invasive and trophically analogous native species may allow prediction of invader ecological impact. The framework developed here demonstrates how comparisons of invader and native functional responses, within and between Type II and III functional responses, allow testing of the likely population-level outcomes of invasions for affected species. Recent studies support the predictive capacity of this method; for example, the invasive 'bloody red shrimp' *Hemimysis anomala* G.O. Sars, 1907 shows higher Type II functional responses than native mysids and this corroborates, and could have predicted, actual impacts in the field. The comparative functional response method can also be used to examine differences in the impact of two or more invaders, two or more populations of the same invader, and the abiotic (e.g. temperature) and biotic (e.g. parasitism) context-dependencies of impact. The framework may also address the previous lack of rigour in testing major hypotheses in invasion ecology, such as the 'enemy release' and 'biotic resistance' hypotheses, as the approach explicitly considers demographic consequences for impacted resources, such as native and invasive prey species. Finally, I discuss a number of challenges in developing this approach: incorporating indirect effects (e.g. trait-mediated indirect interactions); deriving functional responses by methods other than laboratory experiments; the generation of sufficient case studies to test the overall hypothesis that functional responses can indeed predict invader impacts; and the inclusion of the methodology in risk assessment frameworks.

Keywords: functional response; impact; predator; prediction; risk assessment

Invaders Under Threat: How Alien Ponto-Caspian Gammarids Respond to their Potential Predators and Competitors

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Dikerogammarus villosus and *Pontogammarus robustoides* belong to the most invasive amphipods in European waters, considerably influencing invaded ecosystems. To understand their interactions with local communities, we studied their behavioural responses to potential predators and competitors in a Y-shaped tank with one arm fed with water conditioned by the scent of a signal organism and the other arm obtaining control water.

Dikerogammarus villosus, was attracted to the scent of *P. robustoides*, whereas *P. robustoides* avoided *D. villosus*, regarded as a stronger competitor. Both species did not respond to conspecifics, thus these behaviours were induced by another species, rather than just by the increased density (irrespective of species).

Responses of both species to predators were surprising. Gammarids selected the arm with the scent of a wide range of predators, including sympatric species (European perch, racer goby), those met in novel areas (spiny-cheek crayfish) and totally unknown species (red-bellied piranha). The only exception was the eastern Asian Amur sleeper, which, however, also started to "attract" gammarids when fed on their conspecifics. Gammarid behaviour can be explained by the preference of these cannibalistic organisms for potential food or by the reduction of activity in the presence of a predator: individuals entering the arm with the predator signal would freeze and thus stay there longer than in the control arm. Indeed, we observed a clear reduction of movement in the arm with the predator scent, whereas, surprisingly, gammarids were not attracted to their favorites food, chironomid larvae. These results confirm the latter hypothesis.

Inactivity seems to be an efficient defiance against predators that are more agile than their prey. The ability to detect and respond to a wide range of predators may be a mechanism favouring invasive species in their novel areas.

Keywords: induced anti-predator defence, habitat preferences, *Dikerogammarus villosus*, *Pontogammarus robustoides*, fish predators

The Impact of Biological Invasions on Reciprocal Relationships in Biological Communities

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The mechanisms that facilitate success of an invasive species include both ecological and evolutionary processes. Invasions can impact on parasite communities through both the introduction of exotic parasite species and effects of invading hosts on native parasite dynamics. The freshwater mussel *Anadonta woodiana* is native from Asia and an invasive species in Europe, and caused a complete ecological reversal by turning the European bitterling *Rhodeus amarus*, a parasite of European fresh water mussels, into a host. We investigate the possibility that the bitterling *Rhodeus ocellatus*, a generalist parasite of freshwater mussels originating from Asia and able to parasite *A. woodiana* in its native range, may become an invasive species in Europe and its potential effects on the native coevolved system. Using an outdoor garden experiment, we provide evidence that *R. ocellatus* can successfully establish in replicated mesocosms containing combinations of different mussel species originating from Europe, including *A. woodiana*. We furthermore study the effect of competition between *R. ocellatus* and *R. amarus* at the population level, as well as host preference and competition for hosts between both bitterling species using behavioural tests. We also show that hybridization is possible between *R. ocellatus* and *R. amarus*. Hence, the bitterling *R. ocellatus* provides a good study case on how a parasite can potentially benefit from the invasion of its hosts outside its native range and how an invasive parasite can affect a coevolved system.

Keywords: Host-parasite interactions, adaptive evolution, biological invasion, coevolution dynamics

Impacts of Invasive Alien Marine Species on Ecosystem Services and Biodiversity: a pan-European Review

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Our review identified 86 alien marine species, within 13 phyla, having high negative or positive impacts on ecosystem services and biodiversity in European seas. We classified the mechanisms of impact, commented on the methods applied for assessing the impact and the related inferential strength, and reported on information gaps.
Food provision was the ecosystem service impacted by the greatest number of alien species, positively or negatively. Following food provision, the ecosystem services being negatively affected by the highest number of alien species were ocean nourishment, recreation and tourism, and lifecycle maintenance. The ecosystem services that were most often positively impacted were cognitive benefits, water purification, and climate regulation. In many cases, marine aliens were found to negatively affect keystone/protected species and habitats. Thirty percent of the assessed species had an impact on entire ecosystem processes or wider ecosystem functioning, more often in a negative way. Forty-nine of the assessed species were reported as being ecosystem engineers, fundamentally modifying, creating or defining habitats by altering their physical or chemical properties.
The positive impacts of alien species are probably underestimated, mainly due to a perception bias against alien species. Among the species assessed as high-impact species, 17 had only negative impact, and 7 had only

positive impacts; while the majority (62 species) had both negative and positive impacts, the overall balance being often unknown. Although, invasive species have modified marine ecosystems, evidence for most of the reported impacts is weak, being based on expert judgement or dubious correlations, while only 13% of the reported impacts were inferred via manipulative or natural experiments. Evidently, stronger inferences are needed to improve our knowledge of the consequences of marine biological invasions and to better inform environmental managers.

Keywords: impact assessment; high-impact aliens; provisioning services; regulating and maintenance; cultural

Impacts of Alien Species on Human Health in Europe: A Scoping Review

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Impacts of alien species on human health have recently become a major issue in public health and invasion ecology. In Europe, attention has been focussed on a few species, whereas the health impacts of many other alien species are far less recognized. We here provide a first review of the impact of alien species on human health in Europe. We investigated relevant literature regarding (i) taxonomic and geographical coverage (ii) covered invasion stages (iii) origin of harmful alien species and pathways of introduction, (iv) consideration of climate change impacts, and (v) whether temporal trends and costs were assessed and management measures derived. For this purpose, we conducted a systematic search in Thomson Reuters Web of Science and detected 79 relevant articles providing syntheses (n=21) or primary research results (n=58). Most articles were dealing with vascular plants (n=33), mainly Ragweed Ambrosia artemisiifolia L., and dipterans (n=25). Review papers were often covering large regions (global and European scale), whereas primary research articles were mainly conducted at the (sub) national scale. Most articles were dealing with spread, while introduction, establishment, impact and response were less investigated. Regarding pathways, articles were dealing mainly with contaminants that originated from North America and East Asia. About 30% of the articles, mainly those related to species distributions, also provided information about the usually increasing trend. Only two primary papers assessed the severity of the impact, and only three articles assessed climate change impacts. In 28% of the primary papers, specific management or control measures were derived while in only one primary paper the socioeconomic costs were assessed. We conclude that the impact of alien species on human health is hardly investigated in a comprehensive way, and that several important aspects such as the early invasion stages of health relevant species, the trend in impacts and the socioeconomic costs are particularly poorly investigated.

Keywords: climate change, management, spread, vector, reservoir

Effect of Invasive Species *Urochloa decumbens* on Carbon Stocks in Cerrado (Brazilian Savanna)

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Savannas and grasslands are important carbon storage zones, especially belowground, nevertheless carbon dynamics in tropical savannas is poorly known. The invasion of native vegetation by alien species, which have distinctive abilities to use nutrients and allocate resources, can alter the dynamics of nutrients and bring long-lasting effects to nutrient stocks. We analysed the effect of *Urochloa decumbens* (Stapf) R.D.Webster, an invasive African grass, in the Cerrado carbon stocks. In both invaded (U) and non-invaded (NI) areas, we determined aboveground live and dead biomass, belowground biomass of roots (every 10 cm until 50 cm depth), and the total carbon in the soil (every 10 cm until 100 cm depth). Vegetation cover was estimated; roots were separated according to diameter (<2 mm; 2−10 mm); and soil carbon stock was calculated for 1 m depth. We compared U and NI aboveground biomass (live, dead and total) and soil carbon stocks through repeated ANOVA and Mann Whitney tests, and comparisons at different depths in the same plots were made through Friedman and paired Wilcoxon tests. The invasive *U. decumbens* covered around 24% of the U plots. No differences were found in live and dead biomass or on aboveground carbon stocks between U and NI. Belowground biomass and carbon stock were 45% higher in U, mainly due to superficial fine roots (<2 mm). Soil carbon stocks were not different between U and NI but differed according to layers. In conclusion, *U. decumbens* did not significantly change the aboveground carbon stock, but enhanced belowground carbon due to fine roots at soil surface. Since total carbon stocks were similar in U and NI we suppose decomposition rates are greater in U. Despite *U. decumbens* increased the soils carbon stock via fine superficial roots, we expect that the overall belowground carbon stock decreases with invasion because the Cerrado shrubs produce considerable root biomass at greater depths.

Keywords: biological invasion, Cerrado herbaceous biomass, carbon storage, ecosystem service.

Re-Assessing the Host Range of the Crayfish Plague Pathogen by Dna-Based Approaches: Implications for Disease Dynamics and Spread

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Due to its devastating impact on populations of European crayfish, the crayfish plague pathogen *Aphanomyces astaci* Schikora has been included in the lists of 100 worst invaders in Europe and the whole world. This parasitic oomycete, originally adapted to coexistence with North American crayfish species, has a relatively narrow host range. It has been usually considered a crayfish-only pathogen, with corresponding implications for disease spread and dynamics. However, recent applications of DNA-based detection of *A. astaci* revealed existence of alternative hosts, which may spread the disease over long distances or facilitate persistence of the pathogen even in the absence of crayfish. A 1940s report already suggested that the infection may be transmitted to Chinese mitten crabs (*Eriocheir sinensis* H. Milne Edwards, 1853), and presence of *A. astaci* was indeed recently confirmed in this catadromous long-distance migrant in several countries. Furthermore, freshwater crab *Potamon potamios* (Olivier, 1804) coexisting with infected crayfish in Turkey is also *A. astaci* carrier, and laboratory transmission experiments suggest that freshwater shrimp species may also get infected. North American crayfish usually withstand infection by *A. astaci* with little harm, while crayfish from other regions are considered susceptible to the disease. However, molecular detection methods confirmed that populations of multiple native European species may occasionally host *A. astaci* in mostly unnoticed chronic infections; this phenomenon deserves further attention. Despite high diversity of North American crayfish, only few species are directly confirmed as *A. astaci* carriers: apart from three most widespread crayfish invaders in Europe, two other *Orconectes* spp. have been recently shown to host the pathogen in European open waters, and additional crayfish species obtained through aquarium trade also carried the pathogen (apparently due to horizontal transmission in the breeding facilities). Improving knowledge on range and distribution of chronic *A. astaci* carriers is crucial for assessing the spread and disease dynamics of this pathogen.

Keywords: crayfish plague; *Aphanomyces astaci*; freshwater crayfish; alternative hosts

Quarantine Arthropod Invasions in Europe: Climate, Host Plants Propagule Pressure and Border Controls

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We studied the relative importance of propagule pressure, climate-matching and host-availability for the invasion of agricultural pest arthropods in Europe. We forecasted newly emerging pest species and European areas with the highest risk of arthropod invasion under current climate and a future climate scenario (A1F1). As expected, all the three factors significantly explained quarantine arthropod invasions in Europe, but the propagule pressure only had a positive effect on invasion success when considered together with climate-suitability and host-availability. Climate change according to the A1F1 scenario generally increased the climate-suitability of North-eastern European countries, and reduced the climate suitability of central European countries for pest arthropod invasions. To our knowledge, this is the first demonstration that propagule pressure interacts with other factors to drive invasions, and is not alone sufficient to explain arthropod establishment patterns. European countries with more suitable climate and large agricultural areas of suitable host plants for pest arthropods should thus be more vigilant about introduction pathways. Moreover, efforts to reduce the propagule pressure, such as preventing pests from entering pathways and strengthening border controls, will become more important in North-eastern Europe in the future.

To evaluate efficiency of border control strategies, we analyzed phytosanitary inspection sampling effort data at Zürich airport, in relation to underlying risks of trade and the EPPO interception database records. We show that inspections intuitively focus on contaminated pathways, but the EPPO database also plays a role in distributing inspections. Furthermore, the majority of import pathways with the potential to disperse quarantine insects are not sampled. We discuss this inspection approach and suggest potential improvements for Europe's biosecurity regarding the management of invasive insects at points of entries. Importantly, European inspectors should record and report sampling efforts together with pathway information, so that interception rates are known and inspection can be optimized.

Keywords: quarantine pest establishment, propagule pressure, host plant availability, climate matching, border controls

Combining Two Major Databases to Assess Taxonomic and Habitat-Related Patterns in Introduction Pathways of Alien Species

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A prerequisite for effective prevention of potentially severe impacts of invasive alien species (IAS) is a comprehensive understanding of their introduction pathways. However, information on introduction pathways is currently scattered across various databases using differing terminology. We assessed introduction pathways (release, escape, contaminant, stowaway, corridor) for major taxonomic groups (plants, vertebrates, invertebrates, algae, fungi, other) and habitats (terrestrial, freshwater, marine) by collating information from two major databases: the Invasive Alien Species Pathway Management Resource (IASPMR), which includes data from IUCN/ISSG's Global Invasive Species Database (GISD), and the European DAISIE (Delivering Alien Invasive Species Inventories for Europe) database. To map the data, we applied the standard pathway categorization schema developed by ISSG in collaboration with leading experts that has recently been endorsed by the CBD SBSTTA in its 18th meeting. This schema allowed us to map the pathway categories of both databases against each other and undertake a comparative analysis of the pathway data, covering more than 2,400 species in IASPMR/GISD and 6,500 species in DAISIE. Results on the relative importance of each pathway category across different taxonomic groups and habitats are presented for each of the databases separately and both combined. Therein, we put particular emphasis on the distinction between pathways of

intentional and unintentional introduction. Our results show striking differences among taxonomic groups, whereas differences among habitats are much less pronounced. Additionally, as each database provides a list of '100 of the worst IAS', we compare these subsets with all remaining 'non-worst IAS' within each database, in order to identify potential differences between the pathways of introduction of the high-profile species and all others. Policy and management implications of these findings will be discussed.

Keywords: comparative analysis; DAISIE; GISD; IASPMR; pathways

The Global Network of Plant Invasion Caused by International Trade

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Global trade plays a key role for the spread of alien species as many species are introduced by means of global trade and transport. However, studies relating international trade flows and the spread of alien species are very scarce mainly due to lack of data. We present a study which combines a novel and unique data set of established alien vascular plant species (i.e., the GloNAF data) with data on 70-years trends of bilateral trade between countries, biodiversity and climate to model the network of global plant invasion. The model identifies major source regions, routes and hotspots of plant invasions in remarkable agreement with observed species numbers. We found a time lag between the increase in trade and the subsequent increase of alien species numbers of around 20 years, evidence for the wide-spread 'invasion debt'. Using most recent trade data, it is possible to predict the global spread of alien plants within the next 20 years. Largest increases of alien plant species are predicted for emerging economies at low latitudes. Climate change will increase invasions in temperate climatic zones and reduce them in tropical regions, yet not by enough to cancel out the trade-related increase.

Keywords: Modelling, vascular plants, time lag, invasion debt, bilateral trade

The Role of Humans in the Dispersal of Pumpkinseed (*Lepomis gibbosus*)

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In Poland, the introduced range of the North American centrarchid, pumpkinseed *Lepomis gibbosus*, is limited mainly to the lower part of the Odra drainage basin (Baltic Sea catchment). Dispersal mechanisms responsible for the dispersal and establishment of new populations relate mainly to human activities such as fish stocking and the release of pet (aquarium) fish, with natural dispersal also observed in some situations. These mechanisms have led to a progressive increase in the distribution of the species. This paper reports on the results of capture-recapture field investigations and experiments in microcosms to measure the water velocity preferences of pumpkinseed in order to determine the species' natural ability to expand its range from a given introduction locality.

Keywords: alien fish, natural dispersal, fish stocking, pet release, water velocity preferences

The Invasion of an American Boatman *Trichocorixa verticalis verticalis* in Europe; Consequences for Native Species, and the Role of the Salinity Gradient

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Trichocorixa verticalis verticalis (Fieber, 1851) (Corixidae, lesser water boatmen) is the only alien aquatic Hemipteran in Europe, where it is concentrated on the Atlantic coastal plain in the southern part of the Iberian Peninsula. We review recent studies which we have completed on its ecology and the relations with native Corixidae with a similar size and habitat preference (genus *Sigara*). The main questions we addressed are: (1) how does its thermal tolerance compare to that of native species? (2) How does its trophic ecology relate to that of native species? (3) Why is it so dominant in saline wetlands yet so much rarer in low salinity wetlands? (4) What is its potential non-native range within Europe and beyond? (5) What effects is it having on other aquatic communities? We show that this species has the potential to disperse across a high proportion of the coastal European lowlands across a wide range of latitudes, but that the projections are not greatly modified by climate change. The success of *Trichocorixa verticalis* in permanent, saline wetlands is related to high plasticity in response to changes in temperature and salinity, and high plasticity in diet. However, the most important factors seem to be its greater resistance of eggs and nymphs to salinity, and a higher fecundity and capacity to reproduce throughout the year. Its rarity in fresher wetlands may largely be explained by its greater susceptibility to parasitic mites (contrary to the enemy release hypothesis), together with a higher predation rate by Odonata larvae compared to native corixids. As in the native range, *T. verticalis* can be a predator on large zooplankton and induce trophic cascades, especially in salt pans. Direct competition and competitive exclusion seems to be most likely with *Sigara selecta*, a halotolerant species.

Keywords: Corixidae, Hydrachnidiae, parasites, salinity, stable isotopes

The Silent Invasion of Native Species in Brazil

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Invasive alien species are the second largest threat to biodiversity and its impact exceeds US$ 30 billion per year on global economy. The environmental changes have been regarded to increase the biological invasions. Similarly, the environmental disturbances mainly those related to changes on land use and climate are correlated to the massive growth of threatening species in their place of origin. While a great concern has been put on invasive species, the impacts caused by 'invasive native" species are under-estimated. In Neotropics nuisance species, their damage and the correlation with environmental problems have been less studied. Our studies revealed that the expansion of some bamboo species, such as *Merostachys* and *Guadua*, and the bracken fern *Pteridium* is a primary problem that disrupts the structure and species turnover in the Brazilian tropical forests. Their aggressive growth capacity, plasticity in functional traits and moderate or strong allelopathic activity can explain their successful dominance in different ecosystems. In aquatic ecosystems, the macrophyte species *Eichhornia crassipes*, *Egeria najas*, *Pistia stratiotes* and *Salvinia molesta* cause concern around the world and also in Brazil, in their native habitat. High temperatures, nutrient input and impoundment are the main factors related to the successful growth. When growing in high abundance, these plants interfere with the utilization of water resources, blocking water flow, depleting oxygen in the water, and causing problems for hydropower generation and navigation. Evidence suggests biotic homogeneization and impoverishment of communities in response to the invasion of some native disturbance-adapted species.

Keywords: terrestrial, aquatic, disturbance, habitat, dominance

Predicting the Potential Distribution of *Amorpha fruticosa* (Mill.); an Invasive Terrestrial Plant Species in the Mureş Floodplain Natural Park

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The paper is aiming to assess the potential distribution of an invasive terrestrial plant species (ITPS) *Ailanthus altissima* (Mill.) in a natural protected area i.e. Mureş Floodplain Natural Park (V IUCN category). The study-area is a complex wetland ecosystem hosting riparian habitats as well as plant and animal species of great scientific value overlapping the Panonic biogeographical region, also designated as RAMSAR and Natura 2000 sites.

It is acknowledged the increasing potential spread of biological invasions over larger areas during the last years and the increasingly stronger connections with their triggering environmental driving forces (natural and human-induced). As a result, the current study proposes a geographical GIS-based quantitative statistical analysis (potential distribution model - ITPS-PODISMOD) of one of the most disturbing species in Europe - *A. fruticosa*. The developed model is seeking to assess the potential distribution of the species using bivariate analysis, which takes into consideration the relationship between variables, in our case *A. fruticosa* as dependent variable and its driving factors as independents variables. Concurrently, each driving factor was ranked depending on the relationships between the analysed species and its ecological conditions. Thus, an ITPS-PODISMOD map displaying areas with different potential distribution of the *A. fruticosa* in relation to the key environmental driving factors in the Mureş Floodplain Natural Park have resulted. Thus, the map revel high and very high (40%) potential distribution of *A. fruticosa,* mainly located in the Mureş River floodplain and in scattered areas in the central, northern and south-eastern parts of the Park area, favoured by alluvial protosoils and erodisoils with varied textures. Over 42% of Park's area display areas with medium potential distribution of species and less than 20% of the analysed territory depict low and very low potential distribution values on forest-covered areas and arable lands.

Assessing the potential distribution of ITPS in protected areas is an important research direction, especially since the adventive species have become biological hazards with negative effects, especially on native biodiversity.

Keywords: Invasive Terrestrial Plant Species potential distribution model (ITPS-PODISMOD), *Amorpha fruticosa*, bivariate analysis, Romanian protected areas, Mureş Floodplain Natural Park.

Acknowledgements: The current research was undertaken in the framework of the EU FP7 – Building Capacity for Black Sea Catchment Observation and Assessment System supporting Sustainable Development (EnviroGRIDS).

Invasive Knotweed (*Fallopia* × *bohemica* (Chrtek & Chrtková) J. P. Bailey) is Allelopathic Only in Artificial Substrates

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Accurate estimation of competition intensity is fundamental in a good understanding of plant communities. Pot competition experiments are often used to establish dominance of competing plants. Such experiments are particularly important and often used in invasive species, either to understand their ecology or to estimate their impact.
Previous pot experiments in which invasive knotweed (*Fallopia* × *bohemica* (Chrtek & Chrtková) J. P. Bailey), an extremely successful plant invader, competed against communities of native species, found inconsistent evidence of invader allelopathy and large differences in the dominance it achieved. These experiments were done in different substrates. We set to establish whether the reason for this discrepancy is indeed the substrate type and we tested invasive knotweed dominance and allelopathy on five species native to Europe in a pairwise competition experiment. Each knotweed-native competitor pair was grown in either artificial substrates, such as compost or compost-based potting mixture, or more natural ones, such as field soil, or soil collected form a natural uninvaded habitat.
The invader was overall more successful in artificial than in more natural substrates. Also, evidences for its allelopathy were more frequent in artificial substrates: four of the five natives were suffering from knotweed allelopathy in the artificial substrates, the other one did so in field soil, and notably none was impacted by allelopathy in natural soil. Adding a slow release fertilizer decreased the overall knotweed dominance and interfered with its allelopathy. Interestingly, however, these changes happen more in artificial substrates.
If artificial substrates, as here, exaggerate allelopathy and dominance of other invasive plants, the problem of over-estimating their performance may be widespread and results of experiments employing such substrates should be interpreted with care. When pot experiments, as the one presented here, are intended as tools for estimating impact and invasion success, it is recommendable to use soil from the targeted habitat and thus avoid misleading results.

Key words: *Reynoutria,* allelopathy, dominance, impact

The Eu Ias Regulation – Policy and Implementation

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The EU IAS Regulation is likely to come into force on January 1, 2015. This Regulation finally plugs the gap in biosecurity that was not covered by Animal and Plant Health legislation which have been long served by existing EU Regimes and directives. The Regulation has at its core the establishment of a black list for the EU (IAS of Union Concern) relating to intentionally introduced species and the species proposed for this list will need to be supported by comprehensive risk assessment. Member States will have to rapidly eradicate newly arrived species on the list and manage those already established and put in place comprehensive monitoring and surveillance to detect them. There will also be the requirements for Member States to analyse and prioritise action on pathways of introduction for unintentionally introduced species and to restore ecosystems. Furthermore, the Commission will establish an information system, a committee of member states representatives and a scientific forum.
While the Regulation represents an excellent outcome after many years of hard work, there will be significant challenges for many EU Member States in fulfilling its requirements especially given the relatively short deadlines for some provisions. There is no standard risk assessment methodology for IAS, pathway prioritisation is still under-developed and many states will struggle to comply with the need to prioritise pathways and develop a national plan. Resources to tackle IAS are lacking across the EU and there is no specific EU financial instrument to help member states meet their requirements, expertise is also lacking in many member states and developing this will be a challenge. Furthermore it will also be challenging to ensure that in implementing the Regulation most effort is directed to prevention and also to tackling newly-arrived species rather than those that are well established and known to be of high impact.

