26-28.
FEBRARY
2025

CONFERENCE ON INVASION BIOLOGY AND ONE BIO-SECURITY

INVASION BIOLOGY
DIVISION

HUN REN
CENTRE FOR ECOLOGICAL RESEARCH

FOREWORD

The massive and continuous introduction of invasive non-native species is threatening our health, our crops, our livestock and our natural environment in unprecedented ways. We cannot prevent the appearance of invasive non-native species, but we can slow the invasion and mitigate its impact. This is necessary because it gives nature and society time to adapt. Managing invasions is a complex social learning process in which natural and social scientists, policy makers, farmers and all citizens have an important role to play.

The One Biosecurity concept provides a suitable framework for understanding invasion and actions, according to which the health of nature, humans and their livestock cannot be separated. The conference aims to provide an opportunity to share theoretical and practical knowledge on invasive species between researchers, practitioners and policy makers.

ORGANIZING COMMITTEE

László Zsolt Garamszegi
Zoltán Botta-Dukát
James Dickey
Eszter Fodor
Róbert Gallé
Erika Juhász
Krisztián Katona
Orsolya Kiss
Kornélia Kurucz
Előd Márton
Gábor Lövei
Zsolt Molnár
Tamara Szentiványi
Zsóka Vásárhelyi
Orsolya Valkó

ONE BIOSECURITY – CONCEPT NOTE

Several devastating and dangerous human diseases originated as pathogens of animals, domestic or wild. Such host shifts are becoming more frequent, due to increased contact between humans and wildlife, caused by the growing number of humans and the resulting destruction of biodiversity. Rapidly developing global distribution and travel networks makes the spread of new and emerging pathogens fast and effective, demonstrated by the recent SARS-CoV pandemic.

This realisation gave rise to the One Health concept that highlights that human well-being cannot be treated separately from that of natural ecosystems. However, by concentrating heavily on zoonoses, it largely overlooks other ecological processes that can have consequences for human health. In this approach, plant and ecosystem health considerations remain poorly integrated in terrestrial systems, virtually absent in aquatic ones, and the importance of social aspects of biosecurity and disease management appear to be routinely ignored. Another shortcoming of the framework is that it does not integrate invasive alien species under this umbrella. Invasive alien species pose serious threats to humankind that are comparable to the effects of pathogens — with far-reaching consequences for ecosystems, cultivated plants, as well as human and animal health.

Biological invasions are now recognised as one of the most important elements of global change. Given the serious negative effects, numerous measures and legislation against invasive species have been taken. Nevertheless, despite fundamental similarities in the invasion process of pathogens, pests, and weeds, irrespective of whether they impact human, animal, or plant health, government policymakers and regulators, researchers, and industry generally take a siloed approach to biosecurity delimited by sectoral and taxonomic identities. The One Biosecurity concept has been developed to foster an interdisciplinary approach, building on interconnections between human, animal, plant, and ecosystem health to prevent and mitigate

the impacts of invasive alien species. To date it has focused on describing: (1) the **cross-sectoral impacts of invasive alien species** (e.g., fire ants, rats) that have negative impacts across the human, animal, plant, and ecosystem health sectors; (2) the **multisectoral threat posed by global change drivers** (climate change, agricultural intensification, urbanization) that increase the risk of biological invasions; and (3) the **international policy context** of dealing with pandemic threats posed by invasive alien species. The One Biosecurity concept claims that unified decision support tools for human, animal, plant, and ecosystem health would deliver greater impacts than current sector-specific approaches, by ensuring that policy and management decisions are objective and optimized for the biosecurity system as a whole.

Our aim with starting a conference series devoted to biological invasions is to introduce the One Biosecurity concept to Hungary, and to provide a forum for regular exchange of information and discussions between scientific, policy and public stakeholders to increase awareness about invasions and their management.

CONFERENCE
ON INVASION BIOLOGY
AND ONE BIOSECURITY

26 - 28
FEBRUARY
2025

SCIENTIFIC PROGRAMME

DAY 1 – 26 FEBRUARY

9:20-9:50 COFFEE BREAK

9:50-10:00 Welcome by László Zsolt Garamszegi

10:00-11:00

Plenary talk by **Philip E. Hulme**:
Why we need a One Biosecurity approach to One Health

11:00-12:00 SESSION 1

REGULAR TALKS

Judit Sonkoly
The role of garden centres and plant nurseries in alien plant invasions

Ali Omer
Climatic suitability direct and indirect effects on naturalization success of alien plants in Southern Africa

Krisztián Katona
Wild boar rooting impact on grasslands: how much could betoo much?

Márton Bence Balogh
Human impact on landscapes (land use change) as a driving force of biological invasion

James Dickey
The pet trade as a vector for non-native species spread: insights from Germany

12:00-14:00 LUNCH

14:00-16:00 SESSION 2

REGULAR TALKS

Julie Augustine
Assessing the invasive risk of medically important mosquito species in Hungary with the TAS-ISK toolkit

Péter Borza
The trophic roles of invasive Ponto-Caspian mysids (Crustacea: Mysida)

Enrico Ruzzier
Improving SDM predictive performance for global invasive species: the Lycorma delicatula (Hemiptera: Fulgoridae) study case.

Zsolt Biró
Population biology parameters of the raccoon (Procyon lotor) and the raccoon dog (Nyctereutes procyonoides) in Hungary

Tamara Szentiványi
Urban adaptation, host behavior, and distribution affects the presence of Dirofilaria parasites: a phylogenetic comparative study of wild carnivores

SPEED TALKS

Lilla Szendrei
Significance of plant pathogen fungi “hitch-hiking” on imported tropical fruits to Hungary

Melinda Halassy
Reducing risks to human health by reducing invasion through ecological restoration

Ivett Kocsis
Impact of plant pollen on the early development of plant pathogen: Implications for agricultural health and food safety

Károly Erdélyi
Investigation of Flaviviruses in Invasive Mosquitoes in Hungary

Gergely Tholt
Exploiting the weirdness of aliens – how can you make a selective bait to catch invasive leafhoppers?

Botond Zsombor Pertics
Development of reliable and swift detection methods of wheat dwarf virus and identification of new virus reservoir grasses in Hungary

15:30-16:00 COFFEE BREAK

16:00-17:30 WORKSHOP

17:30 DINNER

19:00 SOCIAL EVENING AND GAME NIGHT

DAY 2 – 27 FEBRUARY

8:00-9:00 BREAKFAST

9:00-10:00 Plenary talk by **Petr Pyšek**: Macroecology and biogeography of plant invasions: what have we learned from large databases?

10:00-11:00 SESSION 1

REGULAR TALKS

Patrícia Elisabeth Diaz-Cando
Enemy behind the gates? Predicted climate change might facilitate C4 grass invasion in European grasslands

György Kröel-Dulay
The invasion of sand dropseed (Sporobolus cryptandrus), a C4 perennial bunchgrass, in sand grasslands of Central Europe

Péter Török
Soil seed bank of the invasive sand dropseed (Sporobolus cryptandrus) poses a future challenge for its suppression

Anikó Csecserits
Estimating the dispersal potential and impact of Opuntia humifusa, a new alien plant: the basis of early warning and management

SPEED TALKS

András Kelemen
Mapping cacti that have escaped human control in Hungary

Dávid Schmidt
A strong invasion wave of mediterranean grass species has reached the Carpathian Basin

11:00-11:30 COFFEE BREAK

11:30-12:30 SESSION 2

REGULAR TALKS

Richard Mally
Historical invasion rates vary among insect trophic groups regular talk

Gergely Shally
Changes in population size and distribution areas of game species in Hungary between 1997–2022

Attila Rigó
Non-native and potentially invasive plants in Budapest

Nathanael J.Litlekalsoy
Hungry Hungry Harmonia – Using Functional Genomics to Measure the Predatory Impact of Invasive Lady-birds Harmonia axyridis

Péter Szilassi
Artificial intelligence-based methods in invasion biology research: case studies from Hungary

12:30-14:00 LUNCH

14:00-15:00
Plenary talk by **Piero Genovesi**: Management of invasive alien species: challenges and opportunities to mitigate the impacts of biological invasions

15:00-16:00 SESSION 3

REGULAR TALKS

Fabio Mologni
Time since first naturalization is key to explaining non-native plant invasions on islands

Zsombor Márk Bányai
The signal and the red swamp crayfish in the Carpathian Basin: present status, distribution and the impacts of the colonised ecosystems

András Weiperth
Are we really able to do anything, or are we just sitting back and watching? The present status and real effects of non-native decapod, fish, amphibian and reptile species in Hungary

Eszter Fodor
Traditional ecological knowledge and local value categorization of invasive alien plant species of herders and farmers in the Kiskunság

Erika Juhász
Short-term response of an invasive fish species on the beaver-made landscape alterations

Róbert Gallé
Milkweed (Asclepias syriaca) invasion, forest-steppe fragment size and isolation jointly constrain arthropod communities and their functional traits

SPEED TALKS

Éva Szita
Dispersal of the invasive Indian wax scale (Coccomorpha, Coccidae, Ceroplastes ceriferus) in Hungary

Orsolya Kiss
The threats of the colonization of an alien perennial grass, Paspalum distichum L. to the native floodplain vegetation in Hungary

Viktor Ulicsni
Everything can be useful – invasive and alien animal species in local ecological knowledge in the Pannonian Biogeographic Region

16:30-17:00 COFFEE BREAK

17:00-18:45 SESSION 4

REGULAR TALKS

Anna Cseperke Csonka
Invasion control by sowing native species – effects of propagule pressure, priority effect and trait similarity

Csaba Tölgyesi
Perspectives in the application of hemiparasites to control invasive plants in Hungary

Jean-Marc Dufour-Dror
Controlling Ailanthus altissima with the hack & squirt technique in Israel

Arnold Erdélyi
Chances of controlling Hungary's worst invasive tree species in forest-steppe forests: from planning to setting up defenses

SPEED TALKS

Csaba Vadász
Control and containment of woody invasive species in The Peszér-forest

Ágnes Tóth
Laundry washing can support plant invasion by influencing the germination potential of cloth-dispersed seeds

Orsolya Valkó
Human-vectored seed dispersal on clothing can contribute to the spread of invasive and weedy species

Balázs Bócsi
Nutria (Myocastor coypus) eradication program in Northern Hungary

László Szabó
The diet composition of two invasive carnivores, the raccoon (Procyon lotor) and the raccoon dog (Nyctereutes procyonoides) based on stomach analysis

Katalin Török
Multi-species seeding may improve resistance against invasion in a sandy habitat

Miklós Kertész
Frequency of biological invasion in different habitat types in Hungary

Georgina Visztra
Usability of citizen science data for research on invasive plant species in urban cores and fringes: A Hungarian case study

Márton J Paulin
Erythmelus klopomor – Promising candidate for classical biological control against the invasive oak lace bug

Jakab Máté Scherman
Habitat-driven differences in pollen-spore interactions: preliminary results of an invasive weed (Ambrosia artemisiifolia)

Alen Kiš
Example of transnational cooperation for efficient IAS management

18:45 DINNER

DAY 3 – 28 FEBRUARY

WORKSHOPS

Living together with invasive species?
real world issues

The day aims to bring together practitioners and researchers to discuss how the knowledge accumulated in practice and national and international research can help each other. In other words, the main objective, to strengthen joint knowledge co-production that can be used to more effectively manage invasive species. During the day we will work in 3-4 rounds and 4-6 groups around the issues identified in the application identified as the most important by participants during the registration process.

Workshops will be held in Hungarian, with the formation of a group in English.

Moderators of the Day: **Zsolt Molnár, Krisztián Katona, Ferenc Sipos, and László Darányi**

8:00-9:00 BREAKFAST

9:00-9:30

WELCOME SPEECH Summary of the last two days,
INTRODUCTION OF GROUPS AND TOPICS

9:30-10:30

FIRST ROUND OF GROUP DISCUSSIONS

10:30-10:50

COFFEE BREAK
AND SWITCH BETWEEN GROUPS

10:50-11:50

SECOND ROUND OF GROUP DISCUSSIONS

11:50-13:00 LUNCH

13:00-13:30

GROUP PRESENTATIONS

13:30-14:30

THIRD ROUND OF GROUP DISCUSSIONS

14:30-14:50

COFFEE BREAK
AND SWITCH BETWEEN GROUPS

14:50-15:50

FOURTH ROUND OF GROUP DISCUSSIONS

16:00-16:30

GROUP PRESENTATIONS
AND CLOSING REMARKS

WORKSHOP TOPICS

(may change slightly):

- What is considered native, neo-native, or alien?
- The state of habitats and the effect of invasion
- Prediction, invasion pathways, new species, examples for successful early eradication
- Climate Change and Invasion
- What to research, what to educate, and what to publish about invasion?
- Long-term population dynamics of invasive species, their roles and the change of their roles in communities
- Eradication by utilisation - i.e., use of invasive species as food in sustainable dining ("Invasivorism")
- How not to plant invasive species in our gardens and parks: from cultivation to regulations
- Invasive animals and strategies to deal with them (fishes, birds, the raccoon, and alligator turtles)
- Concrete examples for effective methods vs recognised failed attempts, and their recorded history
- The cons of chemical control methods, glyphosate and its potential substitute products
- Invasive mosquito species
- When does the extermination of an invasive species become harmful?
- Can an invasive species replace an ecological function instead of displacing it?
- Climate Change (cont.): crops and forests in suboptimal climate, and the future of C4 plants
- When to start managing an invasive species - and the case of the North American sand dropseed
- The role of Government in defence, developing strategies, supporting impacted sectors (i.e., via comparing countries, such as Serbia vs Hungary)
- Involving locals and learning from them about invasive species
- Where to place eradication of invasive species in the list of conservation priorities

MANAGEMENT OF INVASIVE ALIEN SPECIES: CHALLENGES AND OPPORTUNITIES TO MITIGATE THE IMPACTS OF BIOLOGICAL INVASIONS

Piero Genovesi[1,2]

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[2] Chair of the IUCN SSC Invasive Species Specialist Group

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Invasive alien species (IAS) have severe impacts on ecosystems, livelihoods, and global economies. Mitigating these effects requires integrated policy frameworks that combine preventive measures with management strategies. Successful management is built on three complementary approaches: early removal of new invaders, permanent control programs, and targeted eradications. Evidence demonstrates that early detection and rapid response (EDRR) are among the most cost-effective strategies. Prompt removal prevents the establishment of invaders, minimizing ecological and economic damage. Robust surveillance systems, preparedness, trained personnel, and public engagement are critical to enhancing the efficacy of EDRR efforts. Similarly, eradicating established IAS populations has proven effective in protecting native species and has benefited from advancements in removal techniques. However, successful eradication programs depend on meticulous planning, adequate funding, and long-term commitment to prevent reinvasions. For IAS that cannot be eradicated, adaptive long-term control programs are important for mitigating impacts and limiting their spread but must been carefully planned and evaluated. Continuous monitoring and periodic adjustments ensure the sustained effectiveness of these programs. The IPBES thematic assessment highlights that the known

3,500 IAS could be brought under control, thereby contributing to the objectives of the Global Biodiversity Framework and the EU Biodiversity Strategy. Despite this potential, investments in IAS management remain insufficient. For instance, while 80% of countries include IAS-related targets in their national biodiversity plans, 45% allocate no funding for managing biological invasions. To address this gap, countries must prioritize IAS management within their broader conservation policies, allocate sufficient resources, and actively involve the public and local communities. Meeting Target 6 of the Convention on Biological Diversity and enforcing EU Regulation 1143/2014 is achievable. Scientific evidence shows that with adequate effort, the ecological and societal impacts of IAS can be significantly reduced, leading to net economic benefits and contributing to the health of global ecosystems, but this requires a leap in ambition in national and global policies.

