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## 5. HRVATSKI SIMPOZIJ O INVAZIVNIM VRSTAMA s međunarodnim sudjelovanjem

## 5<sup>th</sup> CROATIAN SYMPOSIUM ON INVASIVE SPECIES with International Participation



27-28. XI 2023 .  
Zagreb, Hrvatska

ZBORNİK SAŽETAKA  
BOOK OF ABSTRACTS

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signalni rak / signal crayfish (*Pacifastacus leniusculus*) – Ivana Maguire

grozdasta kaulerpa / seaweed (*Caulerpa cylindracea*) – Ante Žuljević



Hrvatsko ekološko društvo  
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**5. HRVATSKI SIMPOZIJ O INVAZIVNIM VRSTAMA**  
s međunarodnim sudjelovanjem  
27-28. Studeni 2023.  
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Zagreb, Croatia

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**BOOK OF ABSTRACTS**

Zagreb, 2023.

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5. HRVATSKOG SIMPOZIJA O INVAZIVNIM VRSTAMA**

**BOOK OF ABSTRACTS  
OF THE 5<sup>th</sup> CROATIAN SYMPOSIUM ON INVASIVE SPECIES**

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**PROGRAM SIMPOZIJA**  
**PROGRAMME OF THE SYMPOSIUM**

## Programme of the 5<sup>th</sup> Croatian Symposium on Invasive Species

### Monday 27<sup>th</sup> November

08:30 – 09:30	Registration and poster setup
09:30 – 10:00	Opening of the Symposium
10:00 – 10:45	Keynote lecture  Luke Flory (K1) INVASIVE PLANTS AND GLOBAL CHANGE DRIVERS INTERACT TO ALTER COMMUNITIES AND ECOSYSTEMS
10:45 – 11:15	Coffee Break
11:15 – 12:45	Chairperson: Božena Mitić  11:15 <u>Montserrat Vilà</u> , Alejandro Trillo, Pilar Castro-Díez, Belinda Gallardo, Sven Bacher (O1) IMPACTS BY INVASIVE PLANT SPECIES IN EUROPE 11:30 <u>Ali Omer</u> , Franz Essl, Stefan Dullinger, Bernd Lenzner, Adrián García-Rodríguez (O2) INVASION RISK OF THE CURRENTLY CULTIVATED ALIEN FLORA IN SOUTHERN AFRICA IS PREDICTED TO DECLINE UNDER CLIMATE CHANGE 11:45 <u>Tanja Mihinjač</u> , Vesna Tatalović, Josipa Perković, Valentina Borak Martan, Miloš Martinović (O3) LIFE CONTRA <i>Ailanthus</i> – ESTABLISHING CONTROL OF INVASIVE ALIEN SPECIES <i>Ailanthus altissima</i> IN CROATIA 12:00 Maarten de Groot, Erika Kozamernik, Janez Kermavnar, Marija Kolšek, <u>Aleksander Marinšek</u> , Andreja Repe, Lado Kutnar (O4) MODELLING THE POTENTIAL SPATIAL DISTRIBUTION OF INVASIVE PLANT IN SLOVENIAN FORESTS: A RISK MAP OF <i>Phytollaca americana</i> 12:15 <u>Janez Kermavnar</u> , Lado Kutnar (O5) RESURVEY OF VEGETATION PLOTS IN OAK FORESTS (SLOVENIA) REVEALS INCREASING SPREAD OF NEOPHYTES 12:30 Monika Cindrić, Mihaela Mesarić, Sara Srša, <u>Ivana Horvat</u> (