Keywords: EU, Regulation, Policy

Biocontrol - a Tool Not to be Ignored When Drafting the List of Invasive Species for the New EU Regulation

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EU Member States will be tasked with drawing up and agreeing the list of invasive species of specific concern following the implementation of the new EU regulation on the prevention and management of invasive alien species. It is clear that the credibility and efficacy of this hard-fought piece of legislation depends upon this list. It is likely that Member States will consider the cost implications, both positive and negative, when deciding which species will be included within the list; those species which are prevalent throughout Member States and cause serious impacts, may be avoided due to the perceived impossibility of significant control. However, when compiling the species list, it is essential that all control measures be considered including biological ones. Currently, a lack of knowledge, understanding and experience of biological techniques may hinder its use, especially in the case of weeds. In this paper we present examples of apparently hopeless causes that were resolved using natural enemies by more experienced countries of the world. We suggest that Member States will risk more than just continued financial and environmental damage if biocontrol is not given equal status as a control measure and the most notorious species in Europe are not included on the list.

Keywords: biological control, biocontrol, EU Regulation

"NOT ATTENDED"

Can Europe Unite to Tackle Invasive Alien Species?

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Invasive Alien Species (IAS) are one of the greatest threats to biodiversity and represent a globally escalating economic cost. The European Union is presently adopting a new legislation on IAS which represents an ambitious attempt to set a common standard for combating IAS across political jurisdictions. The next year will be pivotal for the success of this policy, since much hinges upon drawing up a meaningful list of species of 'Union concern' and on Member State action. Unless Member States have stronger incentives to nominate species, the list may fail to set an effective benchmark. Furthermore, the European Commission bestows much responsibility to Member States, but provides them with little support to achieve the targets set. We critically assess the new policy based upon a detailed analysis of pan-European capabilities to combat IAS, and in light of the wider policy context. We focus on providing practical advice to Member States and the European Commission, stressing means by which rapid response, adequate coordination with neighbouring states, commercial sectors and the general public could be achieved, such that a strong social norm can be set. The success of this policy will be key for setting new global standards for the management of IAS.

Keywords: invasion, prevention, early-warning, policy, social-norm

The ISEIA and *Harmonia*$^+$ Protocols : Five Years of Prioritization Practice in Belgium

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Before prevention or early eradication of invasive species can take place, it is essential to first identify those species that pose the highest risks. Given the huge and still-increasing number of species that become transported, such a prioritization must allow for a high number of species to be assessed in a relatively short time.
For Belgium, Branquart (2009) launched a scheme that allowed to quickly screen the spread capacity of species and their environmental impacts (ISEIA protocol). The protocol was applied by expert panels to reach consensus on the risks posed by 100 species to the Belgian territory. The results were published in an online database termed *Harmonia*. The ISEIA protocol has also been used out of Belgium to inform pest risk analyses in the Netherlands, black lists in Luxembourg, and horizon scans of potentially invasive species in Great Britain.
Despite its successes, some aspects of invasion were found to be unsatisfactorily covered in ISEIA. It was therefore chosen to refine the scheme, and this led to a new protocol named *Harmonia*$^+$ (finished 2014). This protocol assembles 30 key questions deemed essential for assessing the risk of a particular species. The questions refer to (1) introduction, (2) establishment, (3) spread and (4) impacts, the latter of which deal with (4a) environmental, (4b) plant, (4c) animal and (4d) human health. The answers to the questions are ordinally scaled, and the species can thus become ranked and prioritized. *Harmonia*$^+$ has come about through the collaboration of eight Belgian scientific institutes. An independent panel of test experts deemed the protocol to be clear, consistent and complete.
Both ISEIA and *Harmonia*$^+$ can be consulted at http://ias.biodiversity.be/.

Keywords: risk analysis; horizon scanning; black lists; pest risk analysis; ISEIA

Biological Control of Invasive Plants: The Need for Free Exchange of Genetic Resources

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The number of invasive alien species is continuing to increase worldwide, so there is a growing need to develop sustainable management solutions. Classical biological control is one of the most practical, cost-effective, environmentally sustainable methods to control established invasive weeds. This approach is based on the deliberate release of specialist natural enemies from the weed's native range to reduce its abundance or spread in the weed's introduced range. Many countries in Eurasia, including Turkey, are home of numerous plant species that have become invasive in other parts of the world, including North America, Australia and New Zealand. Effective agents from Eurasia have successfully controlled at least 10 important weeds of Eurasian origin in North America, and research is ongoing for at least 12 more weed species. These projects have stimulated collaboration between scientists from North America, Europe and Asia, resulting in exchange of knowledge and skills, and have supported travel to international meetings and produced publications in international journals. More recently, some alien plants have become invasive in Turkey and neighbouring countries, and we believe that these could profit from the development of classical biological control solutions.
Classical biological control depends on the exchange of genetic material among countries, which is a politically sensitive issue. In this respect, the 2010 Nagoya Protocol for Access and Benefit Sharing (ABS) is an important guide for countries. The special feature of classical biological control agents is that they are not transformed into a commercial product,

but are for the common good. We will discuss the potential benefits of classical biological control of invasive plants in Eurasia and the need for free exchange of biological control agents between countries to mutually benefit from this novel control method.

Keywords: biological control, invasive plants, foreign exploration, Access and Benefit Sharing

Invasive Species Survey in Koh Chang, Thailand

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Non-native species can cause ecological and economic losses. Koh Chang is the second largest island of Thailand which is situated to the east of the country. Since its hinterland is covered by 70% tropical rain forest, it is designated as a marine national park, the best preserved tourist holiday destination in Thailand. The aim of this study was to determine invasive species spatial distribution in this island and the adjacent ones. In April 2014, the main and secondary roads were surveyed and 29 key informants were interviewed. The results showed that 38 species of invasive plants were found during the road survey. They were wide spread in residence, cultivated and uninhabited areas, including nearby islands such as Rang and Lao Ya islands. However, they were absent in evergreen forest due to low light and less human disturbances. Moreover, the interview revealed that 78 species of invasive species were found. This number is higher than those of the direct survey. The most common species were *Pennisetum pedicellatum* Trin., *Bidens pilosa* L., *Gomphrena serrata* L., *Hyptis suaveolens* (L.) Poit., *Imperata cylindrica* (L.) P. Beauv., and *Sphagneticola trilobata* (L.C. Rich.) Pruski. Some invasive species were introduced into the islands, where they were promoted as elephant forage crop, human food and aquaculture. Local people perceived the invasive species as minor problem because most of the weed often grew in the road sides and uninhabited area. They were easily removed by hand and machine or could be killed by chemicals.

Keywords: alien species; introduced species; non-native; pest; weed

Freshwater Invasives Networking for Strategy - Tackling Invasive Alien Species in Europe: the Top 20 Issues

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The Freshwater Invasives Networking for Strategy international conference was held in Galway, Ireland in April 2013. Instead of the traditional style of just giving presentations to an audience, this three day event involved the full participation of pre-prepared delegates from a range of different backgrounds. Scientists from academia and agencies worked alongside practitioners, policy makers, stakeholders and economists in workshop sessions, to discuss priority freshwater invasive issues under four themes. These were Biosecurity, Management and Risk Assessment, Policy and Economics. Eventually, the top 20 issues were nominated by the conference delegates; these issues were related not only to freshwater systems but also to terrestrial and marine invasive situations. Expert delegates were nominated to write sections on select identified issues, resulting in a recent publication, 'Tackling Invasive Alien Species in Europe: the Top 20 Issues', written by 29 authors, which can be used as a tool for invasive alien species management. The presentation explains how the conference evolved and provides a strategic outline of the outcome of the top 20 issues.
http://www.reabic.net/journals/mbi/2014/1/MBI_2014_Caffrey_etal.pdf

Keywords: Networking; Top 20 issues; communication; strategy

Public Outreach and Recording of Invasive Alien Species in the UK

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The Harlequin Ladybird Survey (www.harlequin-survey.org) was one of the UK's first online recording projects, set up to track the spread and study the effects of an invasive alien species (IAS), the harlequin ladybird *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae). Shortly afterwards the UK Ladybird Survey (www.ladybird-survey.org) website was launched. The Harlequin Ladybird Survey was subsequently used as a model to develop a recording programme for other IAS, Recording Invasive Species Counts (RISC - http://www.nonnativespecies.org/index.cfm?pageid=234*)*. Thirteen animal and eight plant species were targeted for recording by the public in RISC. These include common and easily spotted species such as muntjac deer *Muntiacus reevesi (Ogilby, 1839)*, rhododendron *Rhododendron ponticum* L. and Himalayan balsam *Impatiens glandulifera Royle* (with a focus on mapping their distributions and spread) as well as occasional arrivals such as American bullfrog *Lithobates catesbeianus (Shaw, 1802)*, citrus longhorn beetle *Anoplophora chinensis (Forster, 1771)* and water primrose *Ludwigia grandiflora* (Michx.) Greuter & Burdet, which may be targets for eradication.

In this paper we firstly discuss our strategies for engaging the public in these projects, including the use of online recording and Smartphone apps. Secondly, we outline the research outputs generated by these large and high quality datasets submitted by the public. For example, with the ladybird data, we have been able to: 1. Map in unprecedented detail the spread of *H. axyridis* in the UK and discover its habitat requirements and life cycle; 2. Calculate long term trends for the UK's 47 ladybird species: ten species significantly declined over a 20-year period, five increased, and the remainder showed no change; 3. Assess the accuracy and value of data collected via citizen science programmes.

Keywords: citizen science; invasive species; ladybirds; online recording; public outreach

Recommendations for the Management of Invasive Species

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Cutting, mowing, herbicide application, hunting, life-trapping – a large set of measures are applied to eradicate invasive species living in the wild. Sometimes successful, but often not. Invasive species which threaten ecosystems or native species necessitate a management to preserve the site typical biodiversity. For prevention and productive management of invasive species, it is necessary to collect and analyze the measures for their effectiveness and ecosystem impact.
A systematic literature research in combination with a survey under involved German authorities (nature conservation authorities, protected areas authorities, forestry administration, water body authorities, and nature conservation associations) forms the information basis of possible management measures against invasive species. We developed an evaluation system for management measures with three criteria categories: efficiency, ecological impact and human health.
We present and discuss the evaluation system and show measures evaluated as being highly to not at all recommendable for eradication of invasive species, in examples, for European-wide relevant invasive plant, animal and fungus species. The objective of the study, financed by the BMU, is finally to provide a comprehensive handbook on invasive species management with management recommendations for 168 invasive species. The transferability of our results beyond the border of the German study site will be discussed. Conclusively, we argue for the desperate necessity of positioning for European-wide harmonized prevention measures against invasive species.

Keywords: measures; evaluation criteria; prevention

Biosecurity in Ireland – Averting the Threat of Aquatic and Riparian Invasive Species

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The overall economic impact of recreational angling in Ireland is estimated to be *circa* €755 million and to support up to 10,000 jobs. While the quality of the angling product currently available in Ireland is excellent, serious threats to its ongoing performance exist. Foremost amongst these, particularly for the freshwater angler, are non-native invasive species and pathogens. The rate of introduction of these potentially catastrophic species and organisms to the island of Ireland has increased dramatically in the 20th century and has accelerated further in the last two decades. It is noteworthy that the rate of increase has been greatest for freshwater species in the recent past. These invasive species and organisms can directly impact native recreational fishes but can also alter the habitat for these fishes and for the angler. This can be achieved by overgrowing aquatic and riparian systems or by negatively affecting the productivity and functionality of the system. Here, we review the key species and their negative impacts. The continued threat of further introductions of invasive species that are potentially even more damaging than those currently present here from Britain, Europe and elsewhere will also be described.

Inland Fisheries Ireland (IFI), with assistance through European-funded programmes (e.g. Interreg IVA - CIRB and LIFE+ - CAISIE), has spearheaded biosecurity initiatives in this country in an effort to halt the introduction of invasive species and pathogens from abroad and to limit the spread of existing species on the island of Ireland. The primary focus of these initiatives is to create awareness among recreational anglers (and other water users) of the existence of IAS. They will also serve to highlight the serious threat they pose to fish, habitats and recreational exploitation of these resources. It is intended that biosecurity will become instinctive among anglers and an integral part of every angling occasion. Towards that end, IFI has developed a large array of materials and aids that are focused on informing and educating the recreational angler in respect of invasive species, their impacts, how they can be inadvertently introduced or spread and, most importantly, how to limit or stop this spread. IFI has prepared biosecurity protocols for the different categories of freshwater angler (e.g. game, coarse, pike) to minimise the risks of introducing invasive species through contaminated angling gear or related equipment. Furthermore, IFI

has developed innovative cleaning / disinfection methods and products for the angler that make the biosecurity process more efficient and less costly. These methods and products will be described. As a result of these initiatives there has been a significant increase in awareness among recreational anglers about IAS and a healthy attitude towards biosecurity and angling has been demonstrated.

Keywords: angling; fish pathogens; disinfection; protocols; awareness

An International Plant Sentinel Network

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The increasing globalisation of trade in plants and plant material, together with the impacts of climate change, has led, and will inevitably continue to lead, to an increase in the introduction and spread of new and damaging plant pests and pathogens. In recent years the majority of the most destructive of these organisms in temperate forests were either not known to be damaging, or were unknown to science, before their introduction. Most European countries utilise Pest Risk Analysis (PRA) to regulate risk within trade which focuses on known threats, thus damaging unknown organisms can be left unregulated. Botanic gardens and arboreta are in a unique position to aid in the identification of such 'unknowns', as within their collections, they play host to expatriate plants that can act as sentinels for potentially invasive and damaging organisms. The International Plant Sentinel Network (IPSN) aims to provide a platform for sharing information on new and emerging pests and pathogens, thus providing an early warning system and contributing to PRA activities. The project will facilitate collaboration amongst institutes in Europe and beyond, with a focus on linking botanic gardens and arboreta, National Plant Protection Organisations and plant health scientists. The network will focus on increasing knowledge and awareness among garden staff, seeking best practise, developing standardised approaches and providing training materials and methodologies for monitoring and surveying. The network is being established as part of a European-funded (EUPHRESCO) project led by the UK's Food and Environment Research Agency (FERA) in collaboration with Botanic Gardens Conservation International (BGCI) and partners in Europe (Julius Kühn-Institut, Germany; National Plant Protection Organisation, Netherlands; DiBAF, Italy; Forest Research, UK and CABI). Work feeds off the success of other EUPRESCO projects (PRATIQUE and ISEFOR) which have previously illustrated the relevance of using sentinel plants.

Keywords: Early warning, botanic gardens, quarantine pests, building capacity

POSTER PRESENTATIONS

The Distribution of the Eastern Mosquitofish (*Gambusia holbrooki*) and Endemic *Aphanius villwocki* in the Upper Sakarya River Basin (Turkey)

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Non-native freshwater fish species have been long introduced and/or unintentionally transported into ecosystems in different ways. One of the major reasons in declining of native ichtyofauna has been regarded as invasive fish species through competition for food and habitat, predation, hybridization and disease transmission. The invasive Eastern mosquitofish (*Gambusia holbrooki*), which is among the 100 worst invasive animal species of the world, was introduced into Turkeys' freshwaters for the purpose of mosquito control in early 1930's. Many studies have shown the adverse effects of *Gambusia* species on the members of native Cyprinodontidae because of the size and niche similarity between these two groups. The data about its occurrence and distribution in the Sakarya River basin (Turkey), which is also the distribution area of endemic *Aphanius villwocki*, has remained unclear due to its small size and to confusion about which mosquitofish species is the point in question; *Gambusia affinis* or *Gambusia holbrooki*. In this study, we firstly identified the *Gambusia* species. To determine the spatial overlap between *Gambuisa* and *Aphanius*, fish samplings were carried out in the upper part of the basin as it is the distribution area of *Aphanius villwocki*. Samplings were achieved by a small seine net in the littoral zone of the habitats. Fish caught were counted and recorded and finally a distribution map demonstrating the proportions of two species per station was prepared.

Keywords: Invasive fish, Spatial Overlap, Distribution Map, Competition

Reconstructing the Invasion of *Cyperus esculentus* in Central Europe

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Cyperus esculentus (yellow nutsedge) is a serious weed in agriculture worldwide and observational data suggest that it has recently started to spread rapidly in Central Europe. We studied retrospectively its spatio-temporal invasion pattern, rate of spread and habitat affiliation in Austria, Germany and Switzerland based on distribution data from various sources. In total, we found 265 records of *C. esculentus* since 1900. Multiple accidental introductions, coupled with subsequent regional radial expansion describe the spatio-temporal range expansion of *C. esculentus* in the study area. Cumulative number of records and the number of invaded grid cells showed a continuous increase whereupon spread became pronounced recently (>2005). Invasion hotspots were located in the warmest regions of the study area as well as in regions with an oceanic climate. On average, the rate of spread within these invasion hotspots ranged between 3.1 km and 5.7 km per year. *Cyperus esculentus* was primarily found on arable land, while other habitats have been rarely invaded so far. Given its on-going spread, we suggest to prevent anthropogenic long-range dispersal and to thoroughly contain or eradicate incipient infestations of *C. esculentus*.

Keywords: invasive alien species; data sources; distance of spread; habitat; yellow nutsedge

Feral Occurrence of Arable Crops and Vegetables Along the Vltava River - The Influence of Floods

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In June 2013 the river Vltava (Moldau) and its surrounding were affected by flood. After this, new habitats for colonisation occurred– open places with sandy substrate that replaced the original river bank vegetation. During the period from August to October repeated monitoring of river banks in the north-western part of the city of Prague (Czech Republic) was realised focused on the occurrence of domesticated plants – especially arable crops and vegetables. In total, 19 species were determined. The most abundant was *Lycopersicon esculentum* (tomato), creating dense canopies along the river banks. From this group of vegetables *Citrullus lanatus* (water melon), *Cucurbita pepo*, *C. maxima* (squashes), *Cucumis melo* (melon), *C. sativus* (cucumber) and two species of *Physalis* (*P. peruviana*, *P. philadelphica*) were found. Grains were represented by *Echinochloa frumentacea*, *Panicum miliaceum*, *Setaria italica*, *Zea mays*, *Sorghum bicolor*, and *Phalaris canariensis*. With the exception of *Z. mays* and *P. miliaceum* they have low acreage or are not grown at all in our region (*E. frumentacea*). The reason for their occurrence can be found in nearby zoological garden, where those species are used as a feed and that was also affected by flood. We also found individuals of *Brasica napus* and *Helianthus annuus*, but their occurrence as feral plants is not unusual. Next year in June 2014 we were able to find in the same area only 5 crop species: *B. napus*, *H. annuus*, *P. miliaceum*, *Papaver somniferum*, and *Triticum aestivum*.

Downstream Drift of Early Life Stages – an Important Means of Dispersal for Invasive Gobiid Fishes?

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Several Ponto-Caspian gobiid species have colonized freshwaters over large areas of Europe and Northern America since the 1990´s. In addition to human-assisted transportation; these fish are proven capable of colonizing long river stretches in a relatively short time with no human help, despite being rather sedentary and only moderate swimmers. We suggest that passive downstream transportation (drift) of early life stages may play an important role in the dispersion of these fish. In a series of field experiments, we examined the extent to which two gobiid species, round goby (*Neogobius melanostomus*) and tubenose goby (*Proterorhinus semilunaris*), drift in non-navigable, medium-sized rivers, and assess possible consequences for gobiid dispersal.

In newly colonized areas, early life stages of both species frequently drifted downstream in high densities, often forming the majority of the drift assemblage. Gobiids entering drift were of a narrow size range, corresponding to an age of several days, and drifted exclusively during the dark, with highest densities within two hours after the sunset. In contrast with the species' slow upstream movement, drift helped gobiids rapidly colonize a long stretch of the river downstream (approximately 30 km in one year). Gobiid early life stages also proved capable of drifting out of a low-head reservoir and into the main river system through the turbine of a hydropower facility, displaying very low mortality (3% compared to 18% in other species).

Drift of early life stages, therefore, allows rapid downstream expansion of gobiids, with even (low-head) hydropower dams proving a relatively insignificant barrier. Moreover, drift of early life stages will help 'bridge the gap' between the source population and an upstream colony following long-distance upstream movements of pioneers or human-assisted upstream introduction.

Keywords: Gobiidae, larvae, dispersal, invasion pathways

Rapid Colonization of *Arcuatula senhousia* in a Northern Adriatic Lagoon

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The macrozoobenthos in the lagoon of Škocjan Inlet Nature Reserve was studied in the period 2007 till 2014, in order to observe effects of the renaturation process (2007-2008) on its structure and functioning. In the summer 2011, first specimens of the non-indigenous species *Arcuatula senhousia* were noticed. The average density of the species reached 249 ind./m^2. In winter 2012 the averaged density highly increased, reaching 1757 ind./m^2. The highest density ever observed was 3370 ind./m^2. About 75 % of the individuals were smaller than 5 mm, while the biggest specimens measured 34 mm. We assume that the renaturation process played an important role in the successful settlement of *A. senhousia*. Moreover, *A. senhousia* is not the only alien species present in the lagoon. Altogether 5 non-indigenous species were until now recorded in the studied area. Although it is difficult to assess the possible impact of this settlement in the lagoon, we noticed a correlation between the presence and increased abundance of *A. senhousia* and the abundance of Capitellid polychaets. As the Škocjan inlet is still a very young lagoon we expect certain changes in the community structure in the nearby future. The role and fate of nowadays present non-indigenous species is uncertain and should be cautiously monitored, since this lagoon is a protected environment with a considerable importance for numerous breeding and wintering bird species living in this coastal wetland.

Keywords: alien species, Arcuatula senhousia, renaturation, lagoon, nature reserve

Invasive Plant Species in Suranaree University of Technology Campus, Thailand

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From previous surveys and collections of naturally occurring plants in Suranaree University of Technology (SUT) campus, Nakhon Ratchasima, Thailand during the years 1995-2012, more than 400 plant species were found. Of 42 invasive plant species recorded as existing in Thailand, 21 species were found in the SUT area, which were introduced by a variety of ways, both intentionally and unintentionally. Only 6 out of these 21 exotic species are considered to be dominant invasive plants that have a harmful effect on the ecosystem of SUT. These invasive species include *Leucaena leucocephala* (Lam.) de Wit that has spread out in disturbed areas and competed with native tree species, *Chromolaena odorata*, *Eichhornia crassipes*, *Lantana camara*, *Panicum maximum* and *Pistia stratiotes*. Some of these plants are intentionally used for purposes such as ornamental plants (*L. camara*) or handicrafts (*E. crassipes*), but have subsequently invaded other areas on campus. SUT therefore should incorporate an invasive species management program for natural forest landscapes.

Keywords: SUT, exotic species, ecosystem, invasive species,

Prediction of Invasive Species Spread Using Selected Distribution Models

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Invasive species distribution depends on several factors e.g. environmental conditions, distance from the vector of introduction, invaded community composition, the effect of human being etc. Species distribution models (SDMs) allow us probabilistic predictions of invasive plant spatial spread. To meet this need, SDMs are based on combination of environmental factors, occurrence data and statistical approach. Here, we provide an evaluation of different models for local spatial scale. The aim of research is to find suitable environmental variables and model for the prediction of invasive species spread. We used absence and presence data of selected invasive species in our research area (Protected Landscape Area Kokořínsko) in the Czech Republic, Central Europe. This occurrence data and environmental variables were converted to raster shapefile (square grid size is 30 x 30 m) in ArcGIS and thereafter different predictive models were created. Using different models in combination with different species distribution data we found that the quality of input data, both the environmental as well as the data about species distribution, are crucial for model accuracy. The analysis suggests GBM and GAM models suitable for *Solidago* and *Fallopia* species, whereas GLM model are suitable for *Heracleum mantegazzianum*. The MAXENT model achieved very good results in modelling *Fallopia* and *Solidago* species. The reason for the different suitability of models is mainly the difference in the distribution of particular species.

Keywords: SDMs, invasive species, Central Bohemia, biomod2, species distribution

Neophytes in Restored Post-Mining Areas

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Former mining areas are habitat for native and alien species brought to the virgin surfaces through planting and sowing, or succession processes. Post-mining areas are landscapes with extreme conditions and only a few species are able to grow on the occurring tertiary and quaternary substrates. With vegetation surveys of three different post-mining areas in Lower Lusatia (Germany) we show which neophyte species appear over a certain time span in succession, and the differences between succession and afforested areas. We demonstrate the correlation of the appearance of neophyte species and underlying substrates.
The results show an increasing number of neophyte species, but a decreasing proportion of neophytes based on a general increase in species number for the younger succession area. Also the species composition changed during the 7 years. The main neophyte species are *Conyza canadensis*, *Oenothera biennis*, *O. parviflora*, *Senecio vernalis* and *Hordeum jubatum*, and are characterised by specific ecological traits, like anemochoric spread and competitive life strategy. For the older area the number and proportion of neophytes is nearly stagnating with a very slight trend to decrease. In general it is noticed that the number of neophytes increases with the number of native species.
The comparison of a pristine succession area and an afforested area within the same post-mining district, show significant higher numbers of neophytes in the five years younger forested areas. Additionally a look at the underlying substrates indicates that neophytes tend to appear more on sandy substrates. In contrast no clear trend is found for neophytes occurring on substrates of different geological epochs, reflecting the typical soil properties of each epoch.
A germination test on tertiary and two quaternary substrates with the common neophyte *Oenothera biennis* indicates that this neophyte prefers gravelly, tertiary substrate and germinates on all tested post-mining soils.