WHY WE NEED A ONE BIOSECURITY APPROACH TO ONE HEALTH

Philip E Hulme[1]

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The United Nations defines biosecurity as a strategic and integrated approach that encompasses the policy and regulatory frameworks for analysing and managing relevant risks to human, animal and plant life and health, and associated risks to the environment. Thus, biosecurity is an inherently transdisciplinary issue yet regulators, researchers and other stakeholders working in human, animal, plant, or environmental health often work within monodisciplinary siloes unaware of the bigger picture. One Biosecurity challenges this status quo and presents a more inclusive and holistic approach to managing biological invasions that transcends the traditional boundaries of human, animal, plant, and environmental health, explicitly incorporates perspectives of human values, and acknowledges the key role of indigenous people in knowledge production. One Biosecurity operationalises many of the concepts underpinning One Health but with a stronger focus on the threats posed by invasive species to the economy, environment, and human wellbeing. One Biosecurity requires that the key cross-sectoral research innovations be identified and prioritised. Four major interlinked issues include: implementation of new surveillance technologies adopting state-of-the-art sensors connected to the Internet of Things, deployable handheld molecular and genomic tracing tools, sophisticated socio-environmental models and data capture, and the assessment of diverse human values and wellbeing in relation to biosecurity threats. The relevance and applicability of these issues to address threats from pathogens, pests, and weeds in

both terrestrial and aquatic ecosystems emphasise the opportunity to build critical mass around transdisciplinary teams at a global scale that can rapidly advance science solutions targeting biosecurity threats.

MACROECOLOGY AND BIOGEOGRAPHY OF PLANT INVASIONS: WHAT HAVE WE LEARNED FROM LARGE DATABASES?

Petr Pyšek[1,2]

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Biological invasions are a global consequence of an increasingly connected world and the rise in human population size. The number of species introduced outside their native distribution range where they successfully naturalized is rapidly increasing, currently exceeding 4% of the world flora. Naturalized species that have become invasive break down biogeographic realms, affect native species richness and abundance and increase the risk of their extinction, and change ecosystem functioning by altering nutrient cycling, hydrology, habitat structure, and disturbance regimes. Building on the rapid development of global databases in the last decade containing data on naturalized and invasive alien plants, such as GloNAF, GIFT, or SynHab, our knowledge of invasion drivers and mechanisms leading to successful establishment and invasion has improved and was recently summarized in the IPBES report on invasive species. The talk will demonstrate how this new development contributed to a better understanding of the historical processes of human-caused plant exchange between continents and biomes and of mechanisms that determine the spread of plants beyond their original distribution ranges. The role of human activities, plant species traits, habitat affiliations, and changing environments in shaping the present-day map of global plant invasions will be explored in the context of existing hypotheses and frameworks.

ASSESSING THE INVASIVE RISK OF MEDICALLY IMPORTANT MOSQUITO SPECIES IN HUNGARY WITH THE TAS-ISK TOOLKIT

Julie Augustin[1], Zoltán Soltész[1], János Sztikler[2] & László Zsolt Garamszegi[1,3]

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[2] Nemzeti Népegészségügyi Központ, Budapest, Hungary
[3] HUN-REN Centre for Ecological Research, National Laboratory for Health Security, Budapest, Hungary

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Invasive alien species pose a significant and growing threat; they have large impacts on ecosystems, represent a huge economic cost, and threaten human and animal health. Invasive mosquitoes are responsible for several disease outbreaks worldwide, and are potential vectors of other important parasitic agents; thus, the spread of these species represent a major epidemiological risk globally. It is therefore a key challenge to predict the emergence of new species in a given country. Furthermore, for efficient responses, simple decision-support tools are needed, that can transparently inform decision makers about the current and potential future stages of invasions. We used the TAS-ISK screening toolkit to assess the invasiveness risk of eight mosquito species for Hungary. The user answers questions about the geography/history and biology/ecology of the species of

interest, questions about climate change, and provides confidence levels, to obtain risk scores under current and future climate conditions. We established an invasion risk score threshold by assessing three invasive mosquito species already present in Hungary. We also assessed five species that are present in neighboring countries, but not yet in Hungary. The three species established in Hungary showed similar scores, as did two non-established species, indicating a high invasion risk requiring close monitoring. Climate change exacerbates this risk, particularly for *Aedes aegypti*, highlighting the need for focused monitoring programs.

HUMAN IMPACT ON LANDSCAPES (LAND USE CHANGE) AS A DRIVING FORCE OF BIOLOGICAL INVASION

Márton Bence Balogh[1,4], Zalán Tobak[2,4], Dominik Kaim[3] & Péter Szilassi[1,4]

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[2] University of Szeged, Department of Atmospheric and Geospatial Data Science, Szeged, Hungary
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The spread of invasive plant species is influenced by various geographic factors such as the topography, climate, soil and hydrology, but the importance of each factor varies according to the species. Another major influencing factor that must be considered is historical and recent changes in land use/land cover (LULC). LULC changes may support the appearance of some invasive species, but there is uncertainty over the persistence of their effects on biological invasion. This study investigated the potential connections between historical LULC patterns over the past 200 years and the recent emergence of four common invasive plant species in Hungary: *Ailanthus altissima* (tree of heaven), *Asclepias syriaca* (common milkweed), *Elaeagnus angustifolia* (Russian olive) and *Solidago spp.* (goldenrod). Geographic Information System (GIS) data and statistical methods were used to compare historical (1848–1990) and recent (1990–2018) LULC changes with the occurrence patterns of these invasive plants in 2018. The results indicated that *A. syriaca* is more influenced by recent LULC changes while *A. altissima, E. angustifolia* and *Solidago spp.* and are more affected by historical LULC changes. *A. altissima* and *E. an-*

gustifolia thrive at high land-use intensities. *A. syriaca* prefers areas characterised by mixed and decreasing land-use intensities while *Solidago spp.* prefers areas with continuously increasing and decreasing land-use intensities.

THE SIGNAL AND THE RED SWAMP CRAYFISH IN THE CARPATHIAN BASIN: PRESENT STATUS, DISTRIBUTION AND THE IMPACTS OF THE COLONISED ECOSYSTEMS

Zsombor Márk Bányai[1], András Dániel Berényi[2], Kinga Király[3] & András Weiperth[4,5]

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According to our current knowledge fourteen non-native crayfish, eight crab and five shrimp species have been reported in the wild habitats in Hungary and seven crayfish and one shrimp of these species start to colonise the different water bodies of the Carpathian Basin. Among the new reported non-native species in the last two decades, the signal crayfish (*Pacifastacus leniusculus*) and the red swamp crayfish (*Procambarus clarkii*) stand out. Following the first record of the signal crayfish (1996, Szentgotthárd) and red swamp crayfish (2015, Budapest) in Hungary, the first established populations were found in a short term in different habitats in Hungary. While the signal crayfish started to colonise the western and southwest region of Hungary, the red swamp crayfish were illegally stocked some tributary streams and artificial urban ponds and started to colonise the new locations and the estuary area of these streams in the Danube River. Unfortunately, complex research programs on signal crayfish has been very slow to get

off the ground, but on the other hand after the first observation of the red swamp crayfish an intensive survey period was started in the potential habitats in Hungary and a monitoring program was begun in the colonised habitats at the same time. During our country-wide survey program, the signal / red swamp crayfish were detected in 27 / 10 additional drainage area. So nowadays we could not find cross-border running waters in the western and southwest region of Hungary, where the signal crayfish was not detected and four streams, one thermal water polluted channel, three side arms and circa 120 rkm long section of the main arm of the River Danube, three location of Lake Balaton and urban region of Péti-séd occur the red swamp crayfish. The results of our monitoring programs showed that the signal and the red swamp crayfish was capable to completely alter aquatic macrophytes, macroinvertebrates, fish, amphibians and aquatic reptiles. The overall transformation of species composition and the environmental parameters has a significant impact on the ecological status/potential of water bodies. Our results are in line with previous findings on *P. leniusculus* and *P. clarkii* in Western and South Europe and elsewhere.

POPULATION BIOLOGY PARAMETERS OF THE RACCOON (*PROCYON LOTOR*) AND THE RACCOON DOG (*NYCTEREUTES PROCYONOIDES*) IN HUNGARY

Zsolt Biró[1,2], Balázs Bócsi[1,2], László Szabó[1,2], László Galambos[3] & Krisztián Katona[1,2]

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The raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procyonoides*) are present across mainland Europe as a combined result of escapes from captivity and introductions. The spread of these invasive species can threaten native ecosystems, species or even human beings. The raccoon population has increased by 300% in Central Europe since the 1990s. The raccoon dog population increase is not known in Europe, but e.g. in Finland the hunting bag increased from 818 in 1970/71 to 172,000 in 2009. These species are on the European Union's list of alien invasive species (EU regulation 1143/2014) which means the Member States are required to prevent further introductions and to monitor their populations. We have received photo documentation on hunted animals and obtained several carcasses from the hunters from different areas of the country for further examination. These species are characterised by a very flexible diet and habitat use thus the individuals in Hungary can be in good condition and can form a well-breeding population like in other countries. Our objectives were to describe the body mass, body size, body condition and reproductive index of Hungarian raccoons and raccoon dogs and to compare them with values found elsewhere in their range. The body mass, body, hind foot and tail length

were measured on the carcasses. The body condition was estimated by the kidney fat index and body mass index (BMI) while the reproductive ability was characterized by the number of placental scars found in the uterus of the females. The investigation was carried out on 55 raccoons and 25 raccoon dogs. No difference was found in the body mass and kidney fat index between sexes in the raccoons. But the Hungarian and Japanese populations differed significantly in the case of each sex, the Japanese raccoons had higher BMI values. The average reproduction rate of the sample females was 2.8 ± 2.09 offspring, which was similar to the Japanese value (3.9). The fertility of the raccoon dogs was much lower than in Denmark or in Finland (2.57 ± 1.67 vs 10.8 ± 0.4 or 9.6, respectively). The body condition of this species was similarly low as in the raccoons (<100 %), however the females have better kidney fat index in the raccoon dogs compared with the males (48.7% ± 22.8 vs 87.4% ± 73.9). This higher body condition parameter however did not cause larger fertility as in Finland. We can conclude that the body size characteristics of the two invasive mammalian predators appear somewhat smaller than in other countries. Body condition scores are also similar, so the two species may be as successful in Hungary as in other occupied areas. However, the reproduction rate is much lower therefore the game managers have a better chance to effectively decrease the population density in our country.

NUTRIA *(MYOCASTOR COYPUS)* ERADICATION PROGRAM IN NORTHERN HUNGARY

Balázs Bócsi[1,2], Zsolt Biró[1,2], László Darányi[3] & Krisztián Katona[1,2]

[1] Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary
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One of the most recent problems in wildlife conservation and management is the spread of different invasive species. As a solution, we have to manage the expansion of these species in the new areas. The nutria *(Myocastor coypus)*, a semi-aquatic, large rodent has appeared in Hungary in the wild in the last decades and started to spread, which means a new potential threat on the native flora and fauna. To secure nature and wildlife in Hungary, a management initiative on invasive species by the Hungarian government was launched, in which the Hungarian University of Agriculture and Life Sciences was the leader of a local nutria eradication project. The control program took place in the Börzsöny mountains (Northern Hungary), which area is under the supervision of Duna-Ipoly National Park Directorate. The project started in June 2024 and lasted until the middle of October 2024. During this time, we used cage traps to capture animals and then we terminated them in a legal and ethical way. We also placed trail cameras near to the traps and at the entrance of the dens to record videos and get more information. The second part of the program took place in the laboratory, where we dissected the carcasses. We investigated the condition and reproduction of the species through measuring the body sizes and observing the genital organs. We eradicated 31 individuals during the project

period, which reflects that our methods were efficient. The most individuals we could eliminate within one day, were 7 specimens. There were 2 different sites of the area (Vámosmikola and Letkés) where we worked. We suppose that we managed to eliminate the most of the occurring nutrias in Vámosmikola, since at the end of the program, nutrias disappeared from that area. In Letkés, still we found several signs of the nutria presence. Based on the laboratory observations the animals were in good condition, their body sizes were fitted to ones living in the native distribution range of the species and they were able to reproduce during the whole period of the project. Although the nutria could disappear from Vámosmikola for a while, they can re-appear again and several individuals should be still present in Letkés, which can provide the basis of a future population increase. As a consequence, we have to continue the eradication program, to stop or at least just slow down the expansion of this non-native, harmful, invasive species.

ENEMY BEHIND THE GATES? PREDICTED CLIMATE CHANGE MIGHT FACILITATE C4 GRASS INVASION IN EUROPEAN GRASSLANDS.

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Climate change is anticipated to facilitate the proliferation of non-native species, particularly C4 grasses, in Europe. Despite this expectation, a comprehensive analysis of the phenomenon is lacking. This study aimed to compile a current inventory of non-native C4 grass species in Europe and forecast their future distribution. Employing systematic literature review methods, relevant publications were scrutinized to compile an accurate species list. Information regarding the current status of identified species, native climatic zones, habitat preferences, and temporal distribution patterns was gathered. The study revealed the presence of 133 non-native C4 grass species across Europe, with Western European countries hosting the highest number (103 species) and Northern Europe the lowest (69 species), although there was significant overlap among regions. Southern Europe exhibited the highest number of naturalized (55) and invasive (21) species, while Northern Europe had the highest number of casual species (53), indicating a delay in colonization. We identified the most widespread

and high-risk species, including those from tropical and subtropical climatic zones, which pose the highest invasion risks. These species predominantly occur in various ruderal and anthropogenic habitat types, but also in natural habitat types, especially in grasslands. Regarding temporal trends, we detected an alarming increase in the establishment of tropical C4 grasses in Europe in recent decades. The findings highlight significant variation in invasive statuses among European countries, suggesting that besides climate and invasion potential, human activities play a crucial role in the invasion process of non-native C4 grass species. The study underscores the necessity for collective efforts to address this burgeoning biodiversity concern. In conclusion, proactive measures are essential to mitigate the impacts of non-native C4 grass species invasion in Europe.

ESTIMATING THE DISPERSAL POTENTIAL AND IMPACT OF *OPUNTIA HUMIFUSA*, A NEW ALIEN PLANT: THE BASIS OF EARLY WARNING AND MANAGEMENT

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Some of the newly emerging alien species will become invasive, but it is difficult to predict which one. As early control of invasive species is the most effective, thus we should collect information already about the newly established populations, to recognize early the "invasiveness" of a species in a given region. This requires an assessment of the potential for spread and the impact on the native community. The North American native prickly-pear cactus (*Opuntia humifusa*) was established in Hungary in 2000 and is becoming an increasingly popular ornamental plant. In our research, we assessed the population size and amount of propagules of the species around one of the oldest and largest stands in Kiskunság, Hungary. Moreover, we investigated the role of roads and habitats in its distribution pattern; and the impact of this species on plant communities. We conducted a systematic survey around the first establishment point, and we measured the size of each stand. We investigated the relationship between the size of cacti stands, the shoot and the fruit number. Based on this we estimated the total propagule pressure of cacti in the studied area. Using paired plots the difference between invaded and

non-invaded stands was studied. We found altogether 64 stands around the first establishment point. The prickly-pear cactus spreads easily by broken shoots, and many of its small stands are vegetatively grown. The stands are significantly closer to roads and significantly more stands are found in dry grassland than random points of the same density. We estimated that in the study area, the prickly-pear cacti produce about 25000 fruits per year. The characteristics of prickly-pear are significantly different from native species in dry grassland (perennial succulent, C4 photosynthetic pathway, fleshy fruit), thus presence and abundance alter the community composition locally. Although it is growing relatively slowly, it produces a large number of viable propagules (shoots, seeds) and this species changes the community characteristic fundamentally. Thus we think, there is an urgent need to control this species and support the local native plant species to develop an invasion-resistant community.

INVASION CONTROL BY SOWING NATIVE SPECIES – EFFECTS OF PROPAGULE PRESSURE, PRIORITY EFFECT AND TRAIT SIMILARITY

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Ecological restoration is an effective tool for limiting invasive alien plants by contributing to increasing the biotic resistance of native communities. We set up a pot and a field experiment to test whether seeding native species can reduce the establishment or growth of invasive alien species, based on priority effect, higher propagule pressure of native species, and the similarity of plant traits. In the pots, we co-seeded invasive alien species (*Asclepias syriac*a, *Conyza canadensis*, *Tragus racemosus*) with native species (*Festuca vaginata*, *Galium verum*, *Gypsophila paniculata*, and *Saponaria officinalis* – selected on the basis of similarity of plant traits), simultaneously or adding invasive species one month later, in equal and fivefold seed quantities. In the field, we seeded the native species in a similar setting on an established stand of *A. syriaca*, but instead of testing for priority effect, the milkweed was limited by mowing. In the pot experiment, the establishment of each invasive species was affected by the tested mechanisms, but in different ways. Height of *C. canadensis* was positively affected by co-seeding with *S. officinalis* and *F. vaginata*, but negatively affected by propagule pressure and priority. Leaf size of *C. canadensis* was negatively affected by priority and propagule pressure, biomass was

negatively affected by propagule pressure. The height of *A. syriaca* was negatively affected by co-seeding with *F. vaginata* and *G. paniculata* and was negatively affected by propagule pressure. The establishment of *Tragus racemosus* seedlings was affected by propagule pressure, but we have no further results due to the die off of seedlings during winter. In the field experiment, mowing increased the number of *A. syriaca* shoots in the short term, but limited flowering ability and cover of *A. syriaca*. Our results show that the establishment and growth of invasive alien plant species can be limited by higher density and priority sowing of native seeds, but the impacts are species specific. Seed production and further spread of established milkweed populations can be reduced by mowing, but further monitoring is needed to show the effect of seeding with native species in the field.

THE PET TRADE AS A VECTOR FOR NON-NATIVE SPECIES SPREAD: INSIGHTS FROM GERMANY

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An increasingly globalised world has facilitated the movement of non-native species (NNS) via the poorly regulated international pet trade. With the management of established NNS often difficult and expensive, increasing focus is being placed on preventative action. However, in the case of the pet trade, successful prevention requires controlling potential pathways, and obtaining baseline knowledge of the species sold and the risks they pose. Here, we performed an in-depth analysis of the German freshwater pet trade as one major vector of NNS, compiling its species inventory and deriving threats of NNS release and establishment in the wild. We surveyed pet stores, websites and the country's largest online classified portal, eBay Kleinanzeigen, recording the taxa encountered. For each species, we determined likelihood of release based on availability and price (cheaper and/or more readily available species have been shown to be of greater risk), and their likelihood of establishment based on ecological niche breadth and niche overlap with environmental conditions in Germany. The survey revealed 669 species, of which 651 were non-native to Germany. More readily available species in pet stores and on websites proved to be cheaper; and on websites, released NNS and native species were significantly cheaper. Species previously released in Germany and

elsewhere demonstrated greater niche breadths and greater niche overlaps between their source regions and Germany; and for species released in Germany, there was a significantly positive relationship between the magnitude of niche overlap and the number of documented occurrences. We combined our release and establishment likelihood findings under our “Release Risk” metrics to highlight the species most worthy of prioritisation. We propose these metrics as innovative, proactive methods for meeting the challenges posed by the global pet trade, which can inform future policy direction and intervention.

CONTROLLING *AILANTHUS ALTISSIMA* WITH THE HACK & SQUIRT TECHNIQUE IN ISRAEL

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The tree-of-heaven, *Ailanthus altissima* (Mill.) Swingle is one of the main alien invasive trees in Israel where it proliferates in natural and semi-natural habitats within the Mediterranean region of the country. A new technique has recently been developed in Israel for the control of *Ailanthus altissima*. It is based on the direct application of minute volumes of Milestone® (active ingredient: aminopyralid) in cuts made around the trunks so the herbicide is in contact and absorbed by the phloem and the xylem. The control does not induce cutting down the trees. The hack & squirt technique ensures an immediate translocation of the herbicide through the entire tree, including down to its root system. Trials performed in Israel have shown that a dose of 3 ml of herbicide per each 5 cm of trunk diameter (dbh) is enough to kill ca-90% of the controlled trees after one single application. The trees lose vitality and die within 7 to 10 months. The most appropriate season for the application is late summer. Once the trees have lost vitality, they can be fallen off safely, if necessary. The hack & squirt technique has several advantages that should be highlighted: Since the trees are not cut down, the resprouting process is not induced and no root sucker develops around the cut stump; this is a major point as *Ailanthus altissima* resprouts vigorously. The technique itself is very easy to apply in most terrains, it does not require special training and it is very quick to apply: A mature tree can be controlled within less than 60 seconds. No electric or gasoline gear is necessary; only an axe and a pipettor are used for the control: no need to recharge electric batteries or to carry heavy gear in the field. The volumes of herbicides used for the

control are very small and no spray is involved in the process. Therefore, this technique is safe for controlling trees in riparian habitats and in protected sites such as national parks or nature reserves. At last, aminopyralid is considered as one of the herbicides with the best ecotoxicological profile, far better than triclopyr or glyphosate. Milestone® has notably been registered under the Reduced Risk Pesticide Initiative of the U.S. Environmental Protection Agency. This technique has been approved in 2023 by the Israel Plant Protection & Inspection Services of the Ministry of Agriculture and is now applied in the country. Since aminopyralid has been approved by the EU in 2015, the technique detailed above can be considered for the control of *Ailanthus altissima*, especially in sensitive habitats and protected areas in Europe.

INVESTIGATION OF FLAVIVIRUSES IN INVASIVE MOSQUITOES IN HUNGARY

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Flaviviruses, including the West Nile virus (*Orthoflavivirus nilense*, WNV) and Usutu virus (*Orthoflavivirus usutuense*, USUV), are emerging zoonotic pathogens transmitted primarily through mosquito bites. USUV shares a similar ecological niche and epidemiological cycle with WNV. Both viruses primarily affect birds, but human infections have been increasingly reported, often presenting as febrile illness or neuroinvasive disease of growing concern in Europe. In this study, we aimed to investigate the presence of WNV and USUV in invasive mosquito populations in Hungary using PCR-based detection methods. Mosquitoes were collected in areas with reported human and equine WNV cases using BG-Sentinel traps. Sampling in 2023 was conducted across 84 locations, where 7774 mosquito specimen (307 invasive) were collected, while in 2024, 4102 mosquito specimens (293 invasive) were trapped at 34 locations. All invasive mosquito species collected were tested (*Ae. albopictus* 62, *Ae. koreicus* 45, *Ae. japonicus* 5 pools), and in addition, mosquitoes from selected sites were fully tested (133 pools), including all specimens trapped regardless of species. Each pool consisted of individuals belonging to the same species and genus, collected during a single sampling event at a specific time and location, with a maximum of 20 specimens per pool. We carried out WNV lineage 1, WNV lineage 2 and USUV detection using a multiplex qPCR by DelAmo et al. (2013) and a single-plex qPCR by Nikolay et al (2013) for USUV confirmation. We

identified 39 USUV and 7 WNV positive mosquito pools in the multiplex assay, but confirmation of the USUV results had reduced the final number of positives. None of the three well established invasive mosquito species were found infected with either WNV or USUV, despite the confirmed circulation of both these flaviviruses in autochtonous vector species. Further virological and epidemiological characterisation of the detected viral strains is under way. This study was part of the continuous monitoring of invasive mosquito populations and their pathogens aiming to better understand and mitigate the risks posed by flavivirus transmission in Hungary.

CHANCES OF CONTROLLING HUNGARY'S WORST INVASIVE TREE SPECIES IN FOREST-STEPPE FORESTS: FROM PLANNING TO SETTING UP DEFENSES

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Ailanthus altissima, *Celtis occidentalis*, *Prunus serotina* and *Acer negundo* are among the worst invasive plant species in Hungary. Numerous attempts have been made to control these tree species, but no eradication success is known even on the local scale. This pressing issue was addressed within the framework of a 5-year LIFE project and several related studies carried out in the Felső-Kiskunság region of Hungary. One of the core elements of the research was a monitoring program, which resulted in a full-coverage dataset: an area of 1500 ha was completely surveyed on the field with 35,000 survey units according to a 25 × 25 m grid. This provided an opportunity to both explore the methodological problems of data collection and to evaluate the success of treatments at high resolution. In addition, specific studies on propagule pressure, vegetation environment, disturbances, seed banks, spreading and revitalization dynamics were carried out. Some of the main findings are summarized below. 1. Our simulation studies have shown that spatially realistic occurrence and abundance patterns of invasive tree species at spatial scales of practical importance can only be approximated by full-coverage field surveys. The low sampling intensities adopted in many descriptive studies lead to order-of-magnitude errors, and often tree species are not even detected in a given spatial unit. This error can, for example, have a serious

impact on the resource estimation of treatments. 2. The rate and magnitude of the invasions of the tree species were primarily determined by disturbance factors. Most of Hungary's forest-steppe forests are managed according to different cutting systems (e.g. coppicing), which entail a series of disturbances in space and time, ultimately resulting in an 'exponential rotational dynamics' of invasions. 3. Vegetation structure is a key explanatory factor of invasibility, and also proved to be a major determinant of invasions of the four tree species in these forests. As a result of different investigations, the low shrub layer (< 2m) can be highlighted as the primary line of defense. However, due to lowland silvicultural practices, shrub cover is often reduced. A well-developed shrub layer would not only contribute to conserve biodiversity, but also to reduce invasions. 4. Propagule pressure can also be interpreted as a null model for the spread of these tree species – as has been shown for many taxa before. However, its importance varies between the tree species, as it definitely plays a greater role in the invasion of *A. altissima* and *A. negundo* than in *C. occidentalis* and *P. serotina* (this may be due to e.g., differences in shade tolerance). 5. Finding and removing all the seed-bearing individuals is one of the keys to successful management: one vital mother tree is enough for a rapid population burst in a large area. 6. The durability of the long-term mitigation of invasions is determined by the maintenance of (semi-)natural condition of the vegetation and the efforts made to achieve this, i.e. passive protection by reducing invasibility.