Keywords: succession; afforestation; substrate; *Oenothera biennis*

Distribution of Exotic Invasive Plant Species in Waterways and Wetlands in Korea

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Exotic invasive plant species are undesirable because they tend to invade natural wetlands and competitively exclude native plant species. Many wetland invasive plants rapidly increase their spatial distribution by expanding into native diverse aquatic ecosystems. In Korea, many irrigated and drainage canals, reservoirs, lakes, and rivers are choked by the explosive growth of aquatic weeds, resulting in enormous direct loss.
Distribution of exotic invasive plant species in irrigation and drainage waterways, and riparian wetlands was reviewed to provide basic information for management of invasive aquatic weeds in wetlands. In Korea, 286 exotic plant species were listed, of which 64 species were in Compositae, 53 species in Gramineae, 29 species in Cruciferae, and 18 species in Leguminosae with a total of 38 families. Dominant exotic emerged plants in wetlands included *Bidens frondosa*, *Trifolium repens*, *Oenothera odorata*, *Panicum dichotomiflorum*, *Xanthium strumarium*, *Rumex crispus*, *Amaranthus lividus*, *Ambrosia artemisifolia*, *Lepidium virginicum,* and *Euphorbia maculata.* Dominant exotic emergent plants in canals, reservoirs and lakes were *Conyza canadensis*, *Conyza annuus*, *Rumex crispus*, *Panicum dichotomiflorum*, *Bidens frondosa*, *Oenothera odorata*, *Xanthium strumarium*, and *Veronica persica*. Dominant exotic emergent plants in riparian wetlands include *Trifolium repens*, *Rumex crispus*, *Bidens frondosa*, *Panicum dichotomiflorum*, *Chenopodium ficifolium*, *Sonchus oleraceus*, *Potentilla supina*, *Thlaspi arvense*, *Amaranthus retroflexus*, *Paspalum distichum*, and *Galinsoga ciliata*. In irrigation and drainage canals and lakes, dominant exotic floating plants were *Myriophyllum spicatum*, *Eichhornia crassipes, Nymphoides peltata,* and dominant exotic submersed plants were *Potamogeton crispus*, *Lythrum salicaria*, *Hydrilla verticillata*, *Marsilea quadrifolia*, and *Najas minor*.

Keywords: aquatic weed; distribution; exotic species; invasive plant species; wetland

Invasion of Racoon Dog in Europe: The Dynamics of Spread, Factors Promoting Successful Establishment and the Assessment of Impact

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Raccoon dog (*Nyctereutes procyonoides*), a canid native to eastern Asia, has become invasive in a large part of Europe. The animals were initially brought to the European part of the former Soviet Union during the first half of 20th century for breeding at fur farms and later were released into the wild for hunting. Over the next 50 years, the raccoon dog colonized 1,4 million km^2 and became established and common in ~30 European countries.

Based on available literature, we update the current distribution of raccoon dog in the invaded range, reconstruct the dynamics of its invasion in Europe, and compare its impact with that of other invasive mammals in Europe. The environmental and economic impact of raccoon dog invasion seems rather limited, with the transmision of infectious diseases, mainly rabies, causing the most concern. We suggest that the combination of several factors promoted the successful invasion of the raccoon dog in Europe: an opportunistic feeding strategy and high habitat adaptability; repeated and numerous introductions over a long period of time, resulting in a high genetic variability; the ability to hibernate; low numbers of predators; the tendency to wander, sometimes to quite distant areas; and very low territoriality resulting in a high intraspecific tolerance.

Our review also highlighted serious information gaps. The data on the ecology and behaviour in the native range of the subspecies *N. procyonoides* subsp. *ussuriensis*, the one that actually invades in Europe, are very scarce. The majority of the native range knowledge comes from Japan, and is based on studies of a different subspecies, or even a separate species as recent molecular data suggest.

Keywords: Europe, factors promoting invasion, impact, invasion dynamics and history, raccoon dog

The Invasive Weeds of Iran

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Farming practices, changes in the habitat characteristics (including disturbance and climate change) and maybe genetic changes, create a window of opportunity for the invasion of weeds. By now, up to 25 species have been recognized as invasive weeds in Iran. Most of them, including *Ranunculus ficaria*, *Trianthema portulacastrum*, *Euphorbia maculata*, *Euphorbia heterophylla*, *Lepyrodiclis holosteoides*, *Ipomea hederacea*, *Ipomea triloba*, *Merremia dissecta*, *Anoda cristata*, *Prosopis farcta*, *Dodartia orientalis*, *Malva sylvestris*, *Alhagi camelorum*, *Amsinckia menzicsii*, *Cucumis melo*, *Acroptilon repens, Cleome viscosa, Trachomitum venetum, Imperata cylindrica* and *Hordeum spontaneum*, are native to Iran and about 5 species, *Azolla filiculoides* (as a fern), *Cynanchum acutum*, *Proboscidea fragrans*, *Prosopis juliflora*, *Leucaena leucocephala*, are exotic species. Almost all invasive weeds of Iran, except *Hordeum spontaneum and Imperata cylindrica*, are dicotyledons and most of them are observed in wheat and soybean fields. Continuous use of herbicides and natural fluctuations in the abiotic environmental factors, especially temperature and moisture, result in killing non-invasive species and so giving opportunity to invasive weeds. This process shifts the flora from non-invasive to invasive weedy species.

Keywords: Exotic, farming practices, native, weeds change.

Disentangling the Worldwide Distribution and Introduction Correlates of Invasive Mosquitofishes

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Non-native species invasions are a serious problem in freshwater ecosystems and represent huge ecological and economic costs worldwide. The mosquitofishes, *Gambusia affinis* and *G. holbrooki*, native to parts of the USA and Mexico, have been introduced worldwide since the 1900s and have often been suggested to be "the most widely distributed fish in the world". We aimed to clarify the worldwide distribution of these two mosquitofishes, to establish their introduction history, and to provide preliminary estimates of the most important predictors mediating their probabilities of introduction, establishment, and invasion history. We obtained the introduction records of *G. holbrooki* and *G. affinis* from FishBase (http://www.fishbase.org/) and three other databases and revised the exact species involved based on the literature and the history of introduction. We found many clear errors in the four databases. We estimate that mosquitofishes have been collectively introduced to 113 countries and have established in all continents except Antarctica. We also analysed the most important factors for predicting the probability of countries acting as donors or recipients of mosquitofish introductions, the establishment success, and the date of first introduction using twelve socioeconomic and climatic predictors and random forests (a machine learning technique). Frost-day frequency, mean temperature, latitude and longitude were the most important predictors of introduction probability and establishment success, whereas country area, gross domestic product per capita, and minimum temperature were better at predicting number of donations to other countries and date of introduction. Our findings suggest that the geographical distribution of fish is poorly known, that databases contain many errors, and that we do not yet know which is the most widely distributed fish species.

Keywords: Climate; *Gambusia affinis*; *Gambusia holbrooki*; invasive species; non-native fish

Distribution of Invasive Plants in Urban Environment is Driven by Habitat Availability and Urban Structure

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Urban environment, with its high level of human pressure and intensive landscape disturbance, i.e. phenomena rapidly increasing over the last century, is suitable for studying introduced species of alien origin. In this paper, we focus on describing the distribution of invasive neophytes (plant species introduced after A.D. 1500) in a mid-sized city in the Czech Republic, central Europe, and assessing the relative effects of habitat diversity vs. urban structure on their abundance, expressed as percentage cover, and species composition. The urban structure was described using the following variables: distance of industrial facilities, distance of water bodies, distance of the city center and extent of greenery. The abundance and composition of invasive neophytes is driven by both the spatial distribution of suitable habitats and the variables characterizing the urban structure. The results demonstrate that the effects of habitat availability and urban structure are closely interrelated, which suggests to obtain robust predictions of invasive species' spread they should be studied in concert. In fact, a large amount of variation was explained by the spatial predictors but not shared with any measured predictors, suggesting that some important characteristics determining the identity and cover of neophytes were not captured by our variables. These significant predictors, however, can be only "ghost shadows" of past events or no longer existing structures that cannot be traced in any presently measurable property.

Keywords: Central Europe, city, habitat, invasive neophyte, transect

Non-Native Ichthyofauna in The Bulgarian Stretch of the Danube River

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Among the four principal aquatic invasion corridors in Europe, the Southern corridor links the Black Sea basin with the North Sea basin via the Danube–Main–Rhine Canal. This complex waterway facilitates an intensive dispersal of previously geographically isolated taxa in both northwest and southeast directions throughout the Danube River basin. About 30 fish species have been introduced during the past century into the Danube River basin. Most frequent are four of the established non-native species: *Pseudorasbora parva, Ameiurus nebulosus, Carassius gibelio* and *Lepomis gibbosus*. The goal of our study is to assess the current state of non-native ichthyofauna in the Bulgarian stretch of the Danube River – species composition, dominant species, abundance and ecological preferences. The study is based on published data and field surveys carried out at 16 sites in the river littoral area in three consecutive years: 2012, 2013 and 2014. The samples were collected by beach seine and electrofishing.

A total of 12 alien fish species have been introduced to the Bulgarian stretch of the Danube River. During the Danube River surveys, 28 fish species were recorded, of them 5 alien species (*C. gibelio*, *Hypophthalmichthys molitrix, P. parva*, *Syngnathus abaster*, *L. gibbosus*). Among them, most frequently found were *P. parva, S. abaster* and *L. gibbosus* (at 40% of all sites), and most abundant was *C. gibelio*, followed by *S. abaster.* The results were analysed and discussed in terms of alien species population dynamics, habitat requirements and potential impact on native aquatic communities.

Key words: Alien fish species, Danube River, occurrence, abundance, ecology.

Acknowledgements: This study was supported within the frames of the East and South European Network for Invasive Alien Species (ESENIAS) and the International Association for Danube Research (IAD), and within a joint project of the Bulgarian Academy of Sciences and the Academy of Sciences of the Czech Republic.

Micromorphology of Achenes in Asteraceae' Genera: *Conyza, Bidens & Solidago*

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Micro-morphology of covering trichomes in achenes is a very important diagnostic feature for many taxa of Asteraceae. Achenes of 8 taxa of *Solidago* L. (from 23 locations), 5 taxa of *Conyza* Less. (48 locations), and 4 taxa of *Bidens* L. (5 locations) have been studied by Scanning Electrone Microscope LEO 1430 VP. The variability of several trichome' characters (form of apical zones, relational sizes of twin cells, angle of divarication between twin cells, ultra sculpture of cells' surfaces, expression of cell structure in achenes' cover) on the intra-specific level is revealed. We first established that achenes of some *Solidago, Conyza* & *Bidens* species have duplex covering trichomes consisting of 2 cells.

The only additional (diagnostic) character of taxonomic value for 7 studied taxa of *Solidago* (excluding native *S. virgaurea*) is the length of trichomes. Achenes of *S. gigantea*, *S.graminifolia* and *S. virgaurea* × *S. gigantea* have long trichomes (118-186 μm); *S. chilensis* and *S. canadensis* s.l. are characterized by trichomes 3 times shorter (33-69 μm). *S. chilensis* has almost glabrous achenes, while in the other species the trichome' density varies on the population level.

As for the genus *Bidens*, native *B.tripartita* and *B.cernua* have simple multicellular trichomes. Invasive *B.frondosa* has duplex trichomes composed of long (247±15 μm) and short (72±5 μm) cells. Alien *B.connata* has two types of trichomes: simple multicellular and duplex ones. For all species the degree of pubescence is not very variable on intra-specific level

Alien *Conyza* species (*C.canadensis, C.sumatrensis, C.bonariensis, C.bilbaoana, C.chilensis*) are not distinguished by trichome' characters. All have duplex trichomes composed of almost equal cells (length 97-179 μm). The number of trichomes and their length are very variable within each investigated population (both in the native and in the secondary distribution range).

This work was supported by the Russian Foundation for Basic Research, grant no.12-04-00965.

Keywords: *Solidago, Conyza, Bidens,* achene, trichome, alien species

A Decade of Invasion: Ecology, Spread and Impacts of *Harmonia axyridis* (Pallas,1773) (Coleoptera: Coccinellidae) in the UK

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The harlequin ladybird *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) was first recorded in the UK in 2003 and was established by 2004. This paper discusses the spread, ecology and effects of *H. axyridis* in the UK since that time.

The Harlequin Ladybird Survey (www.harlequin-survey.org) was launched to track the spread of the species and was very successful in engaging the public to record sightings of *H. axyridis*, which were verified from submitted photographs and specimens. Over 30,000 verified records from more than 1,100 different 10 km squares were verified; thus the spread of the species from the start of the invasion process was tracked in unprecedented detail.

Harmonia axyridis spread from south-eastern England in a westerly and northerly direction and the species is now widespread and common across most of southern and central UK. It is probably now the second most abundant coccinellid (after the 7-spot ladybird *Coccinella septempunctata* L., 1758). The northerly spread rate was calculated as 105 km per year between 2004 and 2008. Although there are a small number of records in the extreme north of England and in Scotland, the main 'invasion front' of the species stopped in northern England in 2009. This is discussed briefly, as is habitat use by *H. axyridis* in the UK, which is very broad.

Standardised local surveys in eastern England were carried out over the last nine years and reveal declines in some native coccinellid species in response to the arrival of *H. axyridis*. In order to study possible intraguild predation (IGP), molecular analyses of the gut contents of *H. axyridis* were carried out. The DNA of *Adalia* species was detected in 19 of 156 (12.2%) *H. axyridis* tested, illustrating that IGP by *H. axyridis* on native coccinellids was occurring. This is one mechanism by which the observed declines in native species may be explained.

Keywords: Coccinellidae; harlequin ladybird; invasive species; PCR; range expansion

Alien Plant Species in Citrus Orchards in the Antalya Province of Turkey

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Citrus are among main income sources in the Antalya Province of Turkey. Weed surveys were carried out in order to determine the species, density, coverage and frequency of the weeds in one hundred citrus orchards in 2013. Nine most intense citrus producing districts of the province were selected for surveys, which were conducted mainly orange, lemon, mandarin and grapefruit orchards. As a result of the surveys, a total of 44 weed species belonging to 16 different families were identified. *Portulaca oleracea* L. (Common purslane) and *Cyperus rotundus* L. (Purple nut sedge), both are cryptogenic species, were the most intense species with 16,6 and 8,6 plant/m^2 density respectively. *Xanthium strumarium* L. (Common cocklebur), an alien species, was the most common species in citrus orchards with % 64 observation frequency. *Abutilon theophrasti* Medik. (Velvetleaf), *Amaranthus albus* L. (Tumble pigweed), *Amaranthus retroflexus* L. (Redroot pigweed), *Bromus tectorum* L. (Downy brome), *Chenopodium album* L. (Common lambsquarters), *Conyza canadensis* (L.) Cronq. (Horseweed), *Bidens tripartite* L. (Threelobe beggarticks), *Cynodon dactylon* (L.) Pers. (Bermuda grass) and *Seteria verticillata* (L.) P.Beauv. (Bristly foxtail) were alien species.

Keywords: Citrus, weed, alien, invasive, Antalya

Dispersal Potential of Spotted Spurge Seed by Soil and Water

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To investigate the spreading potential of spotted spurge (*Euphorbia maculata*) as a newly introduced and troublesome weed species of soybean field in the Golestan province in Iran, the viability of this weed seed in soil and water were examined. Experiments were conducted as completely randomized design with eight replications. Treatment levels of seed viability in soil and water included 1-11 months of seed burial at 10-15 cm depth, and 1-9 weeks of seed soaked in water, respectively. The results indicated that buried seed in soil after 11 months showed germination at a rate of above 95%. Seeds were not able to germinate when submerged. Seeds removed from water after 2 weeks germinated at a rate of above 90%, but germination rate reduced with increasing immersion time, and after 9 weeks seeds had lost their viability. Based on these results, spotted spurge seeds had high persistence in the soil. The seed bank formation ensures that the species can remain at a site for a number of years which may increase the risk and magnitude of future crop yield loss and weed seed production. Seed viability in water for a few weeks allows for dispersal by water irrigation. Also, weed seed can spread by adhesion of soil to the tyres of the operating machine.

Keywords: Farm machinery, seed dispersal, seed longevity, water irrigation

Spotted Spurge and Wild Poinsettia Growth as Affected By Intraspecific Plant Density

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Intraspecific plant density can be important in the initial success of the colonization process for invasive plants and it might have profound effects upon the ability of a species to become established. Spotted spurge (*Euphorbia maculata*) and wild poinsettia (*Euphorbia heterophylla*) are two weeds of summer annuals, native to tropical and semi-tropical regions of America that were introduced to soybean fields in the Golestan province in Iran in recent years where they have been problematic. We studied intraspecific competition on spotted spurge and wild poinsettia growth. Plant density levels included 6, 12, 24 and 48 plants m^{-2}. Results indicated that intraspecific competition had significant negative effect on branching number, weight of leaf and stem per plant for the two weeds. Branching number and dry matter of various plant organs decreased with an increasing density. Plants in low density produced more fruits than plants in either medium or high density plots. Self-thinning was not observed in the high densities. The growth of each plant was reduced, so that inverse of plant weight increased with increasing intraspecific competition. There was no significant difference between total biomass per unit area at various densities of spotted spurge. Total biomass and fruit production of wild poinsettia per unit area were increased with increasing density, as high-density populations were more productive. Variation in plant size in response to density, instead of increased mortality, may allow more plants to survive and therefore maintain a larger number of genotypes in the population. This study also showed that patches of low spotted spurge density can grow rapidly and produce abundant seed, and as the result, in a few years form a dense stand.

Keyword: Competition, *Euphorbia maculata*, *Euphorbia heterophylla*, plant weight, self-thinning, total biomass

Experiences with Ambrosia in Switzerland

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The dicotyledonous summer annual Common Ragweed (*Ambrosia artemisiifolia* L.) is on the one hand a noxious arable weed and on the other hand an invasive neophyte with a great potential to spread. Various possibilities are known for control of Common Ragweed with mechanical and chemical methods on agricultural fields. Limits are set in sunflowers because sunflower and ragweed are botanically related. Because no weed control action results in 100% efficacy, Common Ragweed can propagate quickly in untreated corners of the field or in other disturbed soils. The legal obligation of announcement and control – introduced in Switzerland a couple of years ago – enabled the development of specific distribution maps and enhanced the quality of control measures. Facts and figures from the Canton of Geneva proof that the ragweed invasion has been stopped, but the species is not eradicated. The results of Geneva represent the results of good ragweed control in the whole country. Beside agriculture, traffic infrastructure, building sites, gravel pits and urban park and garden areas are sensible to ragweed invasion. This is why the formation of "Ambrosia Groups" helps to exchange experiences and to understand factors provoking the invasion. The responsibility of individuals helps to improve control efficiency even if financial funds are small. A sustainable control success depends on the efficiency to hamper seed production. The reduction of pollen quantity in the air in a long term is part of the earnings for the control effort. Actually, the publicity of Common Ragweed is fed by specialist information and its distribution in the media. It would be an interesting task to develop in our fast moving era an awareness level comparable to that of the stinging nettle.

Keywords: arable weed, bird seed grain, invasive neophyte, obligation to control

Breaking Dormancy of Wild Oat (*Avena fatua* L.) Seeds

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Wild oat (*Avena fatua L.*) is a weed species often found alongside wheat, rye, barley and oat crops throughout the world, as well as in Serbia. Weed surveys conducted in 2014 in central, south and south-east Serbia found that wild oat spreads quickly and that its presence is increasing due to modest agrotechnical measures and inadequate eradication techniques.
The success of its distribution and persistence as a weedy species can be attributed to its seed germination behavior. Seed dormancy is the major factor which affects germination, seed viability and ability to control wild oat in cereal crops. The aim of this research was to investigate the influence of different factors, such as water, KNO_3, light, darkness and temperature on seed dormancy. Experiments were conducted under controlled conditions. Mature seeds were collected in Obrenovac area at the beginning of July 2013. The seeds were stored at temperature between 15-18°C. The seeds were germinated in Petri dishes, 10 in each dish (5 repetitions); with distilled water, 0,2% KNO_3 solution in darkness at 20°C and at different temperature regimes: 10/16°C and 16/22°C at 10/14h night/day cycle, with and without prior cooling at 5°C for 5 days. Length of the shoot and roots was measured every 5 days. The results were analyzed using t-test.
After data analysis, it was concluded that there are no statistically significant differences of shoot and root length after germination in H_2O and KNO_3 in all treatments, except for 10/14°C regime without prior cooling. Also, noticeably better germination was recorded for the roots and shoot in darkness at 20°C compared to other two treatments, with the exception of KNO_3 with prior cooling of the seeds. If the seed was not subjected to cooling before germination, better germination was noticeable in dark conditions, compared to other two treatments (10/16°C and 16/22°C at 10/14h night/day cycle), with the exception of the root length of seeds germinated in H_2O.

Keywords: *Avena fatua* L., seed dormancy, temperature, KNO_3

Occurrence of Archaeophytes on Arable Land in the Czech Republic - Field Survey in 2006-2008

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Archaeophytes (naturalized non-native plant species, firstly introduced prior to 1492) make substantial part in species composition of weed communities on arable land in all European countries. Loss of species diversity after Second World War caused by the intensification of agriculture refers mainly to this group. The aim of our study was to make an inventory of species composition in Czech farms and to compare the current status of the species with results of previous studies.
The field survey was conducted at 27 conventional and 35 organic farms in 2006-2008. Fields with winter cereals, spring cereals and root crops (wide-row spring crops) were selected for a sampling. In each sampled field, one phytocoenological relevé of standard size of 100 m^2 was recorded in the central part of the field. In total, 290 phytocoenological relevés were carried out, 132 thereof in organic farms and 158 in conventional farms. In total, 172 weed species were found (volunteer crops were not included). Weed species that were found were classified according to their status as apophytes, archaeophytes and neophytes. Among observed species, 56.4 % were considered as archaeophytes (97 species), 33.2 % apophytes (58 species) and 9.88 % neophytes (17 species). Sixteen species considered as archaeophytes are listed on the Black and Red list of the vascular plants of the Czech Republic, five of which are classified as endangered (EN, IUCN classification) (*Veronica agrestis*, *Stachys annua*, *Adonis aestivalis* and *Coronopus squamatus*). Results of the study show further decrease of archaeophytes in current weed communities.

Keywords: archaeophytes, neophytes, phytocoenological relevé, agriculture

Long-term *Artemisia vulgaris* (Mugwort) Control Strategieson Hazelnut (*Corylus avellana* L.)

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Weeds not only limit the hazelnut productivity through competition, but also interfere the harvesting operations. Field experiments were conducted from spring 2010 to 2013 to evaluate mechanical weed control methods used alone or combined with herbicides in hazelnut orchard to control *Artemisia vulgaris L.* (Mugwort). Mechanical method string trimmer (ST) was applied alone or glyphosate (2965g ai ha^{-1}), glyphosate + diflufenican (1870+ 100 g ai ha^{-1}) or glyphosate + carfentrazonee-ethyl (1080+15g ai ha^{-1}). Those combinations were also applied with pendimethalin and oxyfluorfen applied as pre-emergence applications. The experiments were in Fatsa-Ordu, Turkey, on a sandy clay soil with multi-stemmed bush trees hazelnut orchards. The combination treatments increased weed control visual ratings more than that in the control applied alone. Comparison of all treatments revealed that glyphosate and carfentrazone-ethyl application after 15 d of ST was usually the most effective treatment for control of these weed. This combination was more effective to reduce number of seed bank reserve of*Artemisia vulgaris L.* than any herbicides applied alone or mixture with decreasing rate 23.2, 35.5 and 7.4% in 2013 respectively. However, treatments of ST plus glyphosate and carfentrazone-ethyl were also successful with financial implications when compred with application cost. Thus, effective and economic weed management systems in hazelnut should include ST followed by glyphosate plus carfentrazone-ethyl applications. This weed management program could improve weed control and reduce reliance on herbicides in long-term sustainable hazelnut production.

Keywords: *Artemisia vulgaris L.* hazelnut, weed management, herbicides

Parthenium Weed Invasion in Crops: A New Emerging Threat to Agricultural Lands in Pakistan

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Parthenium weed (*Parthenium hysterophorus* L.,) is a weed of global significance that has become a major weed in Pakistan and many other parts of the world. Parthenium weed can be found from 0 to 2,700 m above sea level, in over 30 vegetable, horticultural, grain and field crops, all kinds of pastures and rangelands, and various other environmental situations. Parthenium weed can reduce crop productivity, plant community biodiversity and affect animal and human health. Thus, the problems caused by the weed are numerous and wide spread. In Pakistan, parthenium weed can invade a wide range of crops, of particular concern is the invasion of cereal crops such as rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L.). In such crops, parthenium weed has been shown to reduce yields by as much as 40 %. The invasion by the weed in fodder crops such as sorghum, maize and clover (*Trifolium alexandrianum* L.) is a serious threat to livestock and diary production. Contamination of grains (wheat and rice) with this seed of quarantinable species has severe consequences for the export of these crops. An integrated management program is direly needed to manage this weed in economically important crops and to contain its further spread into new areas that are climatically suitable for its growth.

Keywords: Invasive Alien Species, agriculture, *Parthenium hysterophorus* L. fodder crops

Anthropogenically impacted arborescent habitats as main drivers of introduced species distribution on insular agro-natural landscapes

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Drivers of species composition, such as anthropogenic disturbance, can significantly alter the balance between native and introduced species, making habitats less resilient to invasion. We aim to detect changes in habitat biodiversity and species distribution under increasing anthropogenic impact, and determine (1) if the proportion of introduced species increases as anthropogenic impact rise and (2) if unique associations between species, habitat type, and differential insular anthropogenic impact occur. (Location - The Azores archipelago)
Spider assemblages in five herbaceous and four arboreal habitat types, scaling up from native to anthropogenic managed habitats, were monitored in five differentially agricultural developed islands of the Azores archipelago. A statistical metrics (IndVal) was used to identify indicator species and determine significant associations among the different habitats, islands and species.
Proportion of introduced species increased as anthropogenic impact rose across habitats sampled, however no significant differences were found in species variation and evenness across islands between endemic, native non-endemic and introduced species. Herbaceous habitats present an interaction effect between number of introduced species and island sampled. Arborescent habitats presented significant associations with several introduced species but no island effect. As a rule, islands with a higher proportion of native habitats presented the steepest increase in introduced species as anthropogenic impact rose.
Islands with higher proportion of native areas recruit more introduced species as human impact rises in herbaceous habitats. Arborescent man-made habitats present strong associations, and are an important source, for introduced spiders. While herbaceous pasture land is often reported as the main driver of introduced species composition, when expanding the set of habitats tested, a different situation occurs. Arborescent managed habitat (e.g. orchards) can provide refugia for introduced species and therefore promote the dissemination of invasiveness more so than herbaceous habitats.

Reproduction Ability and Control of Velvetleaf (*Abutilon theophrasti* Medic.) in Sugar Beet

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Velvetleaf (*Abutilon theophrasti*) is a plant native to the warmer parts of Asia, but which nowadays has become one of the most significant and fast spreading alien weed on arable land in Central Europe and Mediterranean. It is difficult to control in sugar beet and in some other crops in which the choice of herbicides is limited.

In our pot and small plot field experiments, we tested biomass and seed production of this species under different weed control regimes in sugar beet. The experiment also aimed at optimizing combination of herbicides and application timing in order to reduce competition and seed production of this weed.

Surprisingly, Velvetleaf plants were highly suppressed by the weed vegetation common in our region. The Velvetleaf biomass and seed production were the lowest in untreated plots, as was the sugar beet yield. The highest Velvetleaf seed production (6,700 to 14,800 seeds/m^2) was found on plots treated by herbicides commonly used in sugar beet (phenmedipham, desmedipham and ethofumesate) which due to effective control of common weeds vacated space for Velvetleaf. Yield decrease on conventionally treated plots was 60-78 % compared to plots weeded by hand with the highest yield. Only the addition of triflusulfuron-methyl herbicide to the conventional herbicide mixture was a solution to control Velvetleaf to a certain extent (83 – 88% efficacy) at least. The seed production varied between 200 to 4,700 seeds/m^2 in this case. For control success, two applications of triflusulfuron-methyl (at the growth stage of Velvetleaf cotyledon leaves and 5 days later) were necessary.

The experiments showed high reproductive potential of Velvetleaf in sugar beet if the weed is not recognized and weed control is not adjusted to the occurrence of this invasive species. Elimination by hand at the early stage of invasion in the field, mitigation effect of native weed flora and effective chemical control using triflusulfuron-methyl in herbicide tank-mixes are the most important weed control measures in sugar beet.

Keywords: weed control, *Abutilon theophrasti,* herbicides, triflusulfuron-methyl, invasive weeds

Molecular and Classical Identification of Wild Oat *(Avena* spp.*)* Species Which are Economically Important in Wheat Areas in Turkey

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Wild oats (*Avena* spp.) are troublesome weeds in their native and nonnative range in wheat fields. In this study economically important wild oat species in Turkey are identified which is important in order to develop control strategies. Despite the presence of eight different wild oat species registered in flora of Turkey, *Avena fatua* L., *A. sterilis* and *A. ludoviciana* are seen as a problem in wheat fields. Herbicides against wild oats were registered in one or more of these species. Two of mentioned three species are considered as subspecies of the same species: *A. sterilis* is a synonym of *Avena sterilis* L. subsp. *sterilis* L. and *A.ludoviciana* is a synonym of *Avena sterilis* L. subsp. *ludoviciana* (Durieu) Gillet et Magne. Although morphologies are similar to each other, they can be considered as two distinct species in many places. Also, *A.sterilis* and *A.ludoviciana* resistance data were evaluated separately. So far, primarily wild oat species which are becoming problem in wheat fields, have been identified as morphological methods. Molecular methods will be investigated in 200 wild oats populations which were collected in wheat field from all geographical regions in Turkey.

Keywords: *Avena*, identification

A Review on Allelopathy Studies to Control *Physalis* spp. in Turkey

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Physalis spp. were introduced to Turkey long time ago which has not been known exactly. They have invaded cotton, maize and soybean etc. fields, and spread and increase year by year especially in the Mediterranean and South East Anatolian Regions. Herbicides are not enough to control these species. Allelopathy is considered an alternative method to manage these weeds. Studies related to allelopathy to control *Physalis* spp. in Turkey is reviewed to find out scientific and technologic needs for further steps.

Keywords: *Physalis* spp., allelopathy, cotton, maize

A New Alien Plant Species in Turkey: *Ipomoea triloba* L.

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There have been three *Ipomoea* species in the Flora of Turkey: *I. stolonifera, I. sagittata* and *I. purpurea*, which are alien species to Turkey. Two of them, *I. stolonifera* and *I. sagittata* were established in natural areas, and the other in both natural and agricultural areas. Another *Ipomoea* species was reported in the cotton fields in the western Mediterranean part of Turkey. It was assumed as *Ipomoea lacunose*. But, our final diagnosis showed that these species is *Ipomoea triloba* L., which is an alien species for Turkey. It is a native plant of tropical America and seen other tropical areas. *I. triloba* is occurring in various habitats. It is a problem already in cotton and corn fields in Antalya province. Identification, distribution and containment studies are immediate research works for these species. Our observations show it has already spread in the western Mediterranean part of Turkey. Measures should be taken to prevent further spread and control in current area.

Keywords: *Ipomoea triloba* L., invasive species, Turkey, alien

Early Warning in Belgium – Waarnemingen.be as an Early-Detection Tool

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Rapid detection of potentially harmful invasive alien species (IAS) is essential to avoid future invasions and management costs. Until recently, the Flemish region (Flanders, Northern Belgium) - and by extension Belgium - had no dedicated portal for reporting observations of such species, despite the high political priority and ongoing current (inter) national initiatives. In 2011, the Agency for Nature and Forest and the Institute for Nature and Forest Research initiated a pilot. For some notorious IAS, an early warning system was launched through the widely used online recording platform www.waarnemingen.be. The system is primarily targeted towards naturalist observers. This was done in cooperation with all Belgian regions and the major non-governmental organisations in the field of nature conservation. The system allows for reporting sightings, consulting fact sheets and setting up user-driven automated e-mail alerts. The aim of the pilot phase (March-November 2012) was to examine how the system could work (which species are picked up, potential reporting bias, data quality). Apart from testing the reporting tool as an early warning system, the project had several spin-offs. In the longer run, we aimed at mobilizing volunteers for monitoring IAS. We also wanted to provide information and raise awareness amongst field workers and the public. Eventually, we hope to streamline the process from reporting to management intervention. The ultimate goal is to have an early warning system for IAS in Flanders (northern Belgium) that connects with federal initiatives and anticipates developments of a trans-European system. The current system is already being used for various rapid response projects in Flanders, including control of invasive aquatic plants such as floating pennywort *Hydrocotyle ranunculoides*, water primrose *Ludwigia grandiflora*, Parrot's feather *Myriophyllum aquaticum*, ruddy duck *Oxyura jamaicensis*, Pallas' squirrel *Callosciurus erythreaus*, quarantine insects, American bullfrog *Lithobates catesbeianus*, giant hogweed *Heracleum mantegazzianum* and Chinese muntjac *Muntiacus reevesi*.

Keywords: prevention; early warning; rapid response; citizen science

A First for New Zealand: Eradicating the European Alpine Newt

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A self-sustaining population of *Icthyosaura alpestris* (European alpine newt) was discovered in New Zealand in late 2013, in close proximity to the already endangered native frogs *Leiopelma archeyi* and *L. hochstetteri*. *I. alpestris* poses a significant threat to New Zealand's rare and endemic native fish and amphibians. It is a voracious predator that eats small vertebrates and amphibian eggs, and carries chytridiomycosis, a fungal pathogen causing global amphibian decline. As there are no native newts in New Zealand, *I. alpestris* also has the potential to occupy habitats here with little competition. The Ministry for Primary Industries (MPI) is attempting to eradicate *I. alpestris*, using a variety of methods including; fyke and box nets, dip nets, drift fences, pitfall traps, detector dogs and manual searches in and around water bodies and high risk areas. Detector dogs have been used very rarely in responses here and have the potential to be a valuable tool. To date, *I. alpestris* has been found only within 350 m of the initial incursion site, presenting an opportunity for successful eradication. This is the first time that eradication of an amphibian has been attempted in New Zealand. Biosecurity responses lead by MPI are run under the Coordinated Incident Management System (CIMS), which involves a holistic approach to mitigate a wide range of risks. Continued collaboration with scientists and experts will be vital as we continue to progress this response.

Keywords: European alpine newt; Amphibian; Eradication; New Zealand.

Attempts to Control the Invasive Aquatic *Crassula helmsii* with Special Reference to Dye Treatment

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Several methods were deployed to control the highly invasive amphibious aquatic *Crassula helmsii* (Kirk) Cockayne (Australian swamp-stonecrop) in a newly created shallow pond adjoining the heath and moorland pools of the nature reserve Huis ter Heide (Tilburg, The Netherlands). The suite of measures included mechanical removal of top soil after draining, followed by extensive covering of pond margins with non-transparent foil, regular manual removal of washed-up plants, and addition of non-toxic dyes. The latter aimed to reduce compensation depth sufficiently to prevent submerged growth below the foil-covered area. Treatment with a mixture of soluble red and black dyes (DyoFix®), commercialized for the control of aquatic weeds and phytoplankton was started in January 2013. Five further additions followed in the course of this year to make up for losses and to increase concentration. Biomass of submerged vegetation was recorded in October 2012 and October 2013. This indicated that *C. helmsii* had replaced *Chara virgata* Kütz. as the dominant species and that its amount had tripled. Even though native species became more widespread in the pond, their joint biomass was reduced to a third. Overall, vegetation height increased slightly, whilst the total number of macrophyte taxa remained similar. Measurement of photosynthetically active radiation at different depths showed that dye addition had not resulted in prolonged light limitation even in the deepest part of the pond, despite the use of considerably higher doses than recommended. Although pond morphology and water-level changes complicated application in this particular case, it appears unlikely that 'shading' with dyes will result in effective control or local eradication of *C. helmsii*, given the growth plasticity and reproductive strategy of this species. Taking previous observations into account, measures to control *C. helmsii* at Huis ter Heide were continued in 2014.

Keywords: New Zealand pigmyweed; aquatic weeds; macrophytes; eradication; light limitation

Acknowledgement: This work was performed within the framework of the EU co-funded Interreg 2Seas project RINSE (Reducing the Impact of Non-Native Species in Europe), which seeks to improve awareness of the threats posed by INNS, and the methods to address them.

Best Practice in Management of *Rosa rugosa*

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Rosa rugosa Thunb. was introduced to Europe from East Asia in the late 18th century and became popular as an ornamental plant in the 20th century. Because of its salt tolerance, ornamental vaule and shielding function, it was regularly planted in coastal regions, e.g. in gardens and along footpaths, from where it spread, naturalised and became invasive. In Europe, it is now a well established alien plant with a distribution area that stretches from Belgium to Norway and the Faroe Islands and along the Baltic Sea from Germany to Latvia and Finland. In coastal areas, this shrub species mainly occurs as an invasive species in dunes, from dynamic yellow dunes across grey dunes to stabilised brown dune heathlands, but also thrives on stony and rocky coasts.

Rosa rugosa establishes by vegetative growth, and often forms large and dense stands, suppressing natural vegetation. Consequently, its presence constitutes a considerable threat to open coastal dune vegetation that represents vegetation of high conservation value.

Nevertheless, before deciding whether or not non-native scrub needs to be controlled, the conservation value of the scrub habitat has to be assessed. However, the conservation value of *R. rugosa* shrublands as well as the ecological services, e.g. as habitat and food resource for birds, is different from native shrublands with indigenous species. *R. rugosa* represents a rapidly growing species, invading valued habitats and therefore control or eradication is necessary in many cases.

Successful removal of *R. rugosa* is difficult due to its functional traits such as the strong ability to resprout from small vegetative fragments from various depths in the soil.

In northwest Europe various management approaches are appied under different circumstances and at different intensities, with varying levels of success:

- Cutting or mowing followed by either covering with sand, burning on site, burial or removal of the plant debris;
- grazing with various large herbivore species to control scrub encroachment or to control regrowth after cutting or mowing;

- herbicide treatment to either kill the bushes or to control regrowth from cut stems;
- digging out of individual shrubs or big infestations using various machines, combined with different follow-up methods.

Apart from the choise of the management method, site specific conditions such as size, slope, soil type; nature protection status; accessibility of the invaded area, available resources and size of the infested area are factors that can explain management outcome.

Keywords: management methods; scrub removal

Effect of Essential Oils on Germinated Seeds of Ragweed

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The major environmental problems of the 21st century, apart from climate change, water scarcity, pollution and resource exhaustion, are invasive weed species. One of problematic invasive plants is ragweed (*Ambrosia artemisiifolia* L.). This weed is a major issue in cultivated crop establishment. In addition, the damages caused by this weed are even greater, since it has been intensively spreading in a number of non-arable lands thus producing a large amount of highly allergenic pollen that causes high rates of sensitization among humans and animals.

Chemical and mechanical weed control methods have been developed to control invasive weeds, such as A. artemisiifolia, and are already partially implemented in the South and East *Europe, although sustainable control strategies to mitigate its spread into these areas have not yet been established. Scientists are trying to develop some biological measures, using natural products with no negative impacts on human health and the environment (Green Pesticides). Among such biological measures, the herbal essential oils gained a g*reat attention.

In the present study, we have tested efficiency of essential oils extracted from *Anethum graveolens L., Origanum vulgare L., Juniperus communis L., Salvia officinalis L., Satureja montana L.* on invasive *A. artemisiifolia*; we used in vitro methods to test the efficacy of *diluted* oils *(500 µl in 100 ml of distilled water)* on *germination of the* weed seeds *and* the germs. *Petri dishes were sealed with parafilm and left for a week in the dark at 27 °C. Following that period, impacts of essential oils' solutions on seed germination and germ growth were observed. Statistical analysis of results obtained from both experiments was performed using analysis of variance.*

Our results confirm that the tested five essential oils possess inhibitory efficacy on germination of the A. artemisiifolia seeds while, except for the oil of S. montana L, the other four oils (A. graveolens L., O.vulgare L., J. communis L., S.officinalis L.) also had inhibitory efficacy on weed germ growth. The obtained results show that all tested oils, due to their in vitro herbicidal activity, might be efficiently used as pre-emergent weed seed germination inhibitors, and as a part of integrated weed management practices.

Key words: ragweed, *Ambrosia artemisiifolia,* essential oils, weed control.

Acknowledgements: We are grateful to the Ministry of Education, Science and Technology of Republic of Serbia for financial support (Project III46008), EU COST Action SMARTER (FA1203) and EU FP7-REGPOT-AREA Project.

EU-COST Action on „Sustainable Management of *Ambrosia artemisiifolia* in Europe“ (COST FA1203-SMARTER): Opportunities and Challenges

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The EU -COST Action FA1203 on "Sustainable control of *Ambrosia artemisiifolia* L. (Asteraceae) in Europe (SMARTER)" was successfully launched in February 2013 and will last for four years. Thirty-three countries have already signed the Memorandum of Understanding and over 180 researchers with specialists in weed research, invasive alien species management, ecology, aerobiology, and economics are registered participants of SMARTER. COST Actions interlink nationally funded research projects enable and finance conferences, working groups, training schools and research exchanges. SMARTER aims to initiate and develop long-term and sustainable control methods, to integrate these into existing mechanical and chemical control measures, and to quantify the success of these measures both for agriculture and health. The focus is on biological control methods with insects and fungi (especially using alien species from the areas of origin of *Ambrosia*) and vegetation management to achieve a competitive plant cover. For this, we developed and parameterizeed models, starting from the population dynamics of *Ambrosia*, on the impact of control measures on the frequency and distribution of *Ambrosia* and finally on pollen counts and allergy occurrences, each with both ecological and economic components. The necessary data are derived from several of the experiments that we carry out in well-coordinated studies across Europe. SMARTER will allow the various stakeholders to select optimal habitat- and region-specific combinations of control methods.

Keywords: *Ambrosia artemisiifolia, Ophraella communa*, invasive plant, biological control, research consortium

Management of *Oxalis pes-caprae* L. in North Cyprus Cereals Fields

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Cereals, especially barley, are important crops in the Turkish Republic of Northern Cyprus where half of the agricultural areas are used for cereal production. Although, *Avena sterilis* L. and *Sinapis alba* L. are most important weed species in cereal areas, however, *O. pes-caprae*, a native of Cape Region of South Africa, can be seen a problem in some cereal fields. This field study was conducted in two locations (Türkmenköy and Mehmetcik) during 2012-2013 cereal cropping season in field conditions according to randomized block parcel design with four replicates and nine characters. Trials was replicated two different location (Türkmenköy and Mehmetcik). As result, it was determined that all herbicides or herbicide mix in different group compared with untreated control. Thifensulfuron + Tribenuron methyl (original formulated mix) and Tribenuron methyl + Bromoxynil (tank mix) were best effective treatments. The effect of herbicides on *O.pes-caprae* were 78.75% and 83.25% in Mehmetcik for Thifensulfuron + Tribenuron methyl (original formulated mix) and Tribenuron methyl + Bromoxynil (tank mix) respectively. Besides; the effect of herbicides on *O.pescaprae* were 73.75% and 83.75% in Türkmenköy for Thifensulfuron + Tribenuron methyl (original formulated mix) and Tribenuron methyl + Bromoxynil (tank mix) respectively.

Keywords: *Oxalis pes-caprae*, control, herbicide

Response of Ragweed to Herbicides: Imazamox, Tribenuron-Methyl and Glyphosate

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Ragweed (*Ambrosia artemisiifolia* L.) is an invasive weed species native to America and now widespread in central and southern Europe, with a tendency to spread eastward. In Serbia, it is the most widespread in the Pannonian Plain, the valleys of large rivers and main roads to the south of Serbia. It is weed of row crops (maize, soybean, sugar beet, sunflower, and vegetables), rarely small grains, alfalfa, and clover fields and very frequently found in non-crop fields.

We examined the influence of herbicides including imazamox, tribenuron-methyl and glyphosate on biological production of *A. artemisiifolia*: plant height, fresh weight and seed production under field conditions. Seedlings were produced in nursery, and when the seedlings were at the stage of 2 leaves stage, they were transplanted in the field. Humidity was provided daily by watering the experiment. Application of imazamox (Pulsar-40), tribenuron-methyl (SX-50 Express) and glyphosate (Glifol) in amounts 1x, 0.5x, and 0.25x, is derived from the recommended when the plants reached the 4-6 leaf stage. Therefore, the herbicides were applied; imazamox: 48, 24 and 12 g a.i. ha^{-1}, tribenuron-methyl: 22.5, 11.25 and 5.625 g a.i. ha^{-1} and glyphosate: 1440, 720 and 360 g am ha^{-1}.

The effects of herbicides on height, fresh weight and seed production of *A. artemisiifolia* differed depending on the type and amount of herbicide. The statndard doses of tribenuron-methyl and glyphosate (give dose) significantly reduced the height and fresh weight of *A. artemisiifolia* plants in all the treatments compared to untreated plants. Tribenuron-methyl reduced the height of plants at 32% (1x), 24% (0.5x), 11% (0.25x), and fresh weight compared: 70% (1x), 66% (0.5x), 38% (0.25x) to the control specimen. Glyphosate reduced the height: 55% (1x), 35.7% (0.5x), 26% (0.25x), and fresh weight: 94% (1x), 90% (0.5x), 77% (0.25x) compared with the untreated the control. In contrast, treatments with imazamox have reduced the weight of the plants at all the application rates giving 79% (1x), 74% (0.5x) and 37% (0.25x) and height only at the recommended amount of herbicide application, for 48%. Seed production was not significantly affected by the herbicides applied on *A.*

artemisiifolia. The order of effectiveness of herbicides on *A*. *artemisiifolia* was tribenuron-methyl < imazamox < glyphosate.

Keywords: ragweed, imazamox, tribenuron-methyl and glyphosate

Acknowledgement: We thank the Ministry of Education, Science and Technological Development of the RS for their financial support during the execution of this research (Project III 46008), COST Action SMARTER and EU FP7-REGPOT-AREA Project.

Exotic Dominance of Ruderal Communities Depends on Disturbance Type

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Disturbance commonly promotes the dominance of communities by exotic plants. Given that exotics are mostly ruderals (i.e., plants adapted to disturbed conditions), it is not surprising that they thrive in disturbed sites. Moreover, according to Grime's plant strategy theory, exotic ruderals should overcome native plant species with alternative strategies, such as competitive and stress tolerant, in sites altered by disturbance. It is not clear, however, what would be the outcome of exotic ruderals versus native ruderals in these sites, as well as the role of different disturbance types in the outcome and ultimately in the invasion process. In the current work, we studied the response of exotic and native ruderal species to different types of disturbance in a system with a diverse community of native ruderals, the semi-arid open forest of central Argentina. We conducted extensive plant surveys in sites altered by the three main disturbances in the region, road maintenance (a combination of plowing and mowing with no herbicide applications), fire, and grazing by domestic herbivores to estimate relative abundance of exotic and native ruderals in these sites. In addition, we examined how disturbance type affected resource availability by measuring soil moisture. The richness of exotic ruderals was consistently lower than that of native ruderals in all three disturbance types. Also, the cover of the exotics was lower than that of native ruderals in sites disturbed by grazing and fire. In contrast, the cover of exotic ruderal plants was two times greater than the cover of native ruderals in sites disturbed by road maintenance. Soil moisture was also greater in road maintenance sites than in sites altered by the other disturbance types. These results suggest that exotics overcome natives only under disturbances that profoundly disrupt plant communities and highly increase resource availability.

Keywords: Central Argentina, coexistence, community approach to invasions, dominance, plant abundance

Functional and Phylogenetic Distances Between a Successful Invader and Experimental Native Communities Under Different Stress Levels

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Understanding how changing environmental conditions influence plant community assembly processes is a major challenge in community ecology, especially with increasing biological invasions and global climatic change. Recently, the varying importance of different assembly processes along environmental gradients has been inferred by analyzing functional trait and phylogenetic patterns. However, few have experimentally tested these expectations. Our project aims to test the effect of aridity stress on the strength of competition (or facilitation) between potential invaders and semi-natural native communities. We also test the role of relative functional and phylogenetic characteristics in invasion success, in a controlled garden mesocosm experiment.
The experiment is running since May 2014 and we expect to finish measurements on August 2014. We planted 25 different exotic ornamentals with and without native European grassland communities under different aridity stress levels. The treatments are created manually by applying different water quantities: normal constant and reduced constant.
In order to document how the functional and phylogenetic similarity between successful invaders and native species (measured through the Mean Distance to Native Species, MDNS) changes between stress levels, we measure leaf, height and seed traits and we reconstruct the phylogenetic relationships based on DNA sequences from GenBank.
To assess competition changes on different levels of aridity stress we compare the fitness of the ornamental species when growing in the native community or alone. We quantify growth by measuring dried aboveground biomass and reproductive strength by documenting flowering span, seed production and vegetative reproduction.
According to Stress Gradient Hypothesis and Niche Theory, we expect higher competition strength in milder stress conditions leading to significantly higher MDNS than random for successful invaders. In contrast, in more stressful conditions we expect significantly lower MDNS

(functional/phylogenetic clustering) as a result of the decrease in competition from the natives and greater importance of environmental filtering for invaders.

Keywords: Functional traits, MDNS, competition, ornamentals, community assembly

Which traits are associated with invasiveness in the genus *Impatiens*?