TRADITIONAL ECOLOGICAL KNOWLEDGE AND LOCAL VALUE CATEGORIZATION OF INVASIVE ALIEN PLANT SPECIES OF HERDERS AND FARMERS IN THE KISKUNSÁG

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Knowledge co-production and cooperation between the scientific and local traditional knowledge systems are vital for a better understanding of socio-ecological processes in a rapidly changing fine-scale cultural landscape, such as the grasslands of the Kiskunság region (Hungary). Here, tradition-based small-scale management is essential for the protection of valuable habitats, which means communication and cooperation with locals is also crucial. We aim to support these interactions by conducting interviews with locals, farmers, and herders, documenting the rapidly fading traditional ecological knowledge in order to explore their perceptions of nature, with a special focus on invasive alien plant species, as one of the major drivers of regional landscape change, and serious concern of conservationists in protected areas' land-use management. During data collection, we paid special attention to the diversity of locations, timing and methods of the interviews adapting also to the diverse personalities of informants'. This has helped come even closer to the reality knowledge holders perceive. We conducted 54 interviews with 38 informants so far (1-4 interviews per informant) both outdoor (28 times) and indoor (26 times). While we intended to keep invasive alien plant species (IAS) in focus, we had to avoid designing semi-structured interviews in a way that leads to biased data, therefore we also involved native and rapidly spreading native plant species in our species list (ca. 200 species, 25 IAS). We documented the local folk names and traditional uses of nearly 100 native and 20 invasive alien

plant species, along with local names of their preferred habitats (ca. 50-60 types), and the adaptive changes to the traditional management practices they used in case of these areas. We also collected more than 300 quotes on IAS in general, and numerous quotes containing 'local oral history' type of knowledge about changes in the above-mentioned species' distribution and abundance over time. Nature holds relational value for the respondents, with complex and deep personal emotional attachment to various species, habitats and landscapes, including IAS. We found some unconscious patterns behind the perception of invasive alien plant species. Such as locals automatically regard a species (e.g. *Robinia pseudoacacia, Elaeagnus angustifolia*) that has been part of the landscape since their childhood as native (cf. shifting baseline syndrome) and they find the presence of certain aggressively spreading alien plant species (e.g. *Opuntia* spp.) beautiful and joyful (relational value). Through learning about the differences between the scientific/conservationist and local value categorization systems, we built partnership in local land management, and identified so-called bridging people who can mediate between the two knowledge systems for effective communication and cooperation.

MILKWEED (*ASCLEPIAS SYRIACA*) INVASION, FOREST-STEPPE FRAGMENT SIZE AND ISOLATION JOINTLY CONSTRAIN ARTHROPOD COMMUNITIES AND THEIR FUNCTIONAL TRAITS

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Habitat fragmentation, has far-reaching negative impacts on the environment, resulting in biodiversity loss, soil quality degradation and alteration of water availability. In addition, fragmentation can disrupt ecological processes, potentially facilitating the establishment and spread of invasive plants, which can further harm native arthropod communities and alter their ecosystem dynamics. However, the exact nature of these impacts may vary depending on local conditions. We investigated the impact of fragmentation and milkweed invasion on invertebrate communities in sandy grasslands of forest-steppe habitats in Hungary. We selected 30 grasslands in forest-steppe fragments, varying in size (0.2 to 8.7 ha) and connectivity (Hanski's connectivity index: 0 to 705). We sampled ground-dwelling arthropods, mainly herbivores (true bugs) and predators (spiders), with pitfall traps and pollinators (wild bees) by direct observations along transects in invaded vs. non-invaded patches (min. of 500 m^2) of each fragment. We considered arthropod species' body size (all groups),

dispersal ability and feeding (herbivores and predators) and nesting location and social habit (wild bee) traits in our analyses. In non-invaded patches, the number of monophagous herbivores showed an increasing trend, whereas in invaded fragments, there were more polyphagous individuals with increasing connectivity and fragment size. The dispersal ability of predators was lower as connectivity increased in non-invaded patches but higher in patches invaded by milkweed. Furthermore, fragment size influenced predator hunting strategy, resulting in more web-builders in large fragments. We found more ground nesting bees in the invaded patches of small fragments than in large fragments, however, we did not find a significant effect in non-invaded patches. In summary, we often found interacting effects of the studied variables, fragmentation and invasions, generally modifying each other's effect by filtering for opposite trait levels. The primary focus of restoration projects should be restoring habitat of appropriate size and connectivity and eradicating invasive species while concurrently supporting the revival of native species and their ecological relationships. It is essential to employ adaptive management techniques, including continuous monitoring, to effectively tackle the interaction between fragmentation, invasion, and the preservation of biodiversity.

REDUCING RISKS TO HUMAN HEALTH BY REDUCING INVASION THROUGH ECOLOGICAL RESTORATION

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Invasive species can have a direct health impact and act as vectors, carrying various health risks to cultivated plants and to human and animal health. Ecological restoration is in the forefront of global activities to counteract the negative effects of globalization, including invasion of alien plant species. Ecological restoration can improve public health by increasing the number of healthy ecosystems that provide ecosystem services for human wellbeing, but also by directly reducing invasive alien species with a direct impact on health. Common ragweed, *Ambrosia artemisiifolia*, is an invasive annual plant species in Europe with highly allergenic pollen that causes serious health problems. The species invades most habitat types when soil disturbance occurs, but may disappear from aboveground vegetation as succession progresses and vegetation closes in. We studied the long-term changes in the abundance of *Ambrosia* in various sand grassland restoration experiments including mowing, carbon amendment and seeding treatments. The interventions took place from 1995 on and were monitored for up to 25 years mostly in permanent 2 m by 2 m plots. Among the annual invasive species, *Ambrosia* was one of the most dominant species in the vegetation surveys, with an average relative cover up to 14% in the abandoned fields. The relative cover of annual invasive species including *Ambrosia* decreased over time as expected, with some fluctuations probably due to natural or human disturbances and/

or precipitation pattern. Restorative treatment generally increased the cover of target species that lead to the suppression of *Ambrosia.* Of the three types of treatment used, introduction of native species had the strongest positive effect on the progress of recovery and strongly reduced *Ambrosia*. We have shown that the spontaneous recovery of disturbed areas, such as clear-cut plantations, abandoned old fields and industrial sites can be accelerated by restoration intervention, in particular by introducing native species through seed or hay transfer that in turn reduces the abundance of *Ambrosia artemisiifolia.* Prevention should focus on reducing soil disturbance to avoid infestation of the species, and treatment should focus on restoring disturbed habitats to shorten the time available for spread and pollen dispersal to reduce health risks.

SHORT-TERM RESPONSE OF AN INVASIVE FISH SPECIES ON THE BEAVER-MADE LANDSCAPE ALTERATIONS

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In the middle of the 19th century, the Eurasian beaver was almost completely eradicated from the whole territory of Europe. In parallel to this process, its habitats were largely altered because of human land-use interests. As a result of conservation efforts, the species re-occupied most of its former distribution range. Nowadays, beavers contribute to the restoration of stream complexity and floodplain habitats. As "disturbance agents", they alter physical ecosystem processes, and the established aquatic community has to adapt to the hydrological and geomorphological changes caused by their building activity. Our study aims to understand the changes caused by beaver landscaping in the fish community, in the light of the biological invasion. The research was conducted in the Borsodi-Mezőség region of Northern Hungary, along beaver-impounded and not impounded sections of the Csincse, Eger, Geszti, Kánya, Kácsi, Kis-Csincse, and Laskó streams in four seasons (autumn of 2022, spring of 2023, autumn of 2023, and spring of 2024). Fish were caught using a backpack electric fish catcher. The number of fish individuals per species was analyzed by general linear mixed models in R software environment. In total, 14,538 individuals of 27 fish species were captured. 7 of these species are protected by national regulations, 5 of these are species of community interest in the European Union,

and 6 are considered non-native species in the Carpathian Basin. The most abundant invasive species was the Prussian carp (*Carassius gibelio*), followed by stone moroko (*Pseudorasbora parva*). The number of Prussian carp individuals was significantly higher along the beaver-impounded sections than along the not-impounded sections. Invasive species may react quicker to environmental changes and occupy newly created habitats faster than native species with similar habitat requirements. This fact can be true in the case of beaver-altered fish habitats, as well. It should be noted that we were examining only a short period of time, and the changes in the local fish community should be monitored in the long term. Conservation conflicts may arise during the protection of an ecosystem engineer species. Beaver impacts are natural and predominantly positive, however, the potential risk of exacerbated biological invasions has to be considered during the conservation planning of beaver-altered stream ecosystems. Previously, we highlighted a similar conservation conflict in relation of beavers and invasive woody plant species.

WILD BOAR ROOTING IMPACT ON GRASSLANDS: HOW MUCH COULD BE TOO MUCH?

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Wild boar (*Sus scrofa*) is invasive in various parts of the World including the Americas, Australia and several islands, causing significant ecological disruption by damaging natural and agricultural vegetation, primarily through its rooting behaviour. In its native ranges in Europe and Asia, it is also a very common high-impact ungulate species. It has a great negative influence on forest management and agricultural crop production, but it can also make it difficult to mow grasslands. However, wild boars also contribute to ecosystem health through bioturbation, which helps aerate soil, establishes heterogeneous patches in microtopography and vegetation cover, which promotes the redistribution of soil nutrients, thus enhancing plant diversity. Although it plays a crucial role in the ecological processes of open grassy areas, we have limited knowledge on the spatiotemporal patterns of the rooting and its consequences on the soil and vegetation composition. In Hungary the wild boar lives in high densities, and it also established a dense population in the wetland area of Kolon lake, Kiskunság region, in central Hungary and in the dry grassy area of Budapest at Vöröskővár area. For obtaining a better knowledge about the level of wild

boar impact, our aim was to determine the extent of rooted ground surface and analyse rooting effects on soil nutrients. At the Kolon-lake we flew a drone over 11 sites totaling 261 ha (min.: 0.36; max.: 85 ha) in April–May 2023 and repeated the survey at 5 sites in May 2024. At Vörösk̋vár an area of 5 ha was surveyed monthly through walking transects between spring 2023 and 2024. Additionally, soil properties were measured within and out of 40 rooted patches in April 2023. Analysing the ortophotos we revealed that 8.85±7,65 % of the surface was disturbed by wild boar foraging activity. However, using a grid established by cells of 20×20 m, we found that 84±18 % of those cells contained some rooted surface, meaning that wild boar affected the most parts of the areas by patchily distributed rooting of various sizes. At Vörösk̋vár the monthly average proportion of the disturbed 20×20 m grid cells was 70.82 ± 19.97% (ranging between 35 and 88 %). Among macronutrients, nitrogen, phosphorus and potassium levels were equally lower in the rooting than in the re-distributed soil (ring around the rooting) or in the control samples. However, iron and clay content was higher within the rooted patch, while no difference between rooting and control was found in case of calcium, magnesium and pH level. We conclude that wild boar has a great importance in redistributing soil nutrients, where deeper rooting can cause a decrease in soil nutrients level; moreover, in driving the dynamics of vegetation changes by establishing bare ground available for both, worse competitor native pioneer species, but also to invasive ones, in which case more extended rooted surfaces can promote invasion processes. Reliable prediction of the consequences of wild boar rooting in marshlands and other grassy areas on the soil and vegetation composition based on monitoring of rooted patches is crucial for adequate habitat management.

MAPPING CACTI THAT HAVE ESCAPED HUMAN CONTROL IN HUNGARY

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Cacti (except for one species) are native to the Americas, however, through the ornamental plant trade and their use as crops, they have now reached every country in the world. As invasive plants, they have caused serious problems in many regions, including Australia, where entire parts of the country became depopulated at one time due to cactus invasions. They have also become dangerous transformer plants in South Africa and the Mediterranean. Nowadays, cacti are spreading even in the temperate regions of Europe, and many species easily survive the winters. This is not unexpected, because on the Americas, for example, the *Opuntia* genus has a distribution range stretching from 56° north to 43° south latitude, including mountainous regions. In Hungary, cacti are still in the initial stages of their spread, which means there is still an opportunity to control their expansion. As initial steps, the following tasks are currently underway: (i) Mapping their distribution. (ii) Identifying the causes of their escape from human control. (iii) Initiating their eradication and testing control methods. The mapping started with the review of scientific papers, followed by the grey literature and popular science articles. Given the low number of data, we established a citizen science community in 2022 called "Cacti in Nature" which now has around 2,400 members. We visited some of the identified locations,

recorded the most likely causes of their establishment, and performed vegetation surveys. Documented eradication efforts have also begun in several locations. In 2021, we found data on only 4 cactus occurrences in the scientific literature and an additional 15 from other sources. However, through our own surveys and contributions from the citizen science community, nearly 100 additional occurrences were identified over three years, bringing the total known locations to 115. The most frequent species are: *Opuntia humifusa* (94 populations), *Opuntia phaeacantha* (16), *Opuntia macrorhiza* (8), *Cylindropuntia imbricata* (7), *Opuntia polyacantha* (2), and *Cylindropuntia kleiniae* (2). Some sites harbor more than one cactus species. In the case of three species (*O. humifusa*, *O. macrorhiza*, and *O. phaeacantha*), we revealed that they are capable of reproducing from seeds in natural conditions and that young plants survive the winter. Over half of the cactus colonies originated from the disposal of green waste, followed by direct planting as the next most common origin. Cactus removal was initiated using mechanical and chemical methods, the initial results suggest, that mechanical methods are insufficient for complete eradication. Research on cacti, as potentially transformer plants, is essential because they could pose significant challenges in the future. With increasing aridification, they could gain a competitive advantage over native species, and if local fauna starts consuming their fruits, controlling their spread could become impossible.

FREQUENCY OF BIOLOGICAL INVASION IN DIFFERENT HABITAT TYPES IN HUNGARY

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We study the distribution of invasive plant species among habitat types and ecological condition of habitats. We used the national basic habitat map representing 48 habitat types (http://alapterkep.termeszetem.hu/), and the national high resolution green infrastructure performance map (based on ecological condition, ecosystem services and ecological connectivity) of 6 categories, from settlements to high quality natural habitat, both compiled for the national ecosystem mapping of Hungary (https://termeszetem.hu/). For representing the spreading of invasive plant species, we applied the National GIS Database of Invasive Plant Species of Hungary based on geotagged field photo data collections of Land Use and Coverage Area Frame Survey (LUCAS) from 2009, 2012, 2015, and 2018 (http://earth.geo.u-szeged.hu/invasive/index_en.html). The total 18749 data points show the occurrence of *Ailanthus altissima, Asclepias syriaca, Elaeagnus angustifolia, Robinia pseudoacacia, and Solidago canadensis & altissima spp*. The distribution of the species among habitat types and condition categories were analysed with bivariate glm statistics in R. The habitat preference of two tree species, *Robinia* and *Ailanthus*, is similar, most frequently occurring in settlements and non-native tree plantations, although

their abundance is very different, as Robinia is the most abundant with 17.0% frequency and the *Ailanthus* is the least one with 1.5%. *Solidago* species (7.1%) prefer all moderately humid to wet habitats without closed tree canopies. *Asclepias* (4.0%) frequents vineyards, orchards, sand grasslands, poplar forest and any tree plantations. *Elaeagnus* (3.0%) prefers any grasslands and wet habitats including open sand grasslands and marshes. For all species, the general distributions among the green infrastructure condition categories are similar: they are generally infrequent in agricultural areas (category 1) and the highly natural habitats (categories 4 & 5) and prefer disturbed areas (categories 2 & 3). Our results give us national scale overview of the habitat preferences of the studied species, opportunities for more detailed analyses, and can be starting points of further studies. By applying LUCAS, the European extension of our approach is also possible.