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The majority of naturalized and invasive species recruit from deliberately introduced plants, often ornamentals. The genus *Impatiens* includes about 1,000 species, several of which are invasive species in many parts of the world. The most prominent examples include *I. glandulifera*, a highly invasive annual in temperate regions, and *I. walleriana*, a perennial invasive in the tropics. The genus *Impatiens* is recently becoming more popular with horticulturalists and the number of planted species is growing, which makes the emergence of new successful invaders likely.
We studied biological traits of *Impatiens* species associated with invasiveness expressed as number of invaded regions globally. Ten species with different origin and invasive status were studied: *I. balfourii*, *I. balsamina*, *I. capensis*, *I. edgeworthii*, *I. flemingii*, *I. glandulifera*, *I, noli-tangere*, *I. parviflora*, *I. scabrida,* and *I. walleriana*. For each species, the number of traits was measured corresponding to three life-stages (seed; seedling; adult): seed germination in laboratory and common garden; growth rate, and above and below ground biomass of seedlings in climatic chambers; height, biomass and fecundity of adult plants in the garden.
The species present in more regions produced fewer seed that were heavy and germinating late, their seedlings grew faster and had low root/shoot ratio, as they allocated more biomass to shoots. Seed and seedling traits were better predictors of invasion success than adult traits, such as biomass and fecundity. Seed of fast-growing species germinated poorly and their seedlings performed badly at temperatures typical for spring in the temperate zone. The only perennial, *I. walleriana*, was able to set seed only in a greenhouse, so its invasion in the temperate climate seems unlikely. Overall, the risk of emergence of new invasive *Impatiens* species in temperate regions, among those in our data set, seems to be low. This is inferred from the fact that none of the non-invasive species possess similar combination of traits as the species that are currently invasive.

Dispersal Restrictions May Explain Differences in Colonization by an Invasive Tree in Southern Brazil

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Short-distance dispersal by frugivorous birds can establish patterns of expansion from existing patches of invasive alien species. Different management strategies may be required to prevent the arrival of propagules in uncolonized sites. *Hovenia dulcis*, an invasive tree in forests in South America, native to East Asia, has infructescenses composed by dark and dry, globose capsuled fruits attached to a brown peduncle which grows thick and fleshy when mature. Birds can carry infructescences of *H. dulcis* to perches in other trees, to peck the fleshy peduncles, facilitating epizoochorous dispersal. In this study, we aimed to evaluate the arrival of *H. dulcis* propagules at uncolonized sites from patches of invasion at a local spatial scale. The arrival of seeds carried by birds was compared between sites covered in open and closed vegetation in heterogeneous habitats at different distances from patches of the invasive species. Managed areas where the species was cleared were compared with control areas where no action was taken. There is a seed dispersal limitation for *H. dulcis* at a local scale in the study area associated with the rate and intensity of visitation by frugivorous birds in patches located in the neighborhood of uncolonized sites. In an attempt to contain the invasion process by *H. dulcis* in the study area, the main management strategy indicated is the removal of trees with larger basal area located on patch edges. Conflicts of interest generated from control initiatives should be considered in management strategies developed in the region.

Keywords: bird dispersal, *Hovenia dulcis*, management, patches, propagule arrival

Invasive Terrestrial Plant Species and Climate - Related Variables in the Romanian Protected Areas

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Climatic factors are key drivers in the dynamics of invasive terrestrial plant species (ITPS). The paper is aiming to analyse both the climatic potential and the key meteorological drivers which are responsible for the occurrence, development and spread of a few most aggressive ITPS in Romania. The current assessment is focusing on selected case-studies from the Romanian protected areas, one for each bio-geographical region: Alpine (Maramureş Mountains Natural Park), Pannonic (Mureş Floodplain Natural Park), Continetal (Comana Natural Park), Steppic (Măcin Mountains National Park) and Pontic (Danube Delta Biosphere Reserve).
The authors used and processed annual, monthly and daily extreme climatic values (e.g. temperature, precipitations, wind, and potential evapotranspiration) from all the relevant weather stations in the selected protected areas. Based on these complex environmental data and in accordance to the climatic requirements of each analyzed ITPS *(Acer negundo* L.*, Ailanthus altissima* (Mill.) Swingle*, Amopha fruticosa* L.*, Elaeagnus angustifolia* L.*, Fallopia japonica* (Houtt.) Ronse Decr.*, Robinia pseudoacacia* L. etc.) the authors linked the resulted meteo-climatic drivers and computed climatic indicators (e.g. Palfai aridity index, Standardized Precipitation Index, Thornthwaite Aridity Index) with the most relevant biological and spread indexes and indicators (e.g. growth habitat/rate, fruit/seed abundance).
Furthermore, the paper is aiming to categorise the most widespread and dynamic ITPS which are affecting the ecological balance of the analysed protected areas in order to outline each one's niche profile in terms of climatic and topoclimatic requirements related to thermal, pluvial and eolian factors' dynamics.
Taking into consideration the conservation value of the protected areas under scrutiny, the paper could bring important contribution to developing and implementing management and control measures required by each protected area management plan.

Keywords: climatic potential, key meteorological drivers, Invasive Terrestrial Plant Species (ITPS), protected areas.

Acknowledgements: The current research adjoins studies undertaken in the framework of the EU FP7 – Building Capacity for Black Sea Catchment Observation and Assessment System supporting Sustainable Development (EnviroGRIDS) and INTERREG IV B - Adaptive Management of Climate-induced Changes of Habitat Diversity in Protected Areas (HABIT-CHANGE) projects.

Looking for Potential Woody Plant Invaders in Upper Žitava region (Slovakia). Part 1: An old Parks Survey

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Our participation in COST action TD1209 „European information system for alien species" is aimed at the identification of woody plant taxa with a potential to become invasive as well as the definition of the most important vectors and pathways for their spread in the Upper Žitava region. For this purpose we mapped old parks around mansions established in 19th century in villages near the Mlyňany Arboretum SAS, taken as sources of highly acclimatised trees/shrubs. In the next step we would like to survey allochtonous dendroflora of adjacent settlements, as sources of genetic variability, as well as small forests, river banks and balks connecting them, as suitable bio-corridors for spread after escape from culture.
Our mapping in parks revealed from 75 to 317 individuals of 8–37 foreign taxa, belonging to 8–17 families, especially family *Cupressaceae*, *Fabaceae*, *Sapindaceae* and *Pinaceae*. Most of them originate in North America and were planted in late socialism (20–40 years ago, Tajná and Klasov) or early socialism and before this era (40–60, 60–80 and 80–100 years ago, Nová Ves nad Žitavou and Beladice). Only in the park of Malé Vozokany mansion, most of plantations were realised in the democratic era (about 20 years ago). The oldest trees we found were individuals of *Acer saccharinum*, *Aesculus hippocastanum*, *Castanea sativa*, *Chamaecyparis lawsoniana*, *Gingko biloba*, *Gymnocladus dioicus*, *Juglans nigra*, *Liriodendron tulipifera*, *Magnolia acuminata*, *Picea omorika*, *Pinus nigra*, *Pinus ponderosa*, *Pinus wallichiana*, *Platanus* x *acerifolia*, *Pseudotsuga menziesii*, *Sophora japonica*, *Thuja occidentalis*. In Mlyňany Arboretum SAS also grow more over-100-years old trees: *Abies grandis*, *Abies normanniana*, *Pinus ponderosa*, *Sequioiadendron giganteum*, *Taxodium distichum*, *Thuja plicata*. Taking into account the age/expected acclimation level to the new environment, reproduction biology and naturalisation level of these species as described in literature, good candidate for new invasive woody plant species can be *Juglans nigra*, *Pinus nigra*.

Keywords: invasive potential, woody plants, upper Žitava region (Slovakia), old parks

Tolerance to environmental stress - an important component of invasion success

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The Chinese pond mussel *Sinanodonta woodiana* is an invasive bivalve species present in the flowing and standing waters of most of Europe. In a series of physiological and toxicological experiments, we examined if invasive mussel (*S. woodiana*) is more tolerant to environmental pressures, in comparison with indigenous mussel (*Anodonta anatina*). Electron transport system (ETS) activity and concentration of stress enzymes (catalase, glutathione reductase and acetylcholinesterase), as well as the comparison of the activity of multixenobiotic resistance mechanisms (MXR) in gill tissue, were used to evaluate a physiological response on water temperature extremes, feeding and starving, and zinc contaminations. *S. woodiana* showed higher tolerance to metal contaminations as well as to increased water temperature which is an important physiological benefit for further invasion success, especially in the context of climate changes.

Key words: invasive mussel*, Sinanodonta woodiana, Anodonta anatina,* ETS activity, MXR mechanisms

Invasiveness of Three Species of *Pinus* in Cerrado (São Paulo State, Brazil)

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Several *Pinus* species have been brought to Brazil for forestry improvement and commercial uses. Among them, *Pinus elliottii* Engelm. and *Pinus caribaea* Morelet have been reported as invasive, especially in open and/or disturbed environments, but at different scales of harm. In São Paulo State, the Cerrado (grasslands and savannas) is being invaded by *Pinus* species, however, information about their potential of invasion (invasiveness) is lacking to enable both prevention of invasion and a proper management; therefore, it is necessary to evaluate the invasiveness of *Pinus* species in the Cerrado region. This study aimed to assess and compare the invasiveness of *P. oocarpa* Schiede ex Schltdl., *P. elliottii* and *P. caribaea*, evaluated in relation to: a) propagule pressure and time of dispersal, through the analysis of seed rain; b) seed viability and germination, tested in laboratory; c) growth and mortality, evaluated in greenhouse. Biological material of the three species was collected in two Ecological Stations (Itirapina and Santa Bárbara) surrounded by *Pinus* plantations, in São Paulo State. Results indicated the three species have distinct dispersal periods, related to high rainfall, although less evident for *P. oocarpa;* strobiles of *P. elliottii* and *P. oocarpa* remain in the trees and are able to disperse seeds throughout the year; *P. elliottii* produces more seeds compared to the others. High viability and germination rates were observed for all species, around 80-90%. Despite having the lowest percentage of germination, *P. caribaea* starts germinating fast, followed by *P. oocarpa* and *P. elliottii*. Six months after storage, germination rates varied little. Although *P. caribaea* grew faster in the first two weeks, *P. oocarpa* showed the highest growth velocity in 15 weeks. Mortality was higher in the first five weeks after germination, and around 15%, 22% and 8%, respectively for *P. caribaea, P. elliottii* and *P. oocarpa.* Although *P. oocarpa* is not reported as invasive in Cerrado our data (low mortality, high viability, high and fast germination rates) show its potential to become invasive, as the other two species.

Keywords: germination, growth and mortality, pine species, seed dispersal, viability

Can Reproductive and Dispersal Characteristics Explain the Naturalization of Garden Plants?

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The paper aims at assessing the relative role of reproductive and dispersal traits in determining the escape from cultivation and subsequent naturalization of alien plants introduced as garden ornamentals. Towards this objective, we collated information on reproductive traits of 90 species cultivated in private gardens in the Czech Republic. The species were divided into four groups based on the combination of two criteria, frequency of planting and escape from cultivation: (i) frequently cultivated species that are known to escape from cultivation in the Czech Republic; (ii) frequently cultivated but not known to escape; (iii) rarely cultivated and not escaping; (iv) rarely cultivated but escaping. The traits studied were classified as related to reproduction or dispersal, and included: seed production, seed mass, animal dispersal (epizoochory), terminal velocity of diaspores (anemochory), buoyancy (floating capacity), persistence of seed in the soil (type of seed bank), germination under field conditions, seedling establishment, and germination in climate chamber.
The traits were used to explain the probability of escape from cultivation, and the status of the species in the Czech Republic (naturalized vs casual). In addition, we analysed the role of reproductive and dispersal traits together with the estimate of current propagule pressure, inferred from quantitative primary data on the frequency of planting of each species in the Czech Republic, and species' minimum residence time. Preliminary results indicate that garden species that are tall, have propagules floating for a long time, their seedling establish easily and seeds are efficiently dispersed by wind, are more likely to escape from cultivation and naturalize than those not possessing these traits. Surprisingly, the frequency of planting did not appear as a significant predictor of the naturalization success.

Keywords: garden plants, reproductive traits, dispersal traits, naturalization

How the Yellowhammer Became a Kiwi: Using Bioacoustics to Understand Invasion History

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Yellowhammer (*Emberiza citrinella*), once a common country bird in the UK, has experienced recently a sharp population decline in that country (~60% over the last 40 years). However, their distant cousins in New Zealand still thrive well. Yellowhammers were introduced to New Zealand in the late 1860's along with other British birds in order to minimise the impact of insect crop pests. Only after having introduced the birds, the farmers found out that yellowhammers were granivorous and only fed their chicks with insects as a protein-rich resource. It took New Zealanders almost 20 years to realize their mistake – in 1880's yellowhammers were not only removed from the list of insectivorous birds but started to be killed massively. Nowadays, yellowhammer is not a serious pest anymore and the initial blunder offers a unique opportunity to compare two isolated populations, a native and introduced one, for the distribution of different song types, the dialects.

As one dialect can persist on a locality for decades, knowledge about their distribution can help to understand, how the populations of the species spread over the new territory. This project builds on a successful citizen-science project "Dialects of Czech yellowhammer". Volunteers from the UK (source country of introductions) and New Zealand (introduced range) are encouraged to record the song of yellowhammer and thus map the current dialect distribution in both countries. The data on the history of introductions will be compared with the current distribution of dialects in both regions to explore whether the dialect patterns reflect the introduction history.

Preliminary data indicate that the dialects recorded in New Zealand are also recorded in Europe but, surprisingly, among these there are some not observed in Britain as yet. This raises new questions and may even throw some doubts on the general belief that New Zealand yellowhammer populations originated exclusively from British sources.

Keywords: birdsong, dialects, invasion history, citizen-science

Carpobrotus edulis: Physiological Integration as Key to Invade Stressful Ecosystems

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Physiological plasticity is crucial attribute enabling plants to acquire resources from stressful habitats. Although physiological integration is not a new topic in plant biology, its ecological importance in plant invasion has been largely overlooked. *Carpobrotus edulis* is a plant with clonal growth and this attribute could contribute to its invasiveness, however little research has been conducted to determine the importance of clonal traits for the success of the invader. In this experiment we researched the ability of two different populations of *C. edulis* to face the water deficit, and how clonal integration can contribute to the expansion of this species. Physiological integration was determined by studying the dependence of apical growth of the plant of well watered areas versus ramets growing in water stress. Above and belowground expansion was determined: number of ramets, length, biomass, total and internode length, number of new roots, length and biomass. The plant response mechanism was assessed by studying different biochemical parameters related to water stress: pigments, proteins and ROS metabolites.
Our results showed that there is an improvement in apical parts connected to well watered areas by older ramets increasing the biomass allocated to roots and the photosynthetic efficiency. Mechanisms of plant resistance are discussed in order to understand the aggressive colonization of the invader *C. edulis*.

Keywords: *Carpobrotus edulis*, physiological integration, water stress invasion mechanisms.

Factors Shaping the Distribution of *Ambrosia artemisiifolia* in the Czech Republic

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Common ragweed, *Ambrosia artemisiifolia* (Asteraceae), a wind-pollinated annual plant native to North America, was accidentally introduced to Europe in the 19th century. Because of its negative impact on human health, agriculture and biological diversity it is nowadays considered as one of the most dangerous European weeds. Further spread of this species is highly likely, supported by ongoing climatic changes and increasing propagule pressure generated by the rapid increase in abundance in a wider area of central Europe. From the Czech Republic it has been known since 1883, first brought in with cereal crops and clover seed, later also with oil plants, mainly soya beans, feeding mixtures, wool and ship ballast from river transport. Up to the 1990s it was reported from ~80 localities, a number that increased to more than 280 currently known. We analyse the actual distribution of *Ambrosia* with regard to distribution pathways and environmental factors such as climate and soil quality. The preliminary results indicate that the most powerful predictors are the proximity of railway, and warm climate; the localities are most frequent in the warmest parts of the country. This affinity to the warmest regions accords with the physiological mechanism of pronounced decrease in the development rate of seedlings under low temperatures, which probably results in a decreased competitiveness of plants growing in cold climates. The other factor related to distribution, railway, acts as a vector spreading seed that are delivered to suitable environment – spraying of railway areas with herbicides reduces competition from other species and provides space for establishment in vegetation with low cover.

Biomorphology of *Caragana arborescens* Lam. an Invasive Species for European Russia

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Caragana arborescens Lam. (Fabaceae) has invaded native ecosystems in Central Russia since 2005. An analysis of 34 morphobiological characters in naturalizing plants was carried out. Micromorphological characters of flowers at different stages of development are described for typical plants and two cultivars (f. *pendula* and f. *lorbergii*), and in addition for the cultivated *C. laeta*. The pollen fertility is defined. The fructification of 6 taxa (*C. arborescens*, *C. arborescens* f. *pendula*, *C. manshurica*, *C. ussuriensis*, *C. frutex,C. laeta*) was studied too. The size of fruits is the most stable character for *C. arborescens*, the number of fruits on a shoot is more variable, and the number of seeds in a fruit is the most variable. For *C. arborescens* variability in shape and color of seeds is revealed. A number of characters in which potentially invasive *C. arborescens* has a competitive superiority over closely related taxa is revealed. It has a higher number of fruits and seeds, higher pollen fertility (96%), and it is a widely-cultivated shrub.

Leaves of *C. arborescens* contain flavonoids: rutin (0,40–0,55%), kaempferol (0,34–0,48%), quercetin (0,15–0,24%), quercetin-3-O-glycoside (0,45–0,70%), kaempferol-3-O-glycoside (0,30–0,45%) and luteolin-3-O-glucoside (0,20–0,32%). In the inflorescences quercetin-3-O-glucoside (0,30–0,54%), luteolin-3-O-glucoside (0,24–0,30%) diosmetin-3-O-glucoside (0,35–0,42%), apigenin-3-O-glycoside (0,35–0,55%), akatsetin-3-O-glycoside (0,15–0,27%) are present. Leaves and inflorescences appears to be drives of Zn and Ni, and the concentrations of Ca, Mg, Fe, Cu do not exceed the reference values specific to plants of Central Russia. A correlation between the amount of flavonoids and concentration of Fe ($r_{0.95}$=0,85) и Mg ($r_{0.95}$=0,81) was found. Therefore, *C. arborescens* can presumably be used as a medicinal plant enriched with organic silicon and flavonoid complex.

Keywords: *Caragana arborescens,* biomorophology, fructification, flavonoids, microelements

Invasion of *Lupinus arboreus* and *L. polyphyllus* in Native Ecosystems of New Zealand

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Invasive populations of *L. arboreus* Sims on the Southern Island (New Zealand) are observed. A list of dominant species (both native and alien) growing near *L. arboreus* on sandy dunes of the East Coast is given. Unfortunately, native species are represented here by only a few taxa: *Desmoschoenus spiralis*, *Coprosma repens, Myoporum laetum*. However, alien species are growing in masses: *Carpobrotus edulis*, *Senecio elegans*, *Ammophila arenaria* , *Anisantha diandra*, *Leymus* sp., *Arctotis* sp., *Banksia integrifolia* etc.

Both, *L. polyphyllus* Lindl. and *L. arboreus,* have a similar number of leaflets with glabrous upper side. The diagnostic features are the following: width of leaflets (in *L.arboreus* leaves three times narrower and folded along the midrib) and the leaf pubescence (the number of hairs in *L. arboreus* three times higher, and the hairs themselves half as long).

A comparative analysis of the stomata on *L.arboreus* and *L.polyphyllus* growing in similar ecological conditions was carried out. Stomatal ratio of *L.polyphyllus* is 1:3-4, of *L.arboreus* – 1:1. In New Zealand, *L. arboreus* blooms in early October, 2 weeks earlier than *L. polyphyllus*. Unlike *L. polyphyllus*, *L. arboreus* has only yellow flowers, its wings are accreted and larger, and the keel's edge has a "fringe" of long hairs, delaying pollen.

Micromorphological characters of flowers at different development stages for *L. arboreus* & *L. polyphyllus* are described. Flowers of both investigated species possess two types of stamens that release pollen non-simultaneously. When the stamens with large oblong anthers cease releasing pollen, androecial tubes, carrying smaller rounded anthers, begin to grow. They exceed the length of the "old" stamens by 1.5 times, and the flower releases pollen repeatedly.

Seed efficiency and seed's morphometric parameters on *L. arboreus* are defined. Unlike *L. polyphyllus,* having 2 morphotypes of seeds - with marble pattern and dark brown-colored, *L. arboreus* has black seeds without any pattern.

This work was supported by the Russian Foundation for Basic Research, grant no.12-04-00965.

Keywords: *Lupinus*, New Zealand, invasive species, flower morphology, stomata.

Early Warning in Belgium – Waarnemingen.be as an Early-Detection Tool

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Rapid detection of potentially harmful invasive alien species (IAS) is essential to avoid future invasions and management costs. Until recently, the Flemish region (Flanders, Northern Belgium) - and by extension Belgium - had no dedicated portal for reporting observations of such species, despite the high political priority and ongoing current (inter) national initiatives. In 2011, the Agency for Nature and Forest and the Institute for Nature and Forest Research initiated a pilot. For some notorious IAS, an early warning system was launched through the widely used online recording platform www.waarnemingen.be. The system is primarily targeted towards naturalist observers. This was done in cooperation with all Belgian regions and the major non-governmental organisations in the field of nature conservation. The system allows for reporting sightings, consulting fact sheets and setting up user-driven automated e-mail alerts. The aim of the pilot phase (March-November 2012) was to examine how the system could work (which species are picked up, potential reporting bias, data quality). Apart from testing the reporting tool as an early warning system, the project had several spin-offs. In the longer run, we aimed at mobilizing volunteers for monitoring IAS. We also wanted to provide information and raise awareness amongst field workers and the public. Eventually, we hope to streamline the process from reporting to management intervention. The ultimate goal is to have an early warning system for IAS in Flanders (northern Belgium) that connects with federal initiatives and anticipates developments of a trans-European system. The current system is already being used for various rapid response projects in Flanders, including control of invasive aquatic plants such as floating pennywort *Hydrocotyle ranunculoides*, water primrose *Ludwigia grandiflora*, Parrot's feather *Myriophyllum aquaticum*, ruddy duck *Oxyura jamaicensis*, Pallas' squirrel *Callosciurus erythreaus*, quarantine insects, American bullfrog *Lithobates catesbeianus*, giant hogweed *Heracleum mantegazzianum* and Chinese muntjac *Muntiacus reevesi*.

Keywords: prevention; early warning; rapid response; citizen science

Alpha-shapes: A Flexible Profile-Type Technique for Delimiting Climatic Suitability for Non-Native Species

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Statistical techniques which relate the species distributions with environmental data are commonly applied to predict where introduced species may become established. Because species absences can be caused by factors other than an unsuitable environment (e.g. biological enemies), the techniques that discriminate between occupied and unoccupied environments are likely to underestimate potential ranges. However, the techniques that "envelope" the occupied environments (i.e. profile techniques) usually rely on simple convex estimators (e.g. elliptical or rectangular shapes), which tend to overestimate these ranges. Here we describe alpha-shapes, a profile-type technique, that relaxes the assumption of convexity. We use native range data for the invasive *Xenopus laevis* (African clawed frog), to demonstrate how this technique can be used to model climatic envelopes of variable complexity. We compared predictions from an envelope maximizing discrimination between presences and absences, an envelope tightly enclosing all occupied climatic combinations (i.e. the minimum bounding envelope) and an "expert-based" generalization of the previous. Finally, we also show how this technique can be used to identify climatic combinations that are outside the climatic space of the study area (i.e. non-analog climates).

Keywords: alpha-shapes; climatic suitability; presence-only; risk assessment; *Xenopus laevis*

Traits of European Terrestrial Gastropods are Correlated to the Climates Occupied in Non-Native Ranges

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Anticipating the propensity of species to persist under climatic conditions other than their native region is important in assessing the uncertainty of climate-matching as predictor of potential ranges for non-native species. Here we use data from 27 European terrestrial gastropods (slugs and snails) that are established in new regions. The objective is to investigate the degree of climate match between native and non-native ranges and the diversity of novel climates occupied. We then tested a set of ecological, bio-geographical and biological traits as predictors of the patterns found. Based on a principal components analysis and convex-hull envelopes, we found that about half of the species had a large proportion (>25%) of non-native occurrences in novel climates. Generalized estimating equations revealed that climate mismatch was significantly higher for species with narrow native climatic niches, native ranges elongated in a north–south direction or native ranges with the southern limit at lower latitudes. We also found that slugs were occupying a higher diversity of novel climates than snails. These results indicate that the accuracy of climate-matching is largely dictated by the levels of distributional equilibrium of species in their native ranges. In addition, coarse-scale predictions for species that are able to take advantage of microclimatic variability – as appears to be the case with slugs – may also be challenging. Altogether, these results show that the analysis of species traits can be useful for understanding uncertainties in climate-matching exercises for non-native species.