EXAMPLE OF TRANSNATIONAL COOPERATION FOR EFFICIENT IAS MANAGEMENT

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The transnational ecological corridor of Sava River is connecting five EU and non-EU countries, having quite different policies and management practices when it comes to invasive alien species (IAS). The transnational project SavaTIES (DTP2 096-2.3) provided joint platform for IAS management in this heterogeneous environment. Developing an IAS Mapping and Monitoring Protocol the GIS-based IAS database was initiated at two levels – experts and citizen science, creating possibilities to involve wide circle of stakeholders into database building. Gathered information include the types of infested habitats, the size and basic spatial characteristics of the IAS spot and other pragmatic information from the aspect of cross-sectoral cooperation towards effective IAS management. Development of a backend structure for the database implementation was supported by European Alien Species Information Network - EASIN, including a mobile application for IAS mapping. The project team jointly recognised 32 key invasive plant species in the Sava river basin countries. The outputs were tailored to the needs and capacities of conservation practices, being implemented by protected area managers as an early warning system and platform for prioritizing eradication activities depending on the threatened species and habitats. The lessons learned can be upscaled within the scope of HORIZON EUROPE project Restore4Life (101112736).

THE THREATS OF THE COLONIZATION OF AN ALIEN PERENNIAL GRASS, *PASPALUM DISTICHUM* L. TO THE NATIVE FLOODPLAIN VEGETATION IN HUNGARY

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At the advanced stages of invasion, the control of invasive alien species (IAS) often exceeds the capacity of the agencies responsible for IAS control. Therefore, early detection and control of potential IAS in the first stages of the invasion process is crucial for a successful and cost-effective solution. This is particularly urgent when perennial grass species become established in wetlands through hydrochory, as the introduced alien species have the potential to colonize the entire watershed rapidly. Here we present a case study on knotgrass (*Paspalum distichum* L.), an alien perennial grass species first detected in Hungary in 2020, in a floodplain of the Danube River. The study aims to predict the invasion behaviour of knotgrass in the focal region by combining trait-based approaches and risk assessment tools (i.e. EPPO, Harmonia+, A-WRA). In the place of its first detection in Hungary, we compared the species richness, biomass and seed production of the native and the invaded vegetation. We found that knotgrass formed monodominant stands characterized by extremely high biomass decreasing the diversity of vegetation. The fresh weight of biomass was almost three times higher in invaded plots than in native vegetation. There were no significant differences between the seed yield of knotgrass and the dominant species

of native vegetation. All three risk assessment systems that we applied put the knotgrass into the most dangerous category implying that this species can easily start spreading and become a transformer species in Hungary. There are a lot of further potentially suitable habitats for the knotgrass connected with the already occupied site, and the high propagule pressure and strong competitive ability suggest a high probability of future expansion.

IMPACT OF PLANT POLLEN ON THE EARLY DEVELOPMENT OF PLANT PATHOGEN: IMPLICATIONS FOR AGRICULTURAL HEALTH AND FOOD SAFETY

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Pollen production from weeds and other invasive species poses a substantial risk to public health, primarily due to their widespread presence in large agricultural areas and natural habitats. While the amount of airborne pollen biomass is relatively low compared to other plant parts, it holds particularly high biological value. Accumulated pollen grains provide a nutrient-rich supply and serve as strong biological stimulants for the initial growth of fungal spores on plant surfaces. Nevertheless, the function of the pollen-stimulated spore germination and the species-specific differences in the pollen-spore interferences are still less understood. We aimed to investigate how taxon-specific attributes, such as host-pathogen compatibility, cultivation methods, pollination types, and pollen sizes, affect the time- and concentration-specific responses of initial spore germination in *Botrytis cinerea* which pathogen causing serious agriculture problems worldwide. This experimental study involved 20 plant species, including both invasive and non-invasive weeds, as well as agricultural crops. We found high species-specific variations of different pollen in the stimulating effects among different functional groups on spore germination. Pollen collected from host plants, non-cultivated species and species with larger pollen grains was shown to enhance the spore germination of *Botrytis cinerea*. The revealed variances might indirectly reflect the diverse chemical profile of the pollens (i.e., nutrients, specific trigger molecules, hormones), which are likely a result of species-specific

adaptation mechanisms. Our study demonstrated the impact of pollen production on crop-pathogen interactions, which can be considerably influenced by the massive airborne pollen production by invasive plant species. Pollen production could establish a serious environmental and ecological risk to agricultural production and food safety, with the potential for these risks to grow as invasive plant species continue to spread. Therefore, future studies should pay more attention to the pollen-modulated species-specific interactions and their background mechanisms.

THE INVASION OF SAND DROPSEED (*SPOROBOLUS CRYPTANDRUS*), A C_4 PERENNIAL BUNCHGRASS, IN SAND GRASSLANDS OF CENTRAL EUROPE

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Although perennial grasses dominate large biomes, they are relatively rare among the most dangerous invasive plant species in Europe. In particular, perennial grasses with C4 photosynthetic pathway, which is expected to promote their expansion in the future when the frequency of heat waves, droughts, fires, and forest canopy opening may increase, are scarce. *Sprorobolus cryptandrus* is a C_4 perennial bunchgrass native to extensive areas of North America. It was first reported from central Hungary in 2016, but its spreading ability across the landscape and within habitats have not been quantified, and factors determining its success have not yet been assessed. In this study, we focused on the largest stronghold of *S. cryptandrus* invasion in Hungary, and investigated its present distribution in the landscape by mapping along dirt roads. In a separate local study in a heavily infested sand dune site of 2 km^2, we assessed the infestation level and factors affecting the species' establishment. Our landscape-scale mapping found that in April 2023, the distribution of *S. cryptandrus* encompassed a largely contiguous 600 km^2, with documented presence from 282 1-km^2 mapping units. The species occurred more than 5 m away from roads in 71 mapping units, mostly in the centre of its distribution area. *Sporobolus cryptandrus* presence was negatively related to soil organic matter content and positively related to sand content. At the local scale, we found the species in 39% of vegetation plots in a sand dune site originally covered by Pannonic sand steppes, a priority habitat in the EU Habitats Directive. Within just two years, the frequency of occurrence increased

to 60%. *Sporobolus cryptandrus* presence at this site was negatively related to the total cover of resident grassland but, surprisingly, was already unrelated to the distance from roads. Together with the species' broad macroclimatic tolerance in North America and reported mass invasion events in Ukraine and Russia, our results suggest that *S. cryptandrus* likely poses a broad-scale threat to Eurasian dry grasslands, in particular on coarse-textured sandy soils with low vegetation cover. Since eradication or even containment of the species seems unrealistic in the light of its extremely fast spread, we may consider designating stands or landscapes of utmost conservation value, which we try to keep free of the species. As a test of this approach, we started a monitoring along dirt roads in an uninfested grassland landscape (Fülöpháza Sand Dunes), with the aim of early detection and eradication of establishing founding populations.

HUNGRY HUNGRY HARMONIA – USING FUNCTIONAL GENOMICS TO MEASURE THE PREDATORY IMPACT OF INVASIVE LADYBIRDS *HARMONIA AXYRIDIS*

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Invasive alien species' (IAS) impacts are among the leading drivers of biodiversity loss globally with increasing prevalence and magnitude. These impacts are driven by behavioural traits that are expressed differently across the species' invaded range. Functional genomics offers a window into the molecular underpinnings of such biological processes. Adult female *Harmonia axyridis* ladybirds were sampled across an invasion axis running South to North of Great Britain (oldest to newest range) and subjected to three feeding regimes, including non-feeders. RNA samples were isolated from the brains of 54 individuals for RNA-Sequencing. Comparing the oldest and the newest range, 4.1% of genes were significantly differentially expressed ($p < 0.05$), indicating a time since invasion effect. Whereas 8.7% of genes were significantly differentially expressed between feeding regimes, suggesting a transcriptome-behaviour relationship for impactful predatory behaviour in *H. axyridis*. A number of genes that may be used as molecular markers for measuring increased impact via feeding behaviour was identified. Integrating these results into impact predictions have the potential to revolutionise IAS impact modelling.

HUMAN-VECTORED SEED DISPERSAL ON CLOTHING CAN CONTRIBUTE TO THE SPREAD OF INVASIVE AND WEEDY SPECIES

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People can transport numerous seeds on clothing (epianthropochory) worldwide, which can have various conservation implications, both positive effects, such as establishing connections between natural habitats and negative ones, such as spreading weeds and invasive alien species. In our study, we investigated the role of human-vectored seed dispersal (HVD) on clothing in Central Europe. In a multi-site field experiment, we collected 2008 subsamples of diaspores from shoes and socks from 88 volunteer participants from 39 different sites in Hungary, Romania and the Czech Republic. We used variables related to the movement of people, their clothing type, and the visited habitats in the analyses. We detected 229 species in the samples, from which 110 were weeds. We found that HVD on clothing provides opportunities for not only species with adaptations for epizoochory, but also for species with other forms of dispersal (e.g., endozoochory, anemochory). Individual factors (e.g., clothing type, human behaviour, activity type) and site characteristics played an important role

in the spread of seeds from one habitat to another. Our results showed that it is very important to minimize the chances of the spreading of weeds and invasive species in the nature reserves. Furthermore, it is essential to keep the wide audience properly informed about the epianthropochory and the possible prevention measures.

HISTORICAL INVASION RATES VARY AMONG INSECT TROPHIC GROUPS

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Globalization has spread thousands of invasive insect species into new world regions, causing severe losses in ecosystem services. Previous work proposed that plant invasions facilitate insect invasions through the creation of niches for non-native herbivores. Despite the impact of insect invasions, a comprehensive understanding is lacking on how invasion success varies among insect feeding groups. We therefore compiled the predominant larval trophic groups (herbivores, predators, parasites, detritivores, and brood-carers) for 5,839 non-native insect species in nine world regions to compare (1) proportions of species in each group between non-native species and the world's fauna, (2) how invasion success for each trophic group has changed over the last three centuries, and (3) how historical herbivore invasions are related to plant invasions over time and parasite invasions are related to herbivores. We find that herbivores represent a significantly larger proportion (52.4%) among non-native insects compared with the world fauna (38.4%), whereas proportions of non-native detritivores (including fungivores), predators, and brood-carers are significantly lower; parasite proportions do not significantly differ. Predators and

detritivores dominated among invasions in the 18th century but subsequently diminished, likely due to changing invasion pathways, whereas proportions of herbivores, parasites, and brood-carers increased over time. We found herbivore invasions to lag 80 years behind plant invasions, whereas parasitoids appear to co-invade with their herbivore hosts. The dominance of herbivores among non-native insects and their strong cross-correlation with plant invasions further strengthens the hypothesis that plant invasions drive the global rise in numbers of nonnative insects.

TIME SINCE FIRST NATURALIZATION IS KEY TO EXPLAINING NON-NATIVE PLANT INVASIONS ON ISLANDS

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Investigating the extent of insular invasions by non-native species (i.e., the number of islands they occupy) is central to island conservation. However, interrelationships among plant life history traits, naturalization histories, and island characteristics in determining island occupancy by non-native plant species are poorly understood. We investigated whether island occupancy by different non-native vascular plant species declines in relation to their year of first naturalization and whether periods of first naturalization differ among growth forms, dispersal modes, and biogeographic origins. Then, we asked if non-native plants that naturalized more recently occur more frequently on islands that are large, less isolated, and close to urban areas. We contrasted trends across growth forms, dispersal modes, and biogeographic origins. We combined field surveys and published data for 767 non-native plant species on 264 islands in northern Aotearoa New Zealand. We categorized each species according to its growth form (n = 3), dispersal mode (n = 4) and biogeographic origin (n = 5) and identified its year of first naturalization in Aotearoa New Zealand. We tested our hypotheses using ANCOVA and generalized linear models (GLMs). There were similar declines in island occupancy in relation to the year of first natural-

ization across all trait and biogeographic origin categories. First naturalization times of herbaceous species, those with unspecialized dispersal modes, and those originating from Eurasia and the Mediterranean basin were disproportionately earlier than other categories. Non-native plants with more recent first naturalization occur more frequently on large islands close to urban areas, but not on less isolated ones. Relationships with island characteristics did not differ among trait and biogeographic origin categories. Overall, time of first naturalization was more important than trait and biogeographic origin categories in explaining non-native plant invasion patterns on islands. Since there were similar relationships between island occupancy and the year of first naturalization in Aotearoa New Zealand for all categories, management bodies should focus on non-native plant species of trait and biogeographic origin categories that have naturalized recently (e.g., woody species from other regions within Oceania), and on large islands close to urban areas. Introduction and naturalization histories provide essential context for interpreting the role of plant traits and biogeographic origin in understanding plant invasions on islands.

CLIMATIC SUITABILITY DIRECT AND INDIRECT EFFECTS ON NATURALIZATION SUCCESS OF ALIEN PLANTS IN SOUTHERN AFRICA

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The global expansion of commerce, and human movement has led to the widespread introduction of non-native plant species. The naturalization success of these alien plants is associated with various plant characteristics that are also hypothesized to facilitate alien plant species' adaptation to the new environment. In this study, we examined the interplay between plant characteristics and climatic suitability on naturalization success of 1,407 cultivated alien plants in 18 regions of Southern Africa. We assessed the direct effects of climatic suitability (assessed using species distribution modeling) and plant characteristics, including phylogenetic relatedness, seed mass, plant height, native origins, native range size, and growth forms on their naturalization success. We then employed mediation analysis to assess how plant traits indirectly influence naturalization success through climatic suitability. Our findings revealed that naturalized cultivated plants have greater climatic suitability compared to non-naturalized ones. Furthermore, we found that naturalization success was positively associated with seed mass, plant height, native origins in Southern America, Africa and Tropical Asia, a short-lived herbaceous growth form and native range size. In contrast, phylogenetic

distance and a native origin in Europe were negatively associated with naturalization success. Our analysis demonstrated that, except for species native to Africa, these associations between plant characteristics and naturalization success were partially mediated through climatic suitability. The proportion of indirect to total predictor-response effect ranged between 95% in species native to southern America to 32% in species native range size. This research underscores the importance of considering the mediating role of climatic suitability in gaining a comprehensive understanding of how species characteristics influence the naturalization success of alien plants.