Keywords: climate matching; niche conservatism; risk assessment; species traits; terrestrial gastropods

GLOBAL WARNING: A new COST Action About Tree Nurseries as Early Warning System Against Alien Pests

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The international trade in live plants is a major pathway for the introduction of invasive tree pests and pathogens, resulting in environmental and economic damage. Many recently introduced pests and diseases were not known to be harmful, or unknown to science, and were not regulated before they invaded. This indicates that the current system to identify harmful species does not provide sufficient protection from invasions by alien pests and pathogens. A novel way of identifying potentially harmful organisms for regulation is by monitoring European trees planted in regions that export plants to Europe. However, the most effective way of doing so and using exchanging the results of monitoring efforts is through international collaboration. The recently approved COST Action "Global Warning" (FP1401) aims to 1) establish a global network of scientists and regulators in countries where sentinel nurseries could be established from seed, or where there are botanical gardens or arboreta with exotic trees, 2) develop common protocols for the monitoring and identification of pests, and 3) explore ways to regulate the establishment of such nurseries and the use of data collected through them. This Action will also bring together detailed information about the international trade in trees and the environmental value of native trees in Europe

Keywords: Potentially invasive alien species, forest pests and pathogens, international trade in live plants, early warning system

Risk Analysis Invasion of Ten Alien Species in Venezuela

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Biological invasions are a recognized threat to global biodiversity. The invasion management is considered a challenge because, after a species invades, its control is costly and inefficient. Therefore, many efforts have been directed to the development of tools to prevent future invasions as Risk Analysis (RA). The I3N tool promises to be a useful methodology of AR for Neo-tropical region. This tool allows you to categorize species according to: i) its potential for establishment and invasion, ii) the impacts iii) the likelihood of achieving successful control. Our objective was to evaluate the applicability and accuracy of the I3N tool for predicting the risk of invasion by exotic plants in Venezuela. I3N apply the tool and categorize the risk level of ten invasive species (*Azadirachta indica, Calotropis procera, Hyparrhenia rufa, Kalanchoe daigremontiana, Leucaena leucocephala, Melinis minutiflora, Pteridium arachnoideum, Salsola kali, Stapelia gigantea* and *Tithonia diversifolia*) introduced in Venezuela having distribution, abundance and impact variables. Later, we compared this categorization with estimated impact on native richness obtained in the field. From this comparison, we concluded that *M. minutiflora, P. arachnoideum, K. daigremontiana, L. leucocephala* and *S. kali* had the highest impact values according to I3N tool and also generated the greatest impact on species richness estimated. *K. daigremontiana, H. rufa* and *T. diversifolia* had the highest risk of invasion as the RA. Although, *T. diversifolia* and *H. rufa* had the high risk of invasionbut did not had high impact according AR and the estimatiton in the field. In conclusion, our results suggest that the tool I3N categorized as high risk species to those that generate the greatest impact in the field, also this tool in no case was categorized as low-risk species to species generated high impact in the field.

Keywords: tool I3N, invasive plants, control

Seed Morphology: Useful Character for Screening for Invasive Cacti

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All but one of the more than 1900 species in the cactus family (*Cactaceae*) are endemic to the Americas. As a result of their beauty cactus species were already introduced to Europe on the return trip from the first voyage to the Americas in the fifteenth century. Ever since, they have fascinated botanists, plant enthusiasts and collectors. Today, species of *Cactaceae* can be found all over the world and several species have become invasive.
Horticulture has increased greatly in importance as a pathway of introduction for new cactus species worldwide and is virtually the only pathway for the global movement of cacti today. Hundreds of new ornamental cacti are being introduced by seeds outside their native range every year. Reliable ways of identifying invasive taxa are urgently needed.
We studied the seed morphology of 293 cactus species to determine its significance as an invasive character. Seeds were obtained from nurseries in the Netherlands, Spain and Germany. The seed collection represents about 57 cactus genera and provides a good representation of cactus species in the international ornamental trade.
A significant variation was observed in seed morphology (form, colour, brilliance, surface, size, and weight). The seeds of cactus species known to be invasive worldwide fit into a basic type characterized by a light brown colour, large size, rounded shape, rough surface and large mass. Some exceptions do exist.
Overall, seed morphology seems to be a good character to use in screening cacti for invasiveness.

Keywords: biosecurity; *Cactaceae*; seed morphology; ornamental trade

Sentinel Plants to Prevent Biological Invasions

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During the past century, non-indigenous plants pests have been introduced at increasing rates into Europe. A growing number of these species are becoming invasive and contribute to decline in native species diversity, cause changes in ecosystem function, and pose cumulative direct economic impacts. Most alien and invasive pests of trees were not known to be harmful prior to their establishment, making prevention of their introduction and mitigation of impacts difficult. Developing tools to identify pests before they arrive is expected to significantly advance the science and technology of ecological forecasting and risk assessment. We explored the use of 'sentinel' plants, plants surveyed for the presence of damaging pests and pathogens, in China as an early warning system for new and emerging tree pests in Europe. Depending on the native range of sentinel trees, the results provide information on the potential impact on native trees in the importing country, or the likelihood that the pest enters the pathway towards this country.
The sentinel trees strategy has been used to identify Asian fungi pathogenic to European trees, research done within the EU projects PRATIQUE, and fungi pathogenic to Asian species most frequently imported into Europe, research done within the project ISEFOR and the COST Action PERMIT. Plots with sentinel trees were established in Fujian province and close to Beijing, China, using healthy imported seedlings of European broadleaved and conifer species or using seedlings of five Asian broadleaved species that are commonly exported to Europe. The fungal assemblage associated to specific symptoms was studied using traditional methods, isolation on synthetic media, and a molecular approach, 454-NGS analysis. The results will be reported and the differences between the approaches using European and Asian trees discussed.

Keywords: alien species, bioinvasion, pathway risk assessment

Riparian Invasion by Japanese Knotweed *s.l.* – Preliminary Findings for Serbia

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Japanese knotweed [*Fallopia japonica* var. *japonica* (Houtt.) Ronse Decraene], giant knotweed [*Fallopia sachalinensis* (F. Schmidt) Ronse Decraene] and their hybrid *Fallopia* × *bohemica* (Chrtek & Chrtková) J.P. Bailey present a serious threat to native biodiversity, especially in riparian habitats.

Due to their well-known tendency to spread along watercourses, an extensive field survey was carried out along the rivers in Serbia, during the summer/autumn period of 2013, aiming to assess the nature of *Fallopia* spp. riparian invasion. Field surveys were conducted along 500 m long stretches of riverbanks, in accordance with the RHS (River Habitat Survey method) river stretches. Mapping was done using the GPS positioning method and data was subsequently georeferenced using DIVA-GIS software.

Out of 148 river stretches examined, the presence of *Fallopia* spp. was confirmed along the course of 32.14 % of the rivers (8.78 % of river stretches). These results suggest that the majority of rivers in Serbia are still not dangerously invaded by *Fallopia* spp. However, due to the high propagule pressure potential and the fact that the propagation of these species along rivers is reinforced by water flow and seasonal flooding, the further spread of *Fallopia* spp. invasion is expected. Therefore, research efforts in the following years will be focused on the determination of the potential pathways of its subsequent spread.

Keywords: Japanese Knotweed *s.l.*; *Fallopia* spp.; invasion; riparian habitats; Serbia

Acknowledgement: The authors acknowledge the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Projects No. TR 31018, TR 31043, III 43002).

A Catalogue of Non-native Plants for the Island of Rhodes (Greece)

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Rhodes is the largest of the islands of the Dodecanese. It extends from northeast to southwest, between 35° 52' and 36° 27' N lat. With regard to the most recent history, the Italian colonisation promoted land reclamation, agricultural reform and new urban schemes called “Garden Cities”, the introduction and use of ornamental species and the cultivation of several others. The first studies on the flora and vegetation of the island date back to this period and were continued only later in the 80’s by Carlström, by Boratynska and more recently by Hassler and Kleinsteuber & Ristow. All the available literature was taken into consideration for the dedicated data-base. GPS surveys were done in the years 2004 and 2014, with the purpose to assess the persistence of the alien species reported in the literature and to grid-map (10 x 10 km) the distribution of the most common species (i.e., *Ricinus communis*, *Oxalis pes-caprae*, *Arundo donax*, *Carpobrotus* spp.). We present a list of 190 alien species with details to the period of the first occurrence, the area of origin, the invasive status, the introduction pathway and for the most common ones the grid frequency.

Keywords: alien flora; Mediterranean islands; grid mapping

First Record of *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae) in Romania

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The spotted wing Drosophila, *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae, EPPO A2 List) is one of the important invasive species which became a serious threat for fruits production in many countries from Europe. The paper represents the first record on the presence of *D. suzukii* in Romania. Adults of this species were captured in the Tephri traps set up on wild blackberry bushes in the Bucharest city area (Southern Romania) within the framework of a fruit fly trapping program conducted in various fruit trees orchards and small fruit crops in Romania in 2013. Capturing data revealed the fact that the activity of *D. suzuki* started at the beginning of September. Our finding provides important information which can be used for drawing the spreading area in Europe for this species.
Considering the high potential of *D. suzuki* for fruits infestation, we turn our attention to increase the surveillance of pest by trapping in order to estimate its presence and find the most appropriate pest management possibilities needed to reduce losses in yield and quality fruit resulting from insect feeding.

Keywords: invasive species, Drosophila suzukii, Romania

New Potential Pest Species Previously Considered Rare in the Romanian Fauna: *Semanotus russicus (*Coleoptera, Cerambycidae) and *Ovalisia festiva* (Coleoptera, Buprestidae)

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Recently, two species of Coleoptera considered very rare in the Romanian fauna *Semanotus russicus* (Fabricius, 1776) and *Ovalisia (Palmar) festiva* (Linnaeus, 1767) have been reported as harmful species in three cases of *Cupressaceae* nursery attacks.
Semanotus russicus is a rare species in Romania. It ranges in South-East and Central Europe, North Africa, Near East, Transcaucasia. Up to present study most of previous records of *S. russicus* in the Romanian fauna are old (1950-1959). In 2013 we recorded *S. russicus* on *Tuja* shrubs from nursery Baneasa (Ilfov) and in 2014 in Pipera (Ilfov County). The attack of *Tuja* by *Semanotus* was characterised by a long dry and warm aestival season.
Another xerothermic species, considered so far as very rare in the Romanian fauna, *Ovalisia festiva* was detected by us in 2014 in Moara Domneasca (Ilfov) causing significant damages on cultivated *Tuja*. This species was also considered a very rare species in Central Europe and a bit more frequent in South Europe and Asia Minor. Description of species and their attack as well as possibilities to monitor and control them are presented in the paper.

Key words: rare species, *Semanotus russicus*, *Ovalisia festiva*, *Tuja,* Romania

Does Heterogeneity of Habitats/Landcover Reflects on the Composition of Grime CSR Strategies of Invasive Plants Across Different Landscape Scales?

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We have studied the composition of Grime CSR strategies among invasive flora of Croatia, across three different spatial resolutions spanning from 10 km grid to NATURA2000 biogeographical regions. Altogether, over 11.000 distributional records of 57 invasive plants in Croatia were taken from the Flora Croatica Database, while Corine Land Cover and Habitat map of Croatia were used as thematic maps for calculating landscape metrics. The relationship between CSR strategies (converted into "C", "S" and "R" values) and the level of habitat/landcover heterogeneity was analysed, as well as possible correlation between CSR strategies and shares of different landcover/habitat types within basic spatial units. The largest proportion of R-strategists and the highest heterogeneity was found in the Mediterranean region, while the largest proportion of C-strategists and the lowest heterogeneity was found in the Alpine region. When converted into "C", "S" and "R" values, "C" was found positively and "R" negatively correlated with several landscape indices, while "S" was without any significant correlations at middle-scale spatial resolution. However, on a finest spatial resolution there were almost no significant correlations. The shares of landcover/habitat types within spatial units (excluding the biogeographical resolution) did not yield any significant correlation with CSR strategies for landcover at 10 km spatial resolution, while for habitats, as well as for landcover and habitats at medium spatial resolution (i.e. spatial overlap of counties and biogeographical regions) there was a negative correlation of C-strategists with natural vegetation and positive with portion of agricultural land (excluding grasslands). At finest spatial scale (i.e. 10 km grid), S-strategists were found positively correlated with grasslands, and negatively correlated with agricultural areas. Landscape pattern has a potential in explaining the composition of CSR strategies of invasive plants, but to obtain clearer results on finer spatial resolutions, distributional data should be collected systematically for this purpose.

Keywords: biogeographical regions; Croatia; NATURA2000; habitats; Corine Land Cover

Potential Distribution of the Invasive Weed Bermuda Buttercup (*Oxalis pes-caprae* L.) in Izmir

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The Bermuda buttercup (*Oxalis pes-caprae* L.) is a weed of significant importance in many Mediterranean countries. The frequency of this weed was determined in fields of ornamental plants in Karaburun which is a place located in western part of Turkey. Weed surveys were conducted in a total of 38 narcissus fields which covered an area of 40 hectares in 2014. According to results in survey, density of this weed was 115 plants m^{-2} in fields of narcissus. *O. pes-caprae* was found to have high reproduction capacity. Each year, the weed develops a dozen bulbs. Hence, it may be a major problem weed in the future in important horticultural areas. Among the management practices, the most important is to use fermented farmyard manure. Clean cultivation should be done by using clean (free of weed seeds) tillage equipments. Further, field contamination with weeds seed through irrigation water must be avoided. After processing of tillage, the *O. pes-caprae* bulbs must be removed from the field.

Keywords: *Oxalis pes-caprae* L., weed, invasive species.

The Status of Some Alien Plant Species and Invertebrates in Romania

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The paper is the result of author's observations during the period 2005-2014 in the natural ecosystems, orchards, vineyards plantations, field crops and greenhouses. The study is reffer also of the two case studies of main invasive alien species of insect, accidentally introduced in Romania.
The alien plant species listed from different natural and anthropic ecosystems count 435 species but the invasive status of many of them are unclear and controversial. The data from 2000 report up to 11.5% the percent of species with alien origin in Romanian flora but new alien species are continuously reported, further increasing the number of non-native taxa in the national flora.
Our observations regarding the invertebrates species investigated in the mentioned period had listed 22 species belonging to Nematoda and Acarina class. The structure of Insecta belonging to 9 orders listed 118 species, a number of 85 species are pests, 5 are vector and household species and 8 are beneficial species (parasitoid, predator, pollinator or silk production worms).
Regarding to the risk assessment measures at the national level, the existing measures are insufficient, with limited purpose and sectorial. The measures had a low level of awareness of the general public and therefore the opposition by civil society to the Government Administration interventions (which are lack in essence). There is an extremely low degree of accessibility of scientific information, particularly in connection with the identification of species, risk analysis, etc.; the absence of a priority approach to invasive species control actions; introduction of invasive species without restriction by-mail-path often as inadequate measures of inspection and quarantine; inadequate monitoring capacity and lack of effective emergency measures; outdated or inadequate legislation and finally poor coordination between government agencies, local authorities and local communities.

Keywords: alien invasive species, pathways of introduction, risk analysis, risk assessment

North-American Alien Invasive Insect Species – a Case Study of Distribution, Impact and Risk Management for *Metcalfa pruinosa* Say (Homoptera: Flatidae) in Romania

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The North American continent is the origin area of the most alien invasive insect species in Europe, respectively in Romania. More than 5-6 species represent the main insect pest for field crops, trees, orchards and vineyards, and many economically costs are annually involved against their attacks. This presentation shows the introduction pathways and the main drivers which favored those biological invasions.
The aim of this research is a case study of a relatively recent invasion from the point of view of the impact assessment, distribution, and host species range in the guild establishment for the Romanian climatic conditions.
The main objective of this study was to investigate: a) the spreading area of distribution for the invasive species *Metcalfa pruinosa* Say from the second point of its introduction in Romania, around Bucharest, b) the host plants attacked, and c) the spreading pathways. The investigations were carried out by direct observations in the mentioned ecosystems, looking forward to identify the host plants and the degree of the attack on the different parts of the plants.
The preliminary results obtained showed a very rapid progress of the invasion to the north-east part of Bucharest. The invasive species *Metcalfa pruinosa* was detected on 225 plant species (spontaneous and cultivated), and the attack intensity was set for four degrees: 0 (lack of presence), presence, moderate attack and strong attack. In conclusion, in the period 2011-2014 it was agreed that *Metcalfa pruinosa* is a new pest species in the ecological crops of *Ribes nigrum* L., and in the case of 13 plant species from a total of 225, the attack degree increased, especially in the last year of investigations.

Keywords: alien invasive species, *Metcalfa pruinosa* Say, risk management

Alien Plants of the City of Zadar (Dalmatia, Croatia)

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In the flora of the researched area of Zadar, 885 species and subspecies of vascular plants have been registered. The most represented families are *Asteraceae* s.l. (12.42%), *Poaceae* (11.30%) and *Fabaceae* (10.28%). Therophytes are prevailing among life forms (44.63%), and among floral elements these are plants of the Mediterranean region (33.79%). The proportion of alien plants is significant (16.50%) especially neophytes (11.43%) of which there are 15 new ones for the flora of Croatia. The majority of alien taxa originates from America (44.52%) and Asia (25.34%), and according to the invasive status, casual plants are predominating (72.38%). The parallel analysis of the flora of Zadar in four investigated zones and 15 quadrants (1 km^2) showed that the presence of therophytes and neophytes is increasing with human influence while the presence of Mediterranean plants is decreasing. In relation to the flora of the 19th century the significant increase in the presence of neophytes in today's flora of Zadar is observed (2.76% vs. 11.86) as well as therophytes (38.48% vs. 44.63%).

Keywords: Alien plants, neophytes, city of Zadar, Croatia

Biological Characteristics of Common Ragweed (Ambrosia artemisiifolia) – the Most Dangerous Weed in Hungary

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Common ragweed (*Ambrosia artemisiifolia)* is one of the most dangerous weed species in Europe and especially in Hungary. Common ragweed came from America to Europe and from southern countries to Hungary. It became common and the most important arable weed since 1969, which has strong human allergenic effect.

The successful control of this species is determined by its biological characteristics. Common ragweed is summer annual weed with moderate growth. The average seed production is 3000, but on a solitary plant may reach 62000. Seeds are in primary dormancy in autumn for 6-12 weeks. Primary dormancy finishes in January and changes to induced dormancy. Seed germination starts when temperature of soil surface is above 5°C continuously. 60% of the seeds germinate in spring and 40% in summer and autumn from the 0-6.5 centimetre soil layer, but the bulk of seeds germinate from 2.6-3 centimetre depth. Seeds can save their germination ability on the surface for 4 years, while the seeds in deeper soil layer may fit for life until 40 years.

Ambrosia artemisiifolia can be found on all soil types, but it is multitudinous on brown forest soil and loose sandy soil.

We can control common ragweed with using integrated weed management methods, considering biological characteristics of plant.

Keywords: Common ragweed, *Ambrosia artemisiifolia,* germination, soil type

Common Millet (*Panicum miliaceum*) - a New Weed Problem in Maize in Hungary

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Common millet (*Panicum miliaceum*) is one of the oldest cultivated plants, which is known worldwide. It has spread from China into all over the world. It is a crop plant, but it became a dangerous weed mainly on maize fields.
The quick spreading of millet is for various reasons. *Panicum miliaceum* is a C_4-type plant, so it is able to product a large biomass. It germinates also under stress conditions, so climate change and the global warming played a great part in rapid spreading of millet. *Panicum miliaceum* favours hot temperature for germination and tolerates drought. Seeds can germinate shortly after maize, so can competes successfully with maize. Maize was growth mainly in monoculture in Hungary from 1960-1990, and we used chloro-amino-triazines especially atrazine for weed control. Millet is tolerant to these herbicides, so this method contributed the rapid spread.
The cover of *Panicum* increases continuously in maize based on the fifth national weed survey. It is on seventh place in the dominance row of weeds with 1.44 % cover. When infestation level is above 3% in the field, this weed can causes considerable yield loss.

Keywords: Common millet, *Panicum miliaceum*, maize, spreading

Reproductive Capacity of Invasive Weed Species *Asclepias syriaca* L. in Serbia, Bačka Region

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Invasive weed species *Asclepias syriaca* L. (Common milkweed) was probably introduced to southern Serbia from Hungary and was afterwards registered in almost the entire area of Bačka region, northern part of Banat, along the Danube River and other rivers. Common milkweed mostly spreads on ruderal areas. However, it has also been registered in wheat, barley, maize and other crops. The aim of the study was to determine the reproductive capacity of Common milkweed on the territory of Bačka region.

During 2013 samples from 12 localities in Bačka region were obtained. Sampling involved populations of the weed species present in uncultivated meadows, areas by canals and forest ecosystems. Number of stands per $1m^2$, number of capsules per stand, as well as the number of seeds per capsule was determined for each population. Weed seed bank was determined at the depths of 0.0-5.0 and 5-10 cm. Germination of seeds separated from soil and fresh seeds after a one-month vernalization under controlled conditions was also measured. The highest average stand density was recorded at sunny locations in ruderal habitats, such as uncultivated meadows and areas nearby fields and roads (10 plants per $1m^2$). The highest percentage of stands with ripe fruits, in respect to total number of stands per $1m^2$, was recorded in populations, which developed under conditions of partial or full shadow, where, on average, 90% was fruitful. The lowest percentage of fruitful plants (70% on average) was recorded in populations on flooded terrain, as well as the lowest average number of capsules per plant. The weakest seed production per capsule was found in populations on sunny terrain, while the strongest production of shrivelled seeds was found in forest ecosystems. Small amount of non-germinating seeds was separated from soil. Fresh seeds from all localities expressed high germination energy after vernalization, with an average germination value of 93%.

Keywords: *Asclepias syriaca* L., invasive weeds, seed germination, weed seed bank

Temporal and Spatial Scales of Impacts of Alien Species on the Zoobenthos in the Black Sea.

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The macrozoobenthic fauna of the Black Sea includes about 800 species by different estimations of experts. The bottom fauna is formed at the expense of Mediterranean (mainly) and Pontian (relic) complexes of benthic species. Mediterranean species which can withstand salinity less than 19-ppm, were settled across all the Black Sea. The relic fauna (Pontic) remained in water areas with very low salinity. 49 invasive alien species which have overcome the geographical barriers, have been recorded in the Black Sea within the last 100 years alone. The alien species are euryhaline benthic animals mainly. The time trend of settling in the Black Sea is characterised by an increase in the number of benthic invasive species in the second half of the 20th century.

High eutrophication and hypoxia in the 1980s was a deterrent to invasion of new alien species on large areas in the north-western Black Sea. At the same time, two species of the invader-clam, *Mya arenaria* and *Anadara inaequivalvis*, formed the new independent benthic communities in some parts of the Black Sea in this period. The areal of the mollusk *Anadara inaequivalvis* expanded in the early 21st century with the rise in temperature of the upper layer of the sea. Besides these two alien species, the mollusk *Rapana venosa* and the polychaete *Ficopomatus enigmaticus* had a significant influence on the structure of benthic and fouling communities of zoobenthos. Influence of other invasive alien species had local character on the benthic communities of the Black Sea shelf.

Main transit corridor for the introduction of alien species is the Mediterranean and the Marmara Sea. There are exceptions when the first registration of introduction of alien species has been observed off the coast of the Caucasus and on the northwestern shelf of the Black Sea.

Key words: alien zoobenthos, scale invasive, Black Sea

Galinsoga ciliata (RAF.) S.F. Blake Invasion in Arable Areas in Bozdağ District (İzmir, Turkey)

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In survey studies carried out in 2013,in Izmir Province Bozdag County Gundogan province the occurence and density of, Compositae family (*Galinsoga ciliata* (Raf.) S.F. ciliate dicotyledonous weeds was determined. During the surveys it was determined that the above mentioned *G. ciliata* (Raf.) SF blake weed has become a serious problem in about 50 hektars of the total 200 hectars of the province and it has been seen that it was speading quickly and already infected parts of Gundalan and Cavdar springs,with its ability to supress the other other weed species it has become a major problem in the main potatoes, cabbage, cauliflower, broccoli, lettuce and beans fields.

Measurements carried out in 1m2 areas in potatoes, cabbage, cauliflower, broccoli, lettuce and bean plantations showed average of 215.2 in sprouts,184.8 in beans,126 in lettuce ,129.7 in kinds of curly,47.14 in broccoli and 91.5 presence of the above mentioned weed species.

Being an annual, herbaceous plant *G. ciliata* (Raf.) SF Blake can create many seeds and the seeds can retain viability in the soil for many years. Seeds are of small and portable structure which further fasilitites their spread by the wind . Also forming of plant roots by the parts of plant that has contact with the soil further increases their density. *G. ciliata* (Raf.) S. F. Blake like other weed species,creating competes with crop plants affecting the yield and quality, particularly irrigation helps the weed to grow very fast and suppress crop plants , as a result, invades locations.

Primirally control measurements for this weed species includes pcultural methods aiming prevention of contamination. For this reason the seed matearial and seedlings must be weed seed free,the farm manure used must be well fermented,the soil treatment equipment must be clean and also the transport of weed material from field to filed by irrigation water must be controlled.Mechanical control such as hand-pulling and hoeing and removing of weeds from fields before seed dispersal by cutting or hoeing must be implemented.

Keywords: *Galinsoga ciliata* (RAF.) S.F. Blake, weed control, competition, invasive species

A Preliminary Checklist of the Alien Flora of Turkey

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With about 12,000 species, the flora of Turkey is the richest in Europe and it is also richer than that of neighbouring countries. In addition, nearly one in every three plants is endemic, a surprisingly high percentage for a mainland country. It can be predicted that the main drivers of this rich native plant diversity, such as variation in climate, topographical diversity, presence of aquatic habitats, variation in altitudinal range, in addition to human intervention (with voluntary and accidental introductions), could also promote the presence of a high number of alien species. So far, the main contribution to the alien flora of Turkey was related to the DAISIE project. DAISIE had the objective of "creating an inventory of invasive species that threaten European terrestrial, freshwater and marine environments". The plant section of the DAISIE database is based on national checklists from 48 European countries, including some regions or islands, and Israel. The DAISIE project reported only 220 taxa for Turkey, which should be considered an underestimation of the real situation. It should be taken into account that DAISIE included mainly the European part of Turkey, which represents about 3% of the Turkish territory.
With the aim to update the DAISIE database and produce a preliminary inventory of alien plants for Turkey, as a basis for further research and management actions, we have screened all the main available literature on alien plants in Turkey. We took into account primarily the Flora of Turkey and the East Aegean Islands (volumes I-XI), and updated this first list with the many records occurring (mainly after 2000) that have been published in the Turkish Journal of Botany and elsewhere. We present herewith the preliminary checklist resulting from this analysis.