ERYTHMELUS KLOPOMOR – PROMISING CANDIDATE FOR CLASSICAL BIOLOGICAL CONTROL AGAINST THE INVASIVE OAK LACE BUG

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The North American oak lace bug (*Corythucha arcuata*) is potentially a highly dangerous invasive pest of European oaks. It was first detected in Europe (North Italy) in 2000 and in Hungary in 2013, and currently occurs in 26 countries. Most Eurasian deciduous oaks are suitable host plants, therefore more than 30 million hectares of oak dominated forests in Europe can facilitate its further spread. Hungarian oak forests (ca. 600,000 ha) are practically entirely invaded. Its negative effects can be very diverse, for example: decreasing photosynthetic activity, deteriorating oak health, decreasing acorn yield, negative effect on other oak herbivorous insects. One of the main reasons for its rapid expansion and the outbreaks is the lack of an efficient natural regulator in Europe. Only classical biological control seems feasible. It is necessary to find and introduce (only after a rigorous "non-target" study) a specialist native enemy that is effective in the pest's native range. Based on the knowledge available so far, the egg parasitoid, *Erythmelus klopomor* (Hymenoptera: Mymaridae), is the most promising candidate, based on the following aspects: 1) Specialist parasitoid of lace bugs (low risk of non-intended effects). 2) It reproduces parthenogenetically. 3) It is multivoltine, its life cycle is short (about two weeks), so its population growth is likely to follow

(and catch up with) the hosts population growth. 4) It has been found in different climatic conditions. 5) It can be collected en masse in its native area and can be cultivated en masse after the development of the appropriate method. In July 2023, we performed a two-week collecting trip to five northeastern states of the United States (Delaware, Pennsylvania, West Virginia, Virginia and Maryland). In the process, parasitoids were reared from 13 locations, from 24% of the collected 411 egg clusters. In three separate months of 2024 another collection took place in Tennessee and overall 22 other samples were collected. Parasitoids were reared from 9 of these samples, and the preliminary results provided by these samplings show an increase by the parasitoid regarding the number of samples parasitized. On average ¼ of the collected samples was parasitized, and the egg mortality was 14.48%. Our hypothesis is that the parasitism rate increases significantly in the second half of the growing season (late Summer/Autumn). To prove this, we are planning additional collection trips. We are also in the process of collaborating with local researchers, to perform experiments during the entire vegetation period, to study the temporal pattern of the mortality rate caused by *Erythmelus*.

DEVELOPMENT OF RELIABLE AND SWIFT DETECTION METHODS OF WHEAT DWARF VIRUS AND IDENTIFICATION OF NEW VIRUS RESERVOIR GRASSES IN HUNGARY

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Wheat dwarf virus (WDV) is a prevalent pathogen of arable fields. The disease causes huge yield losses in wheat and barley; hence it has a major agricultural significance. WDV is transmitted by the leafhopper *Psammotettix alienus*, thus it can infect and persist in wild grasses after harvesting season. We use WDV as a model pathogen to develop early warning detection techniques that can be applicable for invasive plant pathogens, as well. We also intended to test the applicability of the new method for wider scale and wider scope detection by charting WDV presence in Hungary, and by identifying new virus reservoir plant species. From a methodological point of view, our aim was the improvement of virus presence diagnostics. This was achieved (I) by assuring the reliability of PCR tests by reviewing, verifying and upgrading virus primers available in the literature, and (II) by the development of a quick and easy alternative methodology for effective virus detection, that did not require the use of complicated laboratory equipment. We collected, tested and upgraded different PCR primers to be universal to all available WDV sequences in the nucleotide database, and we also designed new primer pairs to cover the whole genome of WDV, for better support of WDV strain-specificity of unknown environmental samples. We possess an arsenal of reliable primers, by which we could effectively screen the plant and leafhopper

sample pool, collected from the Middle-Transdanubian region. We found that the WDV barley group is more dominant in our collection sites, infecting not only barley, but wheat and other grasses as well. We present the sequence of two WDV barley and a WDV wheat group isolate. The tracking of the changes of vegetation and virus presence for different sampling sites (arable fields) was performed in 2023 and 2024, during which we also identified new reservoir grasses for WDV. Development of a PCR alternative is still underway: preliminary results showed that the emerging LAMP technique is amenable to detect WDV without any complicated laboratory preparation or equipment. We managed to perform successful, strain-specific LAMP reaction in conventional thermos flasks, which implicates that this method is suitable to be applied by non-professionals (e.g. farmers to quickly confirm virus infection in the field) and should be brought into focus in discussions about interdisciplinarity and citizen-science. Understanding this model of virus-vector system and the improvement of the presented methods are key factors to combat other similarly operating plant-vector-pathogen systems.

NON-NATIVE AND POTENTIALLY INVASIVE PLANTS IN BUDAPEST

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Urban environments serve as hotspots for neophyte plant diversity, driven by anthropogenic influences and varied introduction pathways. This presentation explores the diversity, distribution, geographic origin and invasion status of neophyte vascular plant species in Budapest, Hungary, based on surveys conducted between 2018 and 2024. A total of 307 neophyte taxa, representing 77 plant families, were identified within urban habitats. Notably, only 14 taxa were abundant, occurring in more than 10% of surveyed units, while 156 taxa were exceptionally rare, with one or two records. Geographic origin analysis revealed that most of the taxa is originated from Eurasia and the Americas. Most species are casuals (63%), followed by naturalized (20%) and invasive species (17%). Nearly three quarters of neophytes were deliberately introduced, these are mainly planted as ornamentals in the city. The ornamental plant trade is also the source for most of the accidentally introduced species. Several neophyte species that are already spreading in the city could potentially become invasive in Hungary. Examples of such species include perennial *Cenchrus* spp., *Nassella tenuissima* (Trin.) Barkworth, *Eragrostis spectabilis* (Pursh) Steud., *Panicum* spp., *Cyperus eragrostis* Lam. and *Erigeron* spp. The escape of these species from urban areas and their spread in natural habitats is unpredictable, but monitoring may be necessary. It would also be desirable to restrict the trade of potentially invasive plants in ornamental plant trade.

IMPROVING SDM PREDICTIVE PERFORMANCE FOR GLOBAL INVASIVE SPECIES: THE *LYCORMA DELICATULA* (HEMIPTERA: FULGORIDAE) STUDY CASE.

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Given the major phytosanitary relevance of several invasive species, the identification of suitable regions worldwide remains a key action to implement prevention measures, optimise management actions, together with effective monitoring programs. To this aim, we implemented a two-step species distribution model framework, calibrated on the species native range, aimed at disentangling the effects of habitat and bioclimatic variables on the environmental suitability of the invasive *Lycorma delicatula* across the world, using presence-only data. The use of presence-only data implies an allocation of pseudo-absences (PAs) that should take into account the spatial variability of explanatory variables (bioclimatic vs. habitat) and the spatial distribution of occurrences. Since habitat and bioclimatic variables affect species distributions according to processes that act at different geographical scales, we modelled the effect of these variables separately within a habitat (HSM) and a bioclimatic (BSM) suitability model, respectively. This choice stems from the evidence that combining scenopoetic (bioclimatic) variables with those of a local character (habitat) result in an underestimation of the variables' importance in the suitability estimation. Consequently, PAs for estimating the effects of bioclimatic variables were randomly extracted over a latitudinally extended

area well beyond the limits of the modelled species' native range. In contrast, the PAs used to estimate the effects of habitat variables were allocated randomly close to the occurrence data; moreover, given the intrinsic spatial bias of the occurrences obtained from repositories, for HSM we identified an additional set of PAs following the bias pattern itself. In addition, to further improve the predictive performance of the HSM, host plants were integrated into the set of explanatory variables. Both the BSM and HSM were implemented with the *biomod2* R package and were based on an ensemble model approach. The distribution of *Lycorma delicatula* in its native range was substantially defined by the host plant (0.53 of variable importance), built-up areas (0.38), cultivated and managed vegetation (0.08), herbaceous vegetation (0.07) among the habitat variables, whereas the temperature seasonality (0.37), maximum temperature of the warmest month (0.2), and precipitation of the wettest quarter (0.12) were among the bioclimatic variables. BSM and HSM projection maps were combined into an overall suitability map by means of their spatial product. The overall suitability map at the global scale highlighted the suitable areas of South Korea, Japan, the Eastern and Central United States, and the lowlands of the European subcontinent extending from eastern France to those areas of the Caucasus bordering the Azov and Black Seas. In suitable areas of the United States, the species is documented as present and invasive, and current populations are expanding to areas of the central plains following the suitability pattern identified by the model.

CHANGES IN POPULATION SIZE AND DISTRIBUTION AREAS OF GAME SPECIES IN HUNGARY BETWEEN 1997–2022

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Using data from the Hungarian Game Management Database, we analyzed the spatial and temporal trends of distribution and population changes for 24 game species between 1997 and 2022. We focused on relevant hunting bag data for open, unfenced areas included in the annual game management report. For data processing, we utilized a uniform UTM grid (100 km²), linking the game management units to these smaller spatial units based on their area proportions. We summarized and characterized the changes in annual hunting bags and the size of the species' ranges (measured by the number of occupied UTM cells) during the studied period. To evaluate these changes, we performed several calculations: (1) We calculated the change in hunting bags and distribution areas using the correlation coefficient (Pearson r) from the fitted data; (2) We analyzed the slope of the line fitted to the trends of hunting bags and distribution areas over time; (3) We computed a quotient expressed as a percentage, based on the average from the last five years (2018–2022) compared to the average from the first five years (1997–2001), subtracting 100% to determine the degree of change relative to the original state. Our results indicated an increase in population size for most of the examined game species (15 out of 24 species), with three species showing no change

and six experiencing a decrease. The distribution area increased for thirteen species, remained unchanged for six, and decreased for five. Notably, the golden jackal and the raccoon saw the most significant population and distribution area increases. Additionally, all five big game species (red deer, fallow deer, roe deer, mouflon, and wild boar) showed a similar, albeit smaller, increase. Conversely, the greatest decreases were observed in populations of the muskrat, Eurasian coot, bean goose, and mallard. Interestingly, while the population of the European hare decreased over the long term, its distribution area increased. These results, based on long-term spatio-temporal data, enhance previous knowledge that relied solely on population sizes and inform management and conservation planning for game species in the country.

HABITAT-DRIVEN DIFFERENCES IN POLLEN-SPORE INTERACTIONS: PRELIMINARY RESULTS OF AN INVASIVE WEED (*AMBROSIA ARTEMISIIFOLIA*)

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Common ragweed (*Ambrosia artemisiifolia*) is one of the most invasive and widely abundant weed species in agroecosystems and other human-disturbed areas in Hungary. It is a primary source of airborne pollen, contributing to a significant health crisis for humans with allergies. Additionally, ragweed pollen can accumulate on crop surfaces, providing an initial nutrient source for plant pathogens in their early development (i.e. spore germination) before the crops are infected. Previous studies demonstrated that pollen can stimulate spore germination, but the stimulation varies significantly among species. These findings suggested that pollen quantity and/or quality could drive the pollen-spore interactions. Our understanding of the population-specific and individual-specific variations in the effects of pollen stimulation is still limited. Therefore, in this study, we focused on the impact of ragweed pollen on the conidia of Botrytis cinerea. The flowering period of ragweed overlaps with the critical phenological stage of grapevine bunch infection, so the initial growth and infection can be stimulated to boost the virulence of the pathogen. This research aimed to reveal the relationship between the stimulating effect of the pollen and the morphological traits specific to different ragweed populations and individuals that may contribute to this stimulation of fungal spores. We hypothesized that a trade-off exists between biomass allocation to generative and vegetative traits in ragweed, influencing the stimulation level based on pollen quantity and

quality. Consequently, we expected individual-specific differences in spore germination among plants in similar populations (i.e. more vigorous plants increase their fitness by allocating more nutrients to their pollen grains). Specific habitat conditions may shape these individual-specific differences. To investigate we selected different human-disturbed habitats (N=9) to survey the basic morphology of ragweed individuals sampling 100 plants per habitat. From each habitat, 20-20 plants were selected for a detailed morphological survey and pollen harvest. We prepared an aqueous extract from ragweed pollen and exposed conidia of B. cinerea to different concentrations of the extract (0, 1×10^6, and 5×10^6 pollen grains/ml). Spore germination was monitored throughout 0 to 48 hours using a Multiscan FC, with additional measurements supporting visual observations using a Nikon Eclipse 50i microscope. The preliminary results of this study showed habitat- and individual-specific differences in the stimulating effect of spore germination. Specifically, pollen extracts from arable habitats promoted higher spore germination compared to those from rural sites. Additionally, we revealed habitat-specific differences in ragweed morphology. These effects might be related to conflicts in biomass allocation between reproductive and generative growth, which could affect pollen quality. In particular, ragweeds growing in less disturbed, nutrient-rich environments may produce more nutritious pollen grains, potentially stimulating greater spore germination of pathogenic fungi. Our study highlighted that the relationship between host-pathogen dynamics and pollen nutrients poses significant risks to crop production. As a result, the threats that invasive plants present to food safety in agriculture may manifest unexpectedly.