Keywords: alien flora; floristic data-base

The Invasion History, Distribution and Colour Pattern Forms of the Harlequin Ladybird Beetle *Harmonia axyridis* (Pall.) (Coleoptera, Coccinellidae) in Slovakia, Central Europe

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Native to Asia, the harlequin ladybird *Harmonia axyridis* (Coleoptera, Coccinellidae), is one of the most widely distributed coccinellid in Europe, where it was introduced as a biological control agent of aphids and coccids. We report the first record of the predatory coccinellid in 2008 (Coleoptera, Coccinellidae), when it spread to Slovakia from neighbouring countries. Since then *H. axyridis* has spread at the rate 200 km year^{-1} and has successfully established across the country. Reports of observations of the exotic invader in 2008 – 2012 are mapped. The colour forms of the sampled individuals were recorded. The non-melanic colour form f. *succinea* was dominant. In 2012, five years after arrival of this invasive alien ladybird in Slovakia, *H. axyridis* is distributed at altitude from 98 to 1,250 m and occurs in various habitats, mostly in the urban areas or orchards with fruit trees. This study provides further evidence of invasion by *H. axyridis* within Europe. Indeed, the noticeable spread of *H. axyridis* around the world demonstrates the success of this invader. The opportunity to increase our understanding of the ecology of *H. axyridis* is critical for ensuring lessons are learnt from this invasion process.

Keyworlds harlequin ladybird, biological control, non-native species, spread, *Harmonia axyridis*

Occurrence of the Harlequin Ladybird *Harmonia Axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) in Bulgaria – Five Years After Its Introduction

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The multi-coloured Asian lady beetle, or harlequin ladybird, *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) has spread in Europe at a very fast rate occupying different habitats and is regarded as species that may have strong negative effects on biodiversity.
Harmonia axyridis was first observed in Sofia in 2008. A rapid spreading of the ladybird in Bulgaria was observed in 2009 and the infestation by *Eucallipterus tiliae* (L.) on *Tilia cordata* Mill. clearly facilitated its natural spread. During the period 2010-2011 the beetle has spread in Bulgaria occupying different habitats but developing exclusively on broadleaved trees heavily infested by aphids.
The beetle is now regarded as established in habitats at altitude lower than 1450 m. More than 50 arthropod species are detected as a prey of the beetle. At present *H. axyridis* is a dominant species in coccinellid complex mainly on woody plants but on crops as sunflower, corn and wheat as well. Population abundance on different plants and food web of *H. axyridis* in Bulgaria are presented.

Keywords: alien, *Harmonia*, food web, distribution

Sex Composition of *Ailanthus altissima* Population in the City of Prague and the Occurrence of and Romonoecious Individuals

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Ailanthus altissima is one of the most serious woody invaders of the urban areas in warmer regions of the Czech Republic. It is often grown as an ornamental tree. In industrial zones and on waste places self-reproductive populations are fully established. We monitored the share of male and female trees in the city of Prague (Czech Republic). In total, 614 mature individuals were examined. 50% of them were male plants with staminate flowers only, 48.5% were female plants bearing pistillate flowers and 1.5% of the trees were bisexual individuals classified as andromonoecious. Those plants were bearing both staminate and hermaphrodite flowers. Hermaphrodite flowers were found in only some inflorescences together with male flowers. Andromonoecious individuals were able to produce both normal pollen grains and germinable fruits. The number of fruits was much lower in bisexual individuals compared to female plants. In some mature bisexual individuals, the fruit production was 5-10 pieces only. Although, the share of *A. altissima* trees with hermaphrodite flowers is relatively low, this trait can help the species to colonise new areas – in some cases only one single plant can established a new population.

Keywords: invasive tree, flowering biology, dioecy, hermaphrodite.

Growth of Three Invasive Weed Species Under Normal and Elevated CO_2

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Growth and invasiveness of weeds may be increased with increasing CO_2 levels in the atmosphere. We evaluated growth of three invasive weed species under normal (~400 ppm) and elevated (~800 ppm) CO_2 in the closed glasshouse chambers. The invasive weed species in the experiment were *Cirsium vulgare* (Savi) Ten., *Hordeum murinum* L. and *Lactuca serriola* L. The invasive weed species responded variably to the increased CO_2 levels. Although, the growth of *C. vulgare* was improved under high CO_2 than the normal CO_2 level, however, the weed had a statistically similar dry weight, fresh weigh, number of leave, plant height and chlorophyll index under both the CO_2 levels. The high CO_2 level significantly improved the growth of *H. murinum* compared with the normal CO_2 level. Hence, *H. murinum* had a significantly higher dry weight, fresh weight, and plant height at higher CO_2 level than the normal CO_2 level, while the chlorophyll index had an unclear trend. For *L. serriola*, high CO_2 increased the fresh weigh and dry weight of the weed, while plant height and number of leave were not affected by either of the CO_2 levels. In conclusion, the increasing atmospheric CO_2 can improve the growth, and hence, invasiveness of the weed species which can ultimately be dangerous for the native species and agricultural crops.

Keywords: Invasive weeds species, carbon dioxide, growth

Acknowledgement: Thanks to TÜBİTAK for supporting Khawar Jabran for this research work.

Comparison of Different Populations of *Impatiens Parviflora* According to Two Types of Multilocus DNA Markers

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In Northern Europe, the invasion of *Impatiens parviflora* started later than in the rest of Europe, which might be related to colder climate conditions. Differences between countries in social infrastructure might also define scope of extension and flourishing of alien species. Sites firstly invaded by *I. parviflora* were city parks and roadsides and only later on this species started to spread to the forest. Such transformations of *I. parviflora* habitat were documented for Lithuania in the middle of the former century. Genetic adaptation is among the traits that increase the probability of invasion. Recently techniques of randomly amplified polymorphic DNA (RAPD) and inter simple sequence repeats (ISSR) were successfully employed for alien populations of such species as *Erigeron annuus*, *Bunias orientalis*, *Medicago sativa* and *Lupinus polyphyllus*. Among Balsaminaceae, the biggest variety of molecular markers, were applied to *Impatiens glandulifera*. Data concerning molecular variance among populations of *I. parviflora* are very pilot in terms of markers employed and scope of analyzed areas, populations, etc. Present study aimed at evaluation of genetic variability of twenty one Lithuania population of *I. parviflora* according to multilocus markers of two types. Areas investigated covered geographical and habitat diversity for *I. parviflora* in this country. Markers selected were related to 4 loci of ISSR and 8 loci of RAPD. Totally 315 individuals were evaluated. RAPD and ISSR analyses revealed that the percentage of polymorphic DNA loci per population ranged respectively from 7 to 39 % and from 11 to 28 %, genetic differentiation between populations was respectively ΦPT=0.790 and 0.760. Genetic distances among populations ranged in the intervals from 0.135 to 0.426 (according to RAPDs) and from 0.083 to 0.405 (according to ISSRs). Results obtained for *I. parviflora* will be discussed in relation to habitat peculiarities.

Keywords: small balsam, *Balsaminaceae*, invasions, alien species, genetic diversity

Disentangling the Sources of Phenotypic Variation in *Ambrosia artemisiifolia* L.: The Role of Seed Traits

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When invading new environments, a plant invader may express new phenotypes as a result of different ecological and genetic processes. It includes phenotypic plasticity, local adaptation, environmental maternal effects, and genetic drift. The quantification of each of these factors is crucial in the study of biological invasions.
Ambrosia artemisiifolia L. invasion success is strongly linked to seed characteristics (dispersal by human activities, long-lived soil seed bank, etc.). Known as an opportunist and a colonizer, the species is often limited by the competition from other plants. In the early stages of development, the seedlings can be quickly outcompeted and a rapid growth is therefore a major advantage.
First, this study aims to analyze the seed traits variation, and to detect an impact of these traits on the early development of the seedling (environmental maternal effect). Second, we aimed to quantify the respective role of phenotypic plasticity, environmental maternal effect, local adaptation and genetic drift on seedlings phenotype.
Variability of seeds from 3 geographical zones (Belgium – Centre of France – South of France) was assessed. We measured the seed variation in mass, length, width, circularity, and pigmentation. Seeds were disposed in growth chamber under two temperature treatments. After two months, we compared seedling phenotypic variation in germination time, height, aboveground biomass, belowground biomass, early competitive performance, and the final leaf area.
We found a high variability of seed traits. Seeds were varying significantly among zones, populations, and parents, with more than 30% of the variation attributable to the mother plant identity.
The main sources of seedling phenotypic variation appeared to be phenotypic plasticity and environmental maternal effect. No genetic differentiation was detected in this study. Seed mass was positively correlated to seedling biomass, early competitive performance, and the final leaf area. The relevance of traits reflecting environmental maternal effect is discussed.
Phenotypic plasticity and seed characteristics appear to play a major role in the invasion success.

Keywords: *Ambrosia artemisiifolia* L.; phenotypic variation; phenotypic plasticity; controlled experiment

Genetic Diversity and Population Structure of Raccoon Dog *(Nyctereutes procyonoides)* in Invaded Areas

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The raccoon dog *Nyctereutes procyonoides* (Gray 1834) is alien species in Europe. *N. procyonoides* had an active introduction and acclimatization in European part of Russia followed by a migration and colonization to neighbouring countries. Eventually, it has rapidly spread into many European countries. Probably, *N. procyonoides*invaded Lithuania from neighbouring countries such as Belarus and Latvia where the species was introduced in 1936 and 1948, respectively. The species has been declared as invasive since 1970. The aim of the present study was to analyze genetic diversity and population structure of *N. procyonoides*in colonized areas in Lithuania using microsatellite markers. A total of 146 *N. procyonoides*individuals were sampled from four locations in Lithuania. Genetic analysis of five microsatellite loci (FH-2054, FH-2010, PEZ-17, REN112I02 and FH-2096) showed high level of polymorphisms. The mean number of alleles per loci ranged from 6 to 15. Mean expected and observed heterozygosities were 0.839 and 0.757, respectively. Analysis of molecular variance (AMOVA) showed that the within-population genetic diversity was rather high (97%), than variation among populations (3%). PCA analysis showed that Lithuanian populations of *N. procyonoides*are heterogeneous. Using Bayesian-based clustering analysis, two genetically distinct groups were detected. Our results showed high genetic diversity of invaded *N. procyonoides*in Lithuania, and have confirmed two genetically distinct origin of founder populations of raccoon dogs from introduction areas in Europe.

Keywords: raccoon dog, genetic diversity, microsatellite, Lithuania

Comparative Impact of Alien and Native Fungal Tree Pathogens on *Pinus pinea*

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Heterobasidion annosum (Fr.) Bref. is a native pathogen that causes root and butt-rot disease mainly on Italian Stone Pine (Pinus pinea L.) along the peninsula. Its American vicariant, H. irregulare nom. nov. Garbel. & Otrosina, was introduced in Italy during the World War II from North America which is now slowly spreading in several P. pinea stands along Thyrrenian coast.
There is a lack of information on the extent to which invasive organisms may determine physiological changes in host. Aim of this study was to compare the pine tree physiological responses to inoculation with native and invasive pathogens.
Seedlings of P. pinea were inoculated with the invasive fungal pathogen H. irregulare and its related native species H. annosum through stem wounds. Differences in host susceptibility were assayed by measuring the lesions length at different sampling time (3, 14 and 35 days after inoculation). Transcripts analysis on bark samples was carried out by using six different genes (Chitinase, Peroxidase, Antimicrobial peptide, Cinnamoyl alcohol dehydrogenase, Xyloglucan endotransglycosylase, Phenylalanine ammonia-lyase). Biochemical responses of inoculated pine trees were studied by terpenoids analyses.
No significant differences were found between H. annosum and H. irregulare species in terms of transcripts. The expression of the target genes showed significant differences at different time intervals after inoculation. (–)-limonene and (–)-□-pinene resulted as the main terpene. Both wounding and inoculation treatments resulted in an increase in the total quantities of terpenes; terpenes concentration was higher in inoculated tissues compared with the wounded samples.
Preliminary results showed that P. pinea had comparable physiological responses when inoculated with the native and the invasive pathogen. Further investigations will provide more information on the role of terpenes in the chemical defences of Italian stone pine tissues against these fungal pathogens. If the preliminary results will be confirmed, the possible use of terpene markers in selection of less susceptible chemotypes will be evaluated.

Keywords: Heterobasidion irregulare, Heterobasidion annosum, Pinus pinea, transcripts, terpenoids.

Genetic and Morphometric Characterization of Muskrats in Areas of Primary and Secondary Introduction

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The muskrat (*Ondatra zibethicus*) is one of the semi-aquatic mammals which were introduced from North America to various regions around the world. The aim of this study was to compare genetic and morphometric variation of *O. zibethicus* populations in native (Canada) and of primary (Karelia, Finland, Poland) and secondary (Lithuania) introduction areas. A total of 23 measurements were taken on each skull of muskrat. The skull measurements of secondary introducant (Lithuania) females were mostly larger than those of males ($p < 0.05$). But the muksrat skulls were longer and wider in males than in females of primary introducants (Finland and Poland). The mean values of measurements on condylobasal length, braincase length and weight were higher in Finnish and Polish than in Lithuanian populations of muskrat. These can depend on adataptive changes: habitat quality, diet and others. The strong relationship between muskrat body weight and skull length were determined in Lithuania ($r=0.72$, $p<0.001$). A total of 179 samples (71 muskrat from Lithuania and 108 – Karelia) of muskrat were investigated using seven polymorphic microsatellite loci. The numbers of alleles per locus ranged from 5 to 15 in Lithuania (in a total of 67 alleles) and from 8 to 19 – Karelia (in a total of 91 alleles). The genetic diversity was higher in primary (Karelia, H_e = 0.74-0.90, H_o = 0.44-0.80) population of muskrat than in secondary (Lithuania, H_e = 0.35-0.88, H_o = 0.29-0.94), but lower compared with native muskrat population (Canada). The results of principal coordinate analysis showed clear genetic differences between Lithuanian and Karelian populations.

This study was supported by the Research Council of Lithuania (grant No. LEK-14/2012).

Keywords: muskrat, genetic, morphometric variation

Invasive Species in Ukraine

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In Ukraine the problem of invasive species is getting worse every year. Invasive species spread from their original habitat using different means either natural or anthropogenic. The majority of invasive species appear near airports, along the transport routers, water reservoirs and large cities. This information has been confirmed by the results of monitoring. Invasive streams have different direction. Every year there are thousands of invasions where some invasive species acclimatize in new conditions and are harmful for agriculture.

However, most of the species die, but a few of them find favorable climatic conditions for their development. In new conditions, invasive species are aggressive than in its native region. It has no natural enemies that are regulators of population size. Invasive species have ability to reproduce quickly and colonize new territories. Examples are Colorado potato beetle (*Leptinotarsa decemlineata* Say*),* the fall webworm (*Hyphanria cunea* Drury), tomato leafminer (*Tuta absoluta* Mayer), potato tuber moth (*Phthorimaea operculella* Zell.) and western corn rootworm (*Diabrotica virgifera virgifera* Le Conte).

Humans play an important and active role in the introduction of species. Some species imported to Ukraine for gardening and forage improvement for animal husbandry. For example *Sosnowsky's Hogweed* the invasive species which-quickly spreads through Ukraine.

Annual ragweed (*Ambrosia artemisiifolia* L.) is a very harmful specie in Ukraine. This invasive weed infests cultivated crops as well as the urban and country roadsides. Further, it has spread almost on the whole territory of Ukraine. The weed has spread to 70 % area of Ukraine causing allergic diseases to people. Resultantly, about one-third of Ukraine population is suffering from allergies. Unfortunately, nowadays, there are no pharmaceutical drugs for prevention and protection from the allergy caused by this disease.

Longspine sandbur (*Cenchrus longispinus* Fernald.) causes considerable damages to land users of Southern regions of Ukraine. This weed has spread in Kherson, Kharkiv, Odesa, Mykolaiv, Luhansk and Dnipropetrovsk regions, and also in Crimea. The weed infested area is 23295 ha. It is found that *C. longispinus* mostly infests cultivated crops, especially sunflover, corn, gourds, winter wheat and the crops with lower

plant density including gardens, vineyards, meadows and pastures. It grows near roads, lakes, water reservoirs and on forestlands with cut trees.
C. longispinus is extremely harmful for animals. *C. longispinus* seeds decrease wool quality. In the oral cavity of animals, the seeds of *C. longispinus* damage mucous membrane which leads to ulcers and tumors appearance. Further, wool quality is decreased and animal skin is damaged. Thus scientists' attention should be concentrated on restrictions of distribution of dangerous invasive species in Ukraine.

Keywords: invasive**,** species, *Ambrosia artemisiifolia* L., *Cenchrus longispinus* Fernald.

The Effect of Precipitation Reduction and Precipitation Variability on the Invasion Potential of Ornamental Plants

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Many invasive plant species have originally been introduced as ornamentals. However, we continue to introduce a large number of exotic species in our parks and gardens, thus creating a huge potential for future invasions. At the same time, global climate is changing, with an increase in temperature, a reduction in summer precipitation and increased precipitation variability predicted for Central Europe. These climatic changes might further promote the invasion potential of exotic ornamentals. In a series of complementary experiments, we test the effect of precipitation changes on the potential of 25 exotic ornamentals to become invasive in European grasslands.
In the first of these experiments, we compared the potential invasiveness of these 25 species in native European communities, using a semi-natural mesocosm approach.
In order to investigate the performance and competitiveness of the ornamentals under changed precipitation, we experimentally created four different scenarios: (1) constant beneficial precipitation, (2) a reduction of mean precipitation, (3) an increase of precipitation variability, and (4) a combination of the previous two. These scenarios were manually created by applying different water quantities to the treatments.
The experiment allows testing interactive effects of changes in precipitation mean and variability, and it in particular enables us to make a broad comparison of many different ornamental species.
We will present the results of this experiment, and we will outline our strategy for follow-up experiments, which will focus on more detailed precipitation scenarios, and on validating the results of mesocosm experiments in natural populations.

Keywords: invasiveness, ornamental plants, climate change, precipitation

Do Invasive Plants Develop Faster Than Their Native Congeners?

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Plant development is a function of a given temperature and time, called **thermal time** *(TT)*, over which it is acting. The linear approximation of the relationship between the rate of development and temperature makes it possible to calculate two constants: **the sum of effective temperatures** (*SET*), i.e. the amount of heat needed to complete a developmental stage, and **the lower developmental threshold** (*LDT*), i.e. the temperature below which the development ceases. **Thermal window** *(TW)* is defined as the range of temperatures between which the minimum and maximum developmental rates occur. The role of *TT* was demonstrated for insects and other ectotherms (Jarošík et al. 2002, 2004), here we explore whether it can be used to predict the invasiveness of plant species.

We collected data on *TT* requirements of 21 wild-growing pairs of alien species and their native congeners in the Czech Republic. The experiments were carried out in growth chambers under stable regimes (light, moisture and nutrition) differing only in temperature. The treatment temperatures were 10, 14, 18, 22, 26, 30 and 34 °C under 14/10 hours light/dark regime, to cover the range of temperatures and day lengths in the temperate zone during the development of juvenile plants in the field (spring and late summer). To assess the time between appearance of the 1st and 5th stem leaf, or pair of the stem leaves (excluding cotyledons) the plants were checked and measured daily.

We found that under high temperatures invasive alien plants develop faster than their native congeners, and *vice versa*, native plant species develop faster under low temperatures. Faster development under high temperatures might represent an adaptation favouring the rapid start of invasion in warmer regions. Global warming caused by climate change could therefore accelerate the dispersal of invasive plants to new regions, based on the physiological mechanisms.

The War of Phenomenons: Which is Responsible for Northward Distribution of Thermophilic Parrotfish, *Sparisoma cretense* L., 1758, in the Aegean Sea

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Recent marine communities are being altered and remodeling depends on natural changes which occur over geological times. Main and side effects of anthropogenic vectors cause reshuffling of the geographical distributions of plant and animal species. Nowadays, increasing sea water temperature enhances the shifts and pole ward migrations of many taxa that are now extending their natural bio-geographical range. Thus, some species typically known as thermophilic fishes are currently colonizing the northern sectors. These species can be categorized into two major groups and constitute two different phenomenon, known as "meridionalization" and "tropicalization".

Three specimens of *Sparisoma cretense* were collected on March 19th 2014 in the Aegean Sea. This study reports on the additional northward distribution of thermophilic parrotfish and Sparisoma cretense in the Aegean Sea. Additionally, probable reasons in extended distribution of species are discussed within meridionalization and tropicalization phenomenons.

Keywords: *Sparisoma cretense*; parrotfishes; thermophilic species; meridionalization; tropicalization

Threats of Invasive *Acacia dealbata* Link in Chilean Conditions from an Allelophatic Perspective

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Acacia dealbata (Fabaceae) is an Australian species and invader in temperate regions throughout the world. This species is based on a network of functional attributes, and from an ecophysiological point of view this confers a competitive advantage over cohabiting species. The invasion process of *A. dealbata* is partially mediated by releasing allelopathic compounds that affect native plants and soil microbes.
The aim of this work is (i) to determine the time evolution of phytotoxicity that different plant parts exert through direct contact or aqueous natural extracts on the germination process and early seedling growth; (ii) to know the way of action studying radicle morphometric and morphologic variables through scanning electron microscopy and (iii) to quantify the organic chemicals released in the aqueous solution. Target species were *Lactuca sativa* L. (indicator species), *Helenium aromaticum* (Hook.) Bailey (native grass) and *Quillaja saponaria* Molina (native tree). In several treatments, germination was inhibited in more than 90%. Intense reduction of growth, blackening, no root hair formation, rhizodermis destruction and intracellular damage were observed in radicles of the target species. TLC and GC-MS analysis reveals the predominant presence of resorcinol, maculosin and moretenone in the different plant parts. These compounds were possibly responsible for the inhibitory effects observed. The results our studies showed that the greatest damage by allelopathic effect of *A. dealbata* occurs at the root system level. Therefore the survival of the target species may be in danger or be less competitive. *A. dealbata* interferes with the establishment of pioneer herbaceous species in the ecological succession process and can also affect trees if they are hit by a colonizing front.

Keywords: *Acacia dealbata;* allelochemicals; aqueous extracts; morphological damage

Acknowledgments. This research was supported by the CONICYT Project 79100025, the Research and Development Vice Presidency of the University of Concepción and by the CONICYT/National PhD/2013-fellowship folio 63130029 awarded to NA.

Sex pheromone pollution as an overlooked ecological impact of invasive species?

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The use of primordial sex signals in distantly related and geographically separated fish species, topmouth gudgeon *Pseudorasbora parva* (Temminck and Schlegel, 1846) and fathead minnow *Pimephales promelas* (Rafinesque, 1820) has been recently documented. Thus intraspecific selection pressures have not yet caused significant sex chemical signal differentiation between these two species. The female attraction is likely due to a combination of common ancestry and an absence of divergence in allopatry. Under controlled conditions, using indoor flow-through aquaria facilities, we tested cross-species and within-species effects of sex pheromones on fish reproductive success. Pre-spawning pairs of fish were exposed to conditioned water obtained from reproductive heterospecific males (treatment), reproductive conspecific males (control 1), and de-chlorinated water (control 2). Number and size of clutches were recorded continuously. In the absence of mate discrimination among species, which have evolved for long periods of time in allopatry, reunification through species translocation could have represented an overlooked risk of pheromone pollution. However, preliminary results from our experiments do not highlight any functional effect of primordial sex signal on reproductive success despite evidence of increased attraction. Both tested species showed similar trends with respect to spawning ratio, i.e. the proportion of fish pairs that spawned in each treatment (χ^2 test, *P. promelas* $p = 0.25$, *P. parva* $p = 0.66$), time to spawn, i.e. time from start of the experiment to first spawning (ANOVA, *P. promelas* $p = 0.64$, *P. parva* $p = 0.61$), number of eggs laid (ANOVA, *P. promelas* $p = 0.81$, *P. parva* $p = 0.24$). Further work is needed to fully understand the changes in mating behavioural for each species associated with this primordial sex signal.