A STRONG INVASION WAVE OF MEDITERRANEAN GRASS SPECIES HAS REACHED THE CARPATHIAN BASIN

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In the past two years, we have recorded the appearance and rapid spread of several grass species native to the Mediterranean regions of Europe in Transdanubia. Stands of *Anisantha diandra, Anisantha madritensis, Avena barbata, Catapodium marinum, Hainardia cylindrica*, and *Parapholis incurva* were found along major roads, mostly on road edges, while *Psilurus incurvus* was discovered along a railway line. *C. marinum* and *P. incurva* have become new, rapidly spreading non-native species along salted road edges, capable of reaching greater distances in a short period. Based on its initial behavior, *H. cylindrica* shows significant invasive potential and poses a potential threat to our native wet alkaline habitats. *Anisantha diandra, A. madritensis* and *Avena barbata* are species showing dynamic spread in roadside weed communities. Among the species discussed, this is the first report of *A. diandra, C. marinum*, *H. cylindrica, P. incurva*, and *P. incurvus* in Hungary, and several of these are also new records for Central Europe. The occurrence of *A. barbata* and *A. madritensis* has been confirmed in Hungary for the first time in a long period. The emergence of a strong wave of species influx has been triggered by the operation of the international transportation network (continuous habitat corridors, increased road traffic). The completion of a unified motorway network from both Slovenia and Croatia, enabled plants from the Adriatic region to „set out on a journey" and reach the Carpathian Basin. The length of high-speed, fully managed roads (motorways and expressways with

mowed roadside edges, emergency lanes, and rest areas) increased significantly between 2013 and 2023, at the same period, the role of the motorway network has been gradually increasing and heavy vehicles have increasingly been shifted to motorways. According to current calculations, temperature extremes in Central Europe are clearly and significantly shifting towards warming. Specifically, the number of freezing days in winter is expected to decrease, while the occurrence of heatwave days in summer is projected to increase. The decrease of the number of frosty days is particularly favourable for Mediterranean flora elements. Therefore, in the future, we can expect not only the appearance of additional Mediterranean species along roadsides but also the establishment and potentially significant spread of those that have already arrived. This could pose a threat to the stability of some plant communities in the future. The species discussed are characterized by almost immediate establishment and, in most cases, rapid population growth and invasion in their habitats.

THE ROLE OF GARDEN CENTRES AND PLANT NURSERIES IN ALIEN PLANT INVASIONS

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The quickly expanding international horticultural trade has a key role in introducing alien species into new areas, partly because ornamental plants are considered among the main sources of alien plant species, but also because horticultural trade also entails the unintentional dispersal of many contaminant species over large distances. However, apart from sporadic reports of such contaminant species, the phenomenon remains largely understudied. To bridge this knowledge gap, we conducted systematic field surveys in 12 plant nurseries and garden centres in Hungary to assess their role in introducing alien plant species and whether they can function as invasion hubs. We recorded altogether 93,788 individuals of 67 alien species, seven of which have not yet been reported from the country. Despite their small area, garden centres hosted a large proportion of the local alien flora, indicating that they strongly accumulate alien species. Many species had large established populations, implying that garden centres can act as invasion hubs for several species. Most of the species occurred inside the containers of the ornamental plants, indicating that they most probably arrived via long-distance dispersal as contaminants of horticultural stock.

Trait differences between alien species inhabiting garden centres and the regional alien flora indicated that the species most successful at establishing populations inside garden centres are both good dispersers and possess an effective resource-acquisitive strategy. We conclude that alien plant populations in garden centres can exert sufficient propagule pressure to induce local invasions. In the meantime, customers regularly transport individuals and seeds inside the containers of ornamental plants to distant areas, creating opportunities for further long-distance dispersal. Therefore, horticultural trade is not only a pathway of alien plant introductions, it can also play a role in the subsequent stages of the invasion process, demonstrating that contaminant species of horticultural stock need to be better considered in invasion biology.

THE DIET COMPOSITION OF TWO INVASIVE CARNIVORES, THE RACCOON (*PROCYON LOTOR*) AND THE RACCOON DOG (*NYCTEREUTES PROCYONOIDES*) BASED ON STOMACH ANALYSIS

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Large-scale, transcontinental trade has provided ample opportunity for many invasive animal and plant species to conquer and spread in new areas. Among these species are the raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procyonoides*). The raccoon was introduced to Europe from the American continent primarily for the purpose of fur breeding and hunting and secondarily for domestication. Its introduction to the territory of Asia was intended to keep it as a pet. The raccoon dog is a species of Asian origin, which was also brought to Europe for the sale of its fur. The first raccoon was shot in 1998 while the first killing data of the raccoon dog was registered in 1961 in Hungary as a proof specimen. The number of shot animals for both species has been relatively low since then (less than 20 individuals per year), but the trend of the official hunting bag shows a slow increase. Until now, no research has been carried out on the biology of these carnivores and their possible effects on the native species, due to the rare occurrence and low population densities. Preliminary observations proved that raccoons regularly use the baiting sites for wild boar and consume

the corn there. Moreover, our investigations revealed that artificial nests were visited and the eggs were stolen by them. However, nothing was known about the raccoon dog from this aspect. Therefore, the purpose of our recent study was to describe and evaluate the feeding habits of these two mesocarnivores by stomach analyses. Altogether 39 carcasses were collected by the help of the hunters country-wide. After dissection raccoon (n=24) and raccoon dog (n=14) stomachs were analysed. Frequency of occurrence (FO%) and biomass (B%) were calculated. Our results showed that one of the most commonly consumed food items of the raccoon were the arthropods, plants and corn (FO reaching 50%), moreover fruits, mammals, birds, amphibians, molluscs and reptiles were also eaten (FO less than 30%). The raccoon dog primarily consumed mammals (FO=83,33%, B%=32,46) and plants (FO=83,33%, B%=7,77), but arthropods, fruits and birds (FO between 40 and 60%) were also frequent in the diet. Corn, amphibians, reptiles and molluscs were also identified as food components. Both species showed various diets (5< dietary elements) reflecting their opportunistic feeding strategy. For both species significant differences were revealed between sexes and age classes. The diet composition of raccoon and raccoon dog showed huge dissimilarity in the proportion of different food items. Our first results show that these invasive species could have a negative impact on native species in the Carpathian Basin by their diverse feeding habits. Further targeted research is needed to discover the real impact of these predators for the mitigation of their adverse effects.

SIGNIFICANCE OF PLANT PATHOGEN FUNGI "HITCH -HIKING" ON IMPORTED TROPICAL FRUITS TO HUNGARY

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Millions of tons of tropical fruits, including bananas (*Musa* × *paradisiaca* L.), mangoes (*Mangifera indica* L.) and avocados (*Persea americana* Mill.) are imported to the EU from more than 130 countries every year, which could become a potential pathway for plant pathogens. Post-harvest losses caused by plant pathogens, both in general and during transport, are a huge economic problem. Fruits showing symptoms of fungal diseases are often observed in grocery stores. The aim of this study was to identify fungal pathogens introduced into Hungary with the fruit trade. Fruits showing symptoms of fungal pathogens were sampled from supermarkets and fruit merchants in Hungary. The pathogens were isolated from infected fruit tissue into PDA medium. Macroscopic (mycelial colour, shape, edges and pattern of colonies) and microscopic (colour, shape and size of conidia) characteristics of the fungal isolates were recorded. Koch's postulates were fulfilled for all isolates. For molecular studies, DNA was extracted using CTAB method, and PCR was applied to the ITS genomic region, the calmodulin gene and the β-tubulin gene. This study reports the presence of *Colletotrichum asianum*, *C. fructicola*, *C. siamense*, *Neofusicoccum kwambonambiense*, and *Fusarium desaboruense* (syn. *F. sacchari*) on imported tropical fruits first in Hungary. While these pathogens have not yet caused damage to crops cultivated in Hungary, their polyphagous nature suggests the potential for future infections. Disposal practices, such as placing infected fruits or fruit parts in communal waste or compost, could facilitate the

establishment of these pathogens. With global warming, climatic factors will become more favourable for many pathogens, therefore more attention should be paid to newly introduced pathogens.

URBAN ADAPTATION, HOST BEHAVIOR, AND DISTRIBUTION AFFECTS THE PRESENCE OF DIROFILARIA PARASITES: A PHYLOGENETIC COMPARATIVE STUDY OF WILD CARNIVORES

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Dirofilariosis is an emerging mosquito-borne disease among domestic carnivores, wildlife, and humans. Our understanding of its ecological drivers, geographical distribution, and prevalence in sylvatic hosts is limited. We explored several factors that potentially drive the presence of *Dirofilaria immitis* or *D. repens* in 70 species of wild carnivores in the Palearctic region. We found that i) mammals exploiting urban habitats have a higher chance of acquiring *Dirofilaria* infection; ii) diurnal species exhibit a lower likelihood of infection when compared to nocturnal species; and iii) larger geographical distribution range was positively associated with parasite presence. However, host life history did not predict *Dirofilaria* parasitism. Our results suggest that urban habitats can be important reservoirs of emerging infectious diseases. By understanding how urbanization affects wildlife health, we can better manage and mitigate potential disease transmission between wildlife, domestic animals, and humans, reducing the risk of zoonotic diseases. Lastly, exploring the interplay between hosts and parasites in our rapidly changing environment is not only essential for supporting public health initiatives but also crucial for the successful preservation of biodiversity.

ARTIFICIAL INTELLIGENCE-BASED METHODS IN INVASION BIOLOGY RESEARCH: CASE STUDIES FROM HUNGARY

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Artificial intelligence-based applications are becoming increasingly widespread in invasion biology research. In the presentation, we will show the usefulness of AI-based applications in invasion biology research through examples from Hungary. On the one hand, our research team used AI to map and monitor *Asclepias syriaca* at local scale. By using AI-based analysis of hyperspectral UAV photos, we were able to separate *Asclepias syriaca* individuals from native grassland vegetation, thus enabling annual monitoring of this species, assessing its population density, and collecting important data for the subsequent identification of habitat patches invaded by this species from satellite imagery. In another case study, we used AI to create an European-scale distribution map of *Asclepias syriaca*. We have developed a machine learning machine learning (Yolo) based tool to identify its occurrence based on geotagged field photos of the European Union's LUCAS database. The aim of our research is to produce a continental-scale distribution map of this invasive species by automatically analysing

hundreds of thousands of geotagged photos collected with a three year interval in Europe. In our presentation, we will present the first results of our methodology for the detection of *Asclepias syriaca* from field collected photographs. In the third case study, we compare the existing national distribution map of *Asclepias syriaca* with climatic, soil, hydrological, land use change, and other environmental variables. Based on machine learning algorithms (MLA) methods, we can understand the main geographical reasons for the recent dramatic spread of this very common invasive plant species in Hungary, and we can produce a national-scale hazard map of *Asclepias syriaca.*

DISPERSAL OF THE INVASIVE INDIAN WAX SCALE (COCCOMORPHA, COCCIDAE, *CEROPLASTES CERIFERUS*) IN HUNGARY

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The proportion of non-native species within the Hungarian scale insect fauna is over 26%, many of them are invasive. One of the invasive species is the Indian wax scale (Coccomorpha, Coccidae, *Ceroplastes ceriferus* Fabricius; IWS), which was first recorded in Hungary in 2016. IWS is a highly polyphagous species, possibly originated in Asia, but had since distributed in all zoogeographical regions. In 2023 an intensive survey was started to explore distribution of IWS, and a citizen science project was established in April 2024. The number of new records increased to near 100, from 15 districts of Budapest, including 5 records originating from citizen science project. The specimens were recorded from 30 host plants. The most sensitive host plants seem to be *Acer negundo*, *Acer saccharinum*, *Celtis occidentalis*, *Tamarix tetrandra* and *Prunus laurocerasus*.

EXPLOITING THE WEIRDNESS OF ALIENS – HOW CAN YOU MAKE A SELECTIVE BAIT TO CATCH INVASIVE LEAFHOPPERS?

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Many leafhoppers are important pests because they are vectors of various plant diseases. They feed mainly on vegetative plant organs, as their main food source is the sap of transport tissues. Leafhoppers use both visual and olfactory cues to locate their host plants. Most species are attracted by common or non-specific green leaf plant volatiles, during their mating they do not use sex pheromones, therefore they usually cannot be trapped by using specific chemical lure compounds. Their presence in crops or fields is usually indicated by green or yellow sticky traps, however, these traps are not selective and the samples caught are not suitable for DNA-based identification of plant diseases. In our study, we attempted to produce a semi-selective trap for the citrus flatid leafhopper *Metcalfa pruinosa* (*Flatidae*). *M. pruinosa* is a highly polyphagous invasive pest in Europe, that is native in North America. Although it is a polyphagous species, its native - subtropical - host plants differ significantly from its newly acquired host plants in the European flora. While it is not considered a pest in its native area, in Europe it mainly causes plant damage, as its populations can reach enormous numbers, but it is also a possible vector of phytoplasmas. In our first experiment, we used gas chromatography–mass spectrometry to identify volatile organic compounds from different host plants that could act as semiochemicals for *M. pruinosa*. A total of 77 volatile organic compounds were identified, and 29 compounds

elicited an electrophysiological response at the antennae of the grasshoppers. Based on the results, we selected 4 compounds in our second experiment and tested their effect on the behaviour of *M. pruinosa* in Y-tube olfactometers and in 4-choice test arenas. The results showed that both the nymphs and the adults preferred two of the compounds more than the others or the control solvent. According to these results, we have started to develop traps based on volatile substances that can actively attract *M. pruinosa*. The aim is to produce traps that not only indicate the presence of leafhoppers, but also preserve the specimens and make it possible to take DNA samples from them to test for possible plant pathogens, which they might carry. This makes it possible to indicate the spread of pathogens before symptoms are visible on the plants. The results of the pilot trial were promising. We were able to catch *M. pruinosa* specimens without catching any native leafhoppers or other native insects. The only exception was the *Phlogotettix cyclops* (Cicadellidae), another invasive leafhopper species in Europe. The development of the traps is currently under way with plans for further optimization during the next season.

LAUNDRY WASHING CAN SUPPORT PLANT INVASION BY INFLUENCING THE GERMINATION POTENTIAL OF CLOTH-DISPERSED SEEDS

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Unintentional human-vectored seed dispersal (HVD) on clothes occurs when seeds attach to human clothing during various outdoor activities. This process can have significant environmental consequences, since most of the species spread by HVD are weeds and invasive species. The growing global tourism industry further amplifies HVD by facilitating the widespread, unintentional dispersal of seeds. The aim of our study was to examine the effect of laundry washing on the germination potential of cloth-dispersed seeds. We experimentally tested the effects of seven detergent types and three washing intensities in a full factorial design on the germination capacity of 18 plant species. Washing at 60°C significantly decreased the germination capacity in 15 species, whereas washing at 30°C or 40°C had no effect. Detergent type did not affect the germination capacity. These findings highlight that standard household washing practices do not effectively reduce the germination potential of seeds dispersed on clothing. Our results contribute to the growing evidence, that HVD on clothing can be a critical pathway for the dispersal of plant species. Cloth-dispersal can increase the risk of weed and invasive species infestation in both residential and natural areas, amplifying their adverse environmental impacts. Addressing the spread of HVD dispersed seeds requires a combination of biosecurity measures. Self-regulation, such as removing seeds from clothing and disposing them appropriately, is essential.

In addition, educating outdoor workers, who play the largest role in HVD, and the public about simple behavioral changes could significantly mitigate the adverse effects of this process.

PERSPECTIVES IN THE APPLICATION OF HEMIPARASITES TO CONTROL INVASIVE PLANTS IN HUNGARY

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The most common methods to control invasive alien plant species include herbicide application and mechanical removal. Biological solutions, mostly the introduction of natural enemies, such as native hemiparasitic plants, are less often used, although there is increasing evidence on their efficacy worldwide. In Europe, species of the Scrophulariaceae family are used to suppress the competitive power of invasive grasses, but they are not applied as a routine method in conservation practice due to limited experience. Here, we show preliminary results of two novel applications of hemiparasitic plants in Hungary, where other solutions are inefficient or unfeasible, rendering hemiparasite-based biological control the last chance. *Sporobolus cryptandrus* is a North-American grass recently invading dry sandy grasslands in Hungary. Chemical control is inefficient due to the abundant seedbank of the species; grazing is not an option due to its unpalatable leaves, and, in addition, it regenerates fast after the removal of aboveground organs. In a mesocosm experiment, however, we found that *Odontites lutea*, a native hemiparasite of dry sandy grasslands not only considers it a host but can reduce its biomass with 40% within one year. Lower biomass may translate into lower competitive power, providing recolonization opportunities for native species that had developed some resistance against *Odontites* during their evolutionary history. In another experiment we tested *Rhinanthus minor* to suppress a native invasive species, *Calamagrostis epigeios* in isolated moist grasslands of karst dolines. Chemical control is not feasible due to karst water resource protection, and the remote and patchy spatial arrangement

of these habitats makes regular grazing and mowing unfeasible. However, we found that *Rhinanthus*, if sown after an initial mowing round, can reduce *Calamagrostis* biomass with nearly 50% in the following year. Neither mowing without sowing *Rhinanthus* nor sowing *Rhinanthus* without mowing had any detectable effect on *Calamagrostis*. Other plant species did not benefit from *Calamagrostis* suppression in the short run (i.e. the following year), thus we also tested the effect of additional hay transfer from adjacent non-invaded karst dolines. Unfortunately, the extra litter hindered *Rhinanthus* germination and the expected suppression of the invader did not occur. Sowing pure seed may be a better option in future trials. Our two pilot studies provide ample evidence for the need to include hemiparasites in the toolbox of conservation practitioners aiming to control challenging plant invasions, but also highlight the large array of knowledge gaps that future research should address.

MULTI-SPECIES SEEDING MAY IMPROVE RESISTANCE AGAINST INVASION IN A SANDY HABITAT

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Invasive species often play a role in vegetation restoration. Restoration can reduce the probability of their establishment, but restoration treatments might also help their spread by opening up the vegetation matrix. Environmental changes, like drought can have an impact of this relationship. Therefore, thorough analysis of interventions and invasive species behaviour is essential. We have studied the outcome of seeding of ten native species at an old-field, abandoned 10-15 years before. Two grasses and eight forbs of the Pannonian sand grassland community (*Festucetum vaginatae*) were seeded in 2013 and vegetation sampled for species cover and biomass in 2023. As a comparison, native reference grassland and non-seeded old-field was also sampled similarly. In 2022 a very severe drought occurred and as a result, patches of the main community constituent, *Festuca vaginata* died. We have sampled dead and live *F. vaginata* plots as well. Altogether plots of four treatments were sampled in 2023 July. Ten circular quadrats (0.32 m^2) were applied for all treatments, after cover estimate of all species, the above ground biomass was clipped for measurements. Plant total cover correlated well with total biomass; the largest values were measured in the seeded plots with live *F. vaginata*, the lowest in the reference and the dead *F. vaginata* plots. These two were the treatments with the lowest species richness as well. Highest richness was found in the old-field samples. The two dominant species were

F. vaginata in the live plots and the reference, while in the dead *F. vaginata* plots *Dinathus serotinus* reached the highest cover (up to avg. 75%). Relative invasive species cover reached 10% in the old-field, elsewhere it was close to zero. The results can be interpreted as follows: 1) seeding of multiple native grassland species successfully hindered invasive species establishment; 2) major drought event can cause dieback of *F. vaginata*; 3) where this occurs, *D. serotinus* can take over, if present; 4) as another native species could occupy the open spaces, invasive species could not establish after dieback. It is therefore important to use multiple species in restoration introductions.

SOIL SEED BANK OF THE INVASIVE SAND DROPSEED (*SPOROBOLUS CRYPTANDRUS*) POSES A FUTURE CHALLENGE FOR ITS SUPPRESSION

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Sand dropseed (*Sporobolus cryptandrus*) is an invasive C4 grass in some European countries, especially in some regions in Hungary, where it can outcompete native grasses and become dominant in sand grasslands. To support future management actions, we explored the effect of the encroachment of sand dropseed on the composition of soil seed banks in dry sand grasslands in Central Europe. In five mass-locality sites of the species we assessed the composition and vertical segmentation of the soil seed bank in 12 1-m^2-sized plots along an increasing cover of the invasive species. We found that the seed bank diversity and density decreased with increasing sampling depth; the decrease in density was affected by the increasing sand dropseed cover. Neither the diversity nor the seed bank density of other species were affected by increasing sand dropseed cover but both were affected by the sampling site. Most of the studied seed bank characteristics were affected by the

sampling depth, but none of them were affected by the increasing cover of sand dropseed. Increasing cover of sand dropseed in the vegetation was associated with an increasing proportion of sand dropseed seeds in the seed bank, and we found a low-density soil seed bank of the species even in plots with no sand dropseed cover. Our finding that sand dropseed forms a massive soil seed bank, together with the predicted decrease in the precipitation of the summer months and increase in the frequency of droughts in the region, projects further rapid spread of the species.

EVERYTHING CAN BE USEFUL – INVASIVE AND ALIEN ANIMAL SPECIES IN LOCAL ECOLOGICAL KNOWLEDGE IN THE PANNONIAN BIOGEOGRAPHIC REGION

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Invasive and alien wildlife species have a noticeable impact on the lives of people actively using the landscape. Over a short period of time, considerable knowledge and complex perceptions can accumulate about them. Numerous publications come out yearly that examine biological invasions, but with considerable spatial and taxonomic unevenness and very little on local ecological knowledge related to invasion. The exclusion of the public from science and conservation management research creates a gap between the dynamics of invasion processes and the interests of stakeholders. The phenomenon studied in the Pannonian Biogeographic Region (Dunasziget, Őrség in Hungary and Mezőfény in Romania) was based on structured interviews with 90 residents (30 in each landscape) who regularly spend time in the vicinity of the settlement (fishing, mushroom picking, agricultural work, kayaking etc.). The interviewed local knowledge holders cited 56, 13 and 28 species considered alien and/or invasive in the three landscapes respectively, for a total of 70 species. Scientific studies also consider the impact of a similar number of alien and/or invasive species to be significant in the area. Damage to agriculture is the most significant local perception. The pattern of dispersal is described in most detail for slow-mowing (or sedentary) species, while the impacts on native species described with most details on animals. Our data show that the people most affected by damage are more constructive and there are much more

people with negative attitudes than those who are personally affected by damage.

There is a considerable body of local knowledge on invasive and alien species that is comparable to scientific knowledge. Understanding and integrating social and cultural perspectives into research on invasive species, as well as considering the sociological aspects of biological invasions, is key to their sustainable management, both ecologically and socially. It is very important that conservationists also respect and understand local perceptions, as our results show that there is significant potential in this respect in terms of conflict management, economic aspects, but above all the conservation of cultural and the natural environment.

CONTROL AND CONTAINMENT OF WOODY INVASIVE SPECIES IN THE PESZÉR-FOREST

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The Peszér-forest Natura 2000 site (HUKN20002) hosts different, sand-adapted forms of Euro-Siberian steppic woods with *Quercus* species (hereinafter: steppic Oak forests). Currently, together with the effects of climate change, overgrazing by big game species and disturbances caused by particular silvicultural practices, woody invasive alien species (wIAS) have the most significant negative impact on the conservation status of steppic Oak forests of this site. In the case of local steppic Oak forests, *Celtis occidentalis, Ailanthus altissima, Prunus serotina, Acer negundo* are the wIAS characterized with the highest level of invasiveness and *Robinia pseudo-acacia* is characterized with significant habitat and community altering effect. Within the frames of a LIFE-Nature project (LIFE16 NAT/HU/000599) and its after-LIFE period, Kiskunság National Park Directorate implemented various actions against wIAS and could identify the mechanism of spread of wIAS, to quantify resource demand of control or containment of wIAS. Amongst the various effects of climate change on steppic Oak forests of this site, accelerated organism-level turnover is hypothesized to play a key role in species-level turnover resulting in modified community structure and, in most cases, spread of wIAS. Both organism- and species-level turnover can, directly or indirectly, be influenced by the abundance and spatial distribution of specimens of wIAS. Complete eradication of wIAS is impossible at either regional or site-scale in the foreseen future, therefore control and containment are the realistic targets. Successful (and, at the time

scale of decades, cost effective) control or containment at habitat patch level relies on preventing within-patch (plus buffer-zone) seed production of wIAS. We have identified and tested combinations of technologies (selective chemical treatment, complete site preparation, repeated cutting back, manual removal of seedlings of wIAS, grazing in forests etc.) that can be successfully applied for control or containment of woody IAS. Once a habitat patch is characterized with mass presence of wIAS, either control or containment required huge efforts and – due to high number of consecutive actions – long time. For control of wIAS in forest stands with significant conservation value and mass presence of wIAS, reaching the target conditions (total absence of seed-producing specimens of wIAS, admixing ratio of wIAS in the regeneration layer less than 2 %), a set of twenty-two consecutive actions was implemented. Having implemented this full set of interventions (requiring on average 5-6 years), habitat patches (14 forest stands covering 42 hectares) can be characterized with acceptable conditions foreseeingly for 10-15 years without any additional actions. For containment of wIAS, habitat patches with insignificant conservation value and mass presence of wIAS (plantations/ forest stands formed almost exclusively by wIAS) into shrublands or clearings (10 habitat patches covering 14 hectares). At the first stage, seed-producing specimens of wIAS were removed and the re-occurrence of seed-producing specimens is prevented via repeated mechanical interventions (grazing by livestock, mulching, manual removal of seedlings/saplings of wIAS). According to our lessons and findings, sustenance of local, high conservation value steppic Oak forests will require recurring actions; without specific actions these unique habitats will turn into wIAS-dominated habitats.

USABILITY OF CITIZEN SCIENCE DATA FOR RESEARCH ON INVASIVE PLANT SPECIES IN URBAN CORES AND FRINGES: A HUNGARIAN CASE STUDY

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Citizen science data are free and easily accessible, which has led to their wide use for scientific data collection such as mapping invasive plant species. However, the crowd-sourced nature of citizen science data has led to criticism over the quality of the data owing to the fragmented spatial distribution of data collection points. In our comparative analyses we evaluated the usability of citizen science data (Global Biodiversity Information Facility (GBIF)) for mapping the occurrence of five invasive plant species (*Ailanthus altissima, Asclepias syriaca, Elaeagnus angustifolia, Robinia pseudoacacia and Solidago* spp.) in urban cores and fringes in Hungary by comparison to maps obtained from spatially homogeneous data (EUROSTAT Land Use and Coverage Area Frame Survey (LUCAS)) collected by experts. The results showed that the volunteers collected high-quality data on *Ailanthus altissima*, which is specific to urban areas, but they underestimated *Robinia pseudoacacia*, which is often planted for economic benefits. In addition, volunteers collected much more data closer to urban cores. These results suggest that citizen science data may be suitable for mapping urbanophilic species in urban environments. However, spatially homogenous occurrence databases curated by experts are more suitable for mapping invasive species of high economic value.

ARE WE REALLY ABLE TO DO ANYTHING, OR ARE WE JUST SITTING BACK AND WATCHING?

THE PRESENT STATUS AND REAL EFFECTS OF NON-NATIVE DECAPOD, FISH, AMPHIBIAN AND REPTILE SPECIES IN HUNGARY

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Global declines in aquatic ecosystems have been well documented for decades, with invasive species being one of the major threats. For sound management, conservation experts and decision-makers need reliable information about the risks posed and real effect by invasive species on the native ecosystem. In Hungary, the central country of Pannonian Biogeographical Region (PBR), there is some specific, but no systematic overview of the occurrence of non-native decapods, fishes, amphibians and reptiles nor any sound assessment has been made of the potential risks of invasiveness posed by these species. In this presentation, we collated observations on non-native species' occurrence in whole territory of Hungary based on Non-Governmental Organizations databases, expert opinion, citizen science, literature data, and field observations. We

complemented these data with a monitoring programme focused on the urban areas and we also provide a number of examples to illustrate their complex effects some species. We screened 11 decapods, 25 fish, 16 amphibian and 36 reptile non-native species as found across Hungary and in the local pet-trade market. We found nine decapods, 25 fish, five amphibian and 16 aquatic and five terrestrial reptile non-native species in Hungary. Screening revealed that eight decapods, 23 fish, two amphibian and 18 aquatic and 5 terrestrial reptile species can be regarded as posing a high to very high risk of invasiveness, especially after accounting for the effects of climate change. The higher-risk taxa include the three *Procambarus* and two *Neocaridina* species, the signal and spiny-cheek crayfish, 23 different fish taxon, two amphibian species, and three subspecies of pond sliders (i.e. the red-eared slider *Trachemys scripta elegans*, the yellow-bellied slider *T. s. scripta*, and the Cumberland slider *T. s. troostii*), the common snapping turtle, the Eastern River cooter, and Chinese soft-shelled turtled turtles. We conclude that parallel the aquaculture and angling management the pet-keeping presents a serious conservation threat for the Hungary in the last two decades, where urban areas act as hotspots and several overstocked fisheries and angling waters for potential invasion. We emphasize the importance of public campaigns aimed at raising the awareness of the risk posed by invasive species and of continuous targeted monitoring of urban areas to prevent future invasions.

INVASION BIOLOGY

DIVISION