Keywords: fathead minnow; invasion; mate choice; topmouth gudgeon

Soil Microarthropod Communities in Monospecific *Fallopia japonica* Stands: Unveiling Another Aspect of Knotweed Invasion

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Increasing evidence documents strong negative impacts of *Fallopia japonica* Houtt. (Ronse Decraene) on native flora in invaded terrestrial ecosystems. By displacing native plant species, the alien plant can potentially affect higher trophic levels composition, further altering the whole ecosystem functioning. For example, soil microarthropods that are positively influenced by plant diversity, and show clear sensitivity to soil use and disturbance, play a key role in soil functioning. However, no research exists on the impacts of knotweed invasion on soil microarthropods. In this work, we hypothesized that the reduction of plant species richness caused by *F. japonica* invasion had impact on soil edaphic fauna composition. Soil microarthropod communities were assessed in a monospecific *F. japonica* invaded stand, and in adjacent native grassland stand (680 m a.s.l., NW Italy). We collected three topsoil cores (10*10*10 cm) in October 2011 and in April 2012 from three sampling plots in each of the stands. Microarthropods were extracted using Berlese-Tüllgren funnels, the obtained specimens were identified to the order or class level, and counted. Biodiversity was evaluated by the number of observed taxa (NT), Shannon diversity index (H') and Pielou's evenness index (J). Soil biological quality was determined calculating Acari/Collembola ratio and QBS-ar. Soil microarthropod communities showed some interesting differences between the invaded and native stands in terms of observed taxa and their abundances, and seemed to remain constant over time. In *F. japonica* stand, we detected some groups well adapted to soil life (proturans and pauropods), detritivores (millipedes and woodlice) and predators (pseudoscorpions and centipedes) but a very low abundance of ants. In the native stand, similar to previous studies in grasslands, species diversity and soil biological quality showed high values. A better understanding of the impacts of knotweed invasion in novel ecosystems should implicate assessment of potential effects of the alien plant on underground microfauna.

Keywords: *Fallopia japonica*, soil microarthropod communities, soil biological quality, Acari/Collembola ratio.

Saprotrophic Fungal Diversity and Abundance During Litter Decomposition of *Fallopia japonica* and Native Grassland Species

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Japanese knotweed [*Fallopia japonica* Houtt (Ronse Decraene)] achieves high invasion because of its peculiar functional traits, some of the latter being its huge biomass production and litter input. Litter decomposition rate is controlled by environmental conditions, litter quality and decomposer communities composition. Evidences have been found that slow decomposition rates of *F. japonica* litter resulted from its nutritional quality (low N-content and high C/N ratio). However, information on the relation between litter characteristics and fungal decomposer communities during the decomposition process is still lacking. Our aims were: (1) to characterize saprotrophic fungal communities associated with decomposing litter of *F. japonica* and native grassland litter; (2) to correlate dynamics of fungal abundance and diversity to litter quality. We performed a common field litterbag experiment (factors: stand of decomposition, litter type), and isolated the saprotrophic mycoflora associated with litter 4 and 9 months after litterbags were placed in field (spring and autumn). As decomposition proceeded the overall number of taxa increased, while their abundance decreased. We found that diversity and abundance were strongly affected by litter type, but not by stand of decomposition. In spring, dominant taxa were *Epicoccum nigrum* Link from native grassland litter, and *Phoma* spp. from *F. japonica* litter. In autumn, secondary saprophytes were isolated predominantly. Our results demonstrate that the low quality litter of *F. japonica* is associated with specific saprotrophic fungi. Favourable substrates (native litters) were preferentially colonized, but less favourable substrates (*F. japonica* leaves and stems) were eventually exploited by specific taxa. Therefore, our results corroborate the hypothesis that, not species diversity *per se*, but the presence and abundance of particular functional groups drives litter decomposition pattern. Based on these results, we suggest that legacies, left by *F. japonica* via increased low-quality litter inputs and possible changes in saprotrophic mycoflora, should be taken into account in the management of *F. japonica* invaded habitats.

Keywords: *Fallopia japonica*, soil saprotrophic fungi, litter decomposition.

Zebra Mussel *Dreissena polymorpha* as the Feeding Ground and Substratum for a Ponto-Caspian fish *Babka gymnotrachelus*

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The "invasional meltdown hypothesis" is one of the major hypotheses in invasion biology which states that invasive species facilitate the introduction of other invaders. A Ponto-Caspian bivalve *Dreissena polymorpha*, providing shelters and food for other aliens is regarded as an example of invasional meltdown. However, this effect has been recently put in doubt as mussels also improve living conditions for native species.
The presence of mussels increases zoobenthos density including chironomid larvae (usually 2-6-fold, according to the literature data), but, on the other hand, it limits the access of predators to benthic prey. To check if the overall effect of mussel habitats on the consumption of chironomids by an invasive Ponto-Caspian goby fish is positive (supporting the meltdown hypothesis) or negative, we offered chironomids at various densities (500-2000 ind.m^{-2}) on substrata consisting of sand (no protection for prey), mussel-sized stones or dreissenids to the gobies.
At the same prey density, the gobies consumed similar chironomid numbers from mussel and stone substrata, whereas their predation on sand was more efficient. They performed better on dreissenids than on stones when the prey density among mussels became two times greater. Moreover, a two-fold increase in prey density among mussels compensated fish consumption compared to that on the sandy substratum, and a four-fold increase allowed the fish to consume more individuals than on sand.
Thus, the increases in prey density noted in zebra mussel habitats in the field are likely to provide gobies with suitable food sources, regardless of the protection offered by mussels to prey organisms.
Another experiment, in which we offer the gobies with chironomids on various substrata simultaneously, is currently under way. It will allow us to check whether fish are attracted to particular habitats, and if prey abundance affects their selection.

Keywords: racer goby, zebra mussel, invasional meltdown hypothesis

Acknowledgement: This research was supported by the National Science Centre grant 011/03/D/NZ8/03012.

Ranking Invasive Alien Species in Romania

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Resources available for managing invasive alien species are limited, therefore there is a stringent need to identify and prioritise species in order to ensure a feasible and optimal allocation of funds towards species of major concern. In order to categorize invasive alien species in Romania based on their environmental impact, we used a generic protocol that builds upon previous European listing methods and makes use of a recently developed impact assessment tool. We suggest assigning species under assessment to different risk categories/lists using a combination of the magnitude and extent of their environmental impact. The impact refers to any negative consequences an alien species might have on the recipient community while the current distribution and spread are used as indicators of the extent of the impact. Following assessment, species are assigned to different risk categories of high, medium and low environmental concern. The protocol proposed facilitates discrimination between species in terms of their environmental impact and can be applied at different spatial scales and to any species, regardless of their taxonomy or habitat occupied. It is limited, of course, by the availability of data but can be used despite gaps in knowledge of certain types of impact for a particular species. The fact that it is dynamic helps overcome this limitation; species can be reassessed and their category changed, if necessary, as new data becomes available.

Keywords: exotic, non-native, risk assessment, impact, Black List

Comparison of the Condition of Fish Fauna Communities Between the Oder and Vistula Drainage Basins Using the Zoogeographic Integrity Coefficient

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Freshwater ecosystems are particularly vulnerable and threatened environments, mainly due to intensive human exploitation of water resources. One of the priorities of biodiversity protection and maintaining running water systems in good health is the assessment of their ecological integrity. However, not all components of the ecological integrity have been equally treated, and consequences of biological invasions have often been underestimated. The aim of the study was to evaluate and compare temporary alteration in the conditions of fish assemblages in the Warta River system (the Warta and Gwda Rivers) and left-bank tributaries of the Vistula River (the Pilica and Bzura Rivers) using the Zoogeographic Integrity Coefficient (ZIC). The study was based on single run electrocatches in the above mentioned rivers conducted in subsequent decades since the 1960s. In the Pilica and Bzura Rivers, a progressive decrease in the number of native species (especially rheophils) was observed. It was accompanied by a simultaneous increase in the occurrence of alien species in fish samples (9 to 16% in the Pilica and 8 to 22% in the Bzura). Contrary to the left-bank tributaries of the Vistula, in the Warta River system the previously observed degradation of fish fauna was stopped. An increase in native species, including rheophils, was noted. Non-indigenous species accounted for 11% of all fish species in the Warta River, and only 6% in the Gwda River. The changes in ZIC values in the compared rivers are a consequence of 1) a gradual disappearance of native species together with an increasing number of alien species in the left-bank Vistula tributaries, and 2) a recovery of native fauna in the Warta River system. Both Bzura and Pilica Rivers are progressively invaded, especially intensively by Ponto-Caspian gobies. Despite the fact that the Warta River constitutes a part of the Central Corridor for potential Ponto-Caspian invaders the last do not effectively expand through it.

Keywords: biological invasions, fish community, Zoogeography Integrity Coefficient

Lysiphlebus testaceipes: A Globally Introduced Biological Control Agent and an Invasive Species

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The solitary aphid primary parasitoid *Lysiphlebus testaceipes* (Cresson) (Hymenoptera: Braconidae) is currently spreading across the globe. The species is native to North America, polyphagous and has been introduced for the biological control of aphids in several countries around the world. The quite rapid spread and successful establishment of *L. testaceipes* in a number of countries on all continents point to the conclusion that this is a species with high ecological plasticity. Due to its greater ability to tolerate cold conditions, it may also be able to establish in the cool, temperate climates typical of Northern Europe.

The first record of *L. testaceipes* from West Africa was in Benin in 2007, where the alien parasitoid has become one of the key natural enemies of aphids in vegetable systems. After three years of intense surveying, we concluded that the species was the dominating primary parasitoid found across all four agroecological zones. One additional species was found, but its distribution was limited to one single location only.

The establishment of *L. testaceipes* in Benin provides new options for biological control of severe aphid pests in many important crops. Although the species clearly plays a beneficial role in controlling pests, there is limited knowledge or research addressing the risks associated with this exotic biological control agent and its ecological impact.

Based on relevant literature and our research from Benin, we conclude that the species possesses several of the biological traits characterizing a successful invasive alien arthropod species, such as greater diet breadth and habitat breadth. The adaptability of *L. testaceipes* to different climatic regions and changing climate will probably provide it with competitive advantages over less adaptable aphid parasitoids. The species is polyphagous, which along with its obvious ability to quickly acclimatize makes it an invasive alien species (IAS) that needs attention of researchers.

Keywords: *Lysiphlebus testaceipes*, global distribution, IAS-beneficial organism- or both?

What do We Know About Non-Native Fishes? The Perspective from Florida, USA

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Since the 1950s, nearly 200 species of non-native, freshwater fishes have been recorded from temperate and sub-tropical areas of Florida. We performed the first comprehensive overview of research of the 42 fish species that have become established in Florida by reviewing 280 papers from the peer-reviewed literature. The most frequently studied topics were geographic range and life/natural history, while topics such as risk assessments and population-control studies were rare, despite their value to natural-resource managers. There is a great deal of taxonomic uncertainty and confusion associated with many non-native fishes, yet very few studies focused on clarifying those ambiguities. Most reports were descriptive; only 17% were manipulative. Non-native fishes have been shown to affect a wide range of fauna, from zooplankton to mammals and from genes to ecosystems, across the world at various spatial scales. Yet very little data has been collected regarding the effects of non-native fishes in Florida. Lack of data was sometimes equated with lack of effects, although that conclusion must be avoided without confirmatory research. Much more is known regarding the effects of non-native lionfish (*Pterois* spp.), despite its much shorter establishment time. The lack of data on effects is daunting, especially as the number of non-native fish species in Florida continues to grow. Natural-resource managers need biological and ecological information to make policy decisions regarding non-native fishes. Given the near-absence of empirical data on effects of Florida non-native fishes, and the lengthy time-frames usually needed to collect such information, we provide suggestions for data collection in a manner that may be useful in the evaluation and prediction of non-native fish effects there and elsewhere.

Habitat Preferences and Impacts of Invasive *Urochloa arrecta* in Brazilian Inland Waters

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The grass *Urochloa arrecta* (Hack. ex T. Durand & Schinz) Morrone & Zuloaga is a member of Poaceae family native to Africa that roots in the shores of Brazilian aquatic ecosystems and develops floating stems that grows prolifically over water surface, forming dense mats of organic matter. Here we review the literature and unpublished results in order to identify the types of habitat colonized by this species and its impacts on aquatic ecosystems. *Urochloa arrecta* attains expressive biomass in sites which are less exposed to wind and it grows less prolifically in exposed sites and where native species grow poorly. It colonizes different types of substrates; however, it prefers clay and nutrient rich sediments, typical of eutrophic ecosystems. *U. arrecta* is more sensitive to shade than others native Poaceae species and its growth is completely prevented in sites with light levels similar to those found under riparian vegetation. Experiments showed that biotic resistance offered by native macrophytes also reduces significantly the success of *U. arrecta*. Owning to high biomass values, *U. arrecta* causes severe impacts on aquatic communities and ecosystems. When the biomass values of *U. arrecta* is higher than native species, this species exclude the native macrophytes by the competition for space and light. In higher biomass, *U. arrecta*, also leads fish to local extinctions, because this species reduce the space for moving and prevents fish feeding. Impacts on ecosystems (especially in streams) have also been detected, since the accumulation of organic matter together with siltation changes channel morphometry. Owning to these severe impacts, *U. arrecta* can currently be considered one of the worst weeds threatening freshwater ecosystems in Brazil. The riparian forest regeneration in streams is an efficient strategy to eliminate this weed. Moreover, methods to control *U. arrrecta* in larger ecosystems are still to be developed.

Keywords: Aquatic macrophyte; Poaceae; exotic species success; aquatic ecossystem

Acacia dealbata in Mediterranean Shrubland: Soil and Plant Changes After Invasion

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Acacia dealbata Link (Mimosaceae - Fabaceae) is one of the most invasive species in the Mediterranean ecosystems of Europe, Africa and America, where it forms dense monospecific patches threatening soil and plant communities.

The present study was addressed to evaluate the impacts on soil chemical properties, soil microbial communities and understory plant communities, and also to assess the relationships between these compartments after the invasion of *A. dealbata*. Samplings were conducted in Mediterranean shrublands located in the limit of the Mediterranean area (Northwest of Spain) and in the middle of the bioclimatic region in Europe (Elba Island). Three levels of invasion statuses were differentiated according to the gradient generated by *A. dealbata* during the invasion process (invaded, transitional and non-invaded patches) in each studied community.

Alterations of soil chemical features, plant species richness and composition, plant density, total plant cover and microbial communities (i.e. bacterial and fungal communities) were measured and compared to patches with different invasion statuses.

The invaded patches had lower pH values than both the non-invaded and transitional patches. Significant differences were detected for the total N and P contents, which showed the ranking: invaded > transitional > non-invaded plots. Total organic carbon showed higher values in invaded than in non-invaded patches but C/N ratio was variable depending on the Mediterranean area.

We found significant effects of invasion status on the species richness, plant density and total plant cover. Plant values were significantly lower in invaded than non-invaded patches. Invasion by *A. dealbata* was also associated with changes in species composition.

A clear effect of the invasion on the overall structure and of soil microbial communities was observed in shrublands. Soil fungal communities in the

invaded and transition areas clustered both together and apart from the native soil.
All these data confirm that *A. dealbata* modifies several ecological compartments in the invaded shrublands, determining strong changes in the local ecosystem processes.

Keywords: *Acacia dealbata,* ecological impacts, European Mediterranean area

Does Plant Activator Application Help the Antioxidant Defense Of Tomato Plants During Broomrape Infection?

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Broomrapes (Orobanche sp., Phelipanche sp.) are invasive weeds that damage major agricultural plants such as tomato, sunflower, and lentil etc. Broomrape seeds germinate after the release of strigolactone from host plants' roots. In this study, we focused on the antioxidant enzyme levels of root and leaf tissues of tomato (cv. Rio Grande) and ISR 2000 application during broomrape infection. ISR 2000 is a plant activator that widely use in agricultural production.

Tomato seedlings were grown under controlled conditions (24±2 °C, 16/8 hrs light/dark, 55-65% RH) in hydroponic culture with Hoagland solution. Experiment groups were; (A) Control (tomato plants with no affection), (B) Broomrape infection (tomato plants infected with broomrape), (C) ISR 2000 treatment (tomato plants treated only with ISR 2000) and (D) ISR 2000 and broomrape (tomato plants infected with broomrape and treated with ISR 2000 together). Seedlings were treated by ISR 2000 with proposed dosage on the first day of infection stage. *P. aegyptiaca* seeds were germinated with GR-24. Root and leaf tissue samples were analyzed for antioxidant enzymes (SOD, POX, APX, GR, CAT) and pigment analyses on the 0^{th}, 3^{rd} and 7^{th} day after treatment. Statistical analyses were done with SPSS (20.0).

At the end of the experiment, total chlorophyll amount was increased by 40% compared to control plants of infected group with ISR 2000 treatment. SOD, POX, APX, GR and CAT activities were found approximately 3–8 folds higher in root tissues, whereas they increased 2 folds in leaf tissues. While GR activity decreased, CAT activity increased 4 folds in the leaf tissue in same group.

It was determined that antioxidant defense system induced with ISR 2000 treatment during broomrape infection in root tissue of tomato plants. Besides, our results showed that this induction of antioxidant defense system was achieved via ascorbate-glutathione pathway. Moreover, plant activator was more effective in root tissues compared to leaf tissues. As a result of this study, it can be concluded that ISR 2000 treatment provide an additional protection during broomrape infection compared to untreated group in tomato plants.

Keywords: Broomrape; Tomato; Antioxidant Enzymes; ISR 2000

Ragweed Leaf Beetle: a Friend or a Foe?

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The ragweed leaf beetle, *Ophraella communa* LeSage (Coleoptera: Chrysomelidae) is a North American species which was first time noted in Italy and Switzerland in 2013. Most of the common ragweed *Ambrosia artemisiifolia* L. populations in this area were heavily attacked and even established plants were quickly completely destroyed by *O. communa*. In China, the species (*O. communa*) is regarded as a successful biological control agent against *A. artemisiifolia*. Even if the potential risks to non-target species are well known, the threat to closely related wild or crop species and the level of their damage under field conditions remain unclear. *O. communa* is reported as oligophagous species feeding on various plants which belongs the tribe Heliantheae. The aim of this survey was to investigate the potential of *O. communa* association with the alternative hosts surrounding *A. artemisiifolia* populations in the field. The most examined non-target plants were *Artemisia vulgaris* L., *Conyza canadensis* (L.) Cronq., *Helianthus annuus* L., *H. tuberosus* L., *Inula graveolens* (L.) Desf., *Persicaria maculosa* S. F. Gray, *Xanthium strumarium* L. and *Zea mays* L.. The 50 selected plants were visually scouted to determine potential occurrence of any developmental stages and feeding symptoms of *O. communa*. At the end of the inspection, 50 random sweeps were done over the plants with a net. The leaf beetle was able to feed on *A. vulgaris*, *I. graveolens, H. annuus*, *H. tuberosum* and *X. strumarium*. No records out of corn. The most affected non-target hosts in the field have been *I. graveolens* and *X. strumarium*. We will present the data on the presence of *O. communa* on non-target hosts in North Italy (Lombardia) and South Switzerland (Ticino) in 2014. All of these observations will be discussed with a view to highlight limitations of *O. communa* to biological control. The collected data suggests that additional experiments are needed to assess both the impact and the risks of non-target attack by this potential biological control agent under field conditions.

Keywords: *Ambrosia artemisiifolia*; *Ophraella communa*; biological control; non-target hosts

Occurrence of *Dreissena polymorpha* in Bulgarian Inland Waters in Relation to Calcium Concentration

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Freshwater bivalve mollusk zebra mussel, *Dreissena polymorpha* (Pallas, 1771), is one of the most aggressive aquatic invaders in Europe and worldwide. The native range of zebra mussel in Bulgaria includes the Danube River and the Black Sea coastal lakes and river estuaries. The first inland lakes infested by zebra mussel (the reservoirs Ogosta and Ovcharitsa) were reported in 2002, and since then the process of colonisation of inland waters has been continuing. The goal of our work was to study the occurrence of zebra mussel in water basins of Bulgaria in relation to calcium concentration (Ca). To achieve this goal, we collected samples of water chemistry and benthic macroinvertebrates in 50 water bodies during the period of 2006-2011.

Live adult specimens of *D. polymorpha* were found in 23 water bodies, while empty shells in 4 reservoirs. The results of the PCA analysis showed that Ca concentration is one of the main environmental factors which determine the distribution of zebra mussel in the Bulgarian water basins. The Ca concentration in the studied water bodies ranged from 6.01 mg/l (Srechenska Bara Reservoir) to 168.34 mg/l (Asparuhov Val Reservoir). The specimens of *D. polymorpha* were found in water bodies with Ca in the range from 27.05 mg/l (Rabisha Reservoir) to 74.15 mg/l (Ovcharitsa Reservoir). Most abundant populations occurred at Ca of 25-50 mg/l. In water bodies with Ca >70 mg/l (Kovachitsa, Asparuhov Val, Fisek and Poroi) only empty shells were found. The only exception was Ovcharitsa Cooling-Reservoir, where the highest Ca concentration of 74.15 mg/l was measured. The possible reasons for the influence of Ca on zebra mussel distribution are discussed. The results will be of importance for water management and for the development of aquatic IAS prevention and control strategies.

Keywords: zebra mussel; distribution; calcium concentration; Bulgaria

Acknowledgements: This study was supported within the frames of the East and South European Network for Invasive Alien Species (ESENIAS) and the International Association for Danube Research (IAD). Alice Cardeccia was supported by a mobility grant from University of Pavia, Italy.

The Invasive Species Compendium: Information for Assessing Invasive Species Threats

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The European Union is in the process of developing new legislation to prevent and manage the introduction and spread of invasive alien species. The Invasive Species Compendium (ISC) is an updated, open-access, global knowledge resource. It has an important contribution to make to the scientific assessment of the risks associated with invasive alien species and the pathways for their introduction and spread. Detailed, fully referenced datasheets on over 1600 invasive species have been written and peer reviewed by over 1000 experts. Additional datasheets on priority species are being commissioned and existing information updated. Basic data are included on a further 6000 invasive species and are supplemented as new information becomes available. Datasheets include sections on the identification, current distribution, history of introduction, habitats and hosts, biology, pathways, impacts (economic, environmental and social) and management, which are all needed for risk assessment (to determine the likelihood of introduction, establishment, spread and impact). Datasheets are illustrated with colour images and distribution maps and link to related datasheets on their hosts, threatened species, natural enemies, habitats, pathways and the countries in which they have been recorded. Bibliographic records from the CAB Abstracts database and full text articles from the CABI repository are also hyperlinked and integrated into Compendium searches. This subset is updated weekly. Database searches can be used to generate lists of invasive species by selecting criteria such as country (present, native, introduced or invasive), habitat, host, pathway or risk type. The ISC is the latest in a series of Compendia published by CABI. It is developed and maintained by an international Consortium and contributes data to the European Alien Species Information Network (EASIN) and Global Invasive Alien Species Information Partnership (GIASIPartnership). For further information about the ISC, please visit www.cabi.org/isc.

Keywords: invasive alien species, risk assessment, databases, Europe, legislation

Priority Invasive Alien Plants in Natura 2000 Sites in Greece

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Protected areas hold an exceptional level of biodiversity and are very prone to anthropogenic environmental changes. Most studies have found that protected areas contain fewer invasive species than their surroundings, although reverse trends are frequently reported. The present study aimed to identify and rank non-native plant species that are already present in Natura 2000 sites in Greece and could potentially become invasive. Two international Risk Assessment methods were implemented to alien plant species dataset: the European and Mediterranean Plant Protection Organization (EPPO) prioritization scheme and the Australian Weed Risk Assessment (A-WRA). Three different assessment lists were produced by each method; one for minor concern or accepted species, second for species under observation or evaluation, and third for invasive aliens or rejected species. In total, 70 alien plants from 30 different families occurring in 141 Natura 2000 sites were assessed. Amaranthaceae and Asteraceae were the most abundant families (30%) followed by Poaceae (27%) and Fabaceae (23%). According to the EPPO scheme, 10% of species were characterised as invasive, 44% as possibly invasive and 46% as non-invasive. The A-WRA method was stricter than the EPPO scheme, hence, characterising, as 54% species as invasive, 36% as possibly invasive and 10% as non-invasive. Main ranking differences between the two methods can be due to the diverse information required to answer the questionnaires and differences in the relevant importance of questions to the final ranking.

Keywords: Alien plants; early warning; Invasiveness; Protected areas; Weed risk assessment (WRA).

Acknowledgments: Research was partially supported by the COST Action TD1209 “Alien challenge”.

Alien species in the Czech Republic: Black, Grey and Watch List with Recommended Management Action for State Authorities

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Invasive species can cause a broad range of significant negative effects to the properties of recipient ecosystems as well as negatively influence human well-being, health and economy. Therefore, there is a growing need for standardized approach to evaluate and prioritize individual alien species, and provide direct management recommendations to policymakers and state authorities. In the Czech Republic, such rigorous evaluation based on scientific criteria was lacking up to now, and invasive species of concern were being elected for action often on the basis of their popularity. Here, we propose a system for classifying alien species in the Czech Republic and present the first Black (problematic invasive species with recommended immediate management; 90 species), Grey (alien species where immediate action is not needed; 114 species) and Watch List (alien species naturalized or invasive in neighbouring countries, or species which should be monitored in CR) for this country. The classification scheme is based on the magnitude of the species' impact, its distribution and abundance, and feasibility of management action. The classification system makes it possible to accommodate alien species belonging to a range of taxonomic groups occurring in diverse environments (plants, vertebrates and invertebrates). Within each list, taxa are divided into subcategories according to specific recommendations for regulation and management in regional and meta population context.

Keywords: Black list; Czech Republic; management; prioritization; risk assessment

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Venue: Wow Topkapı Hotel and Kremlin Palace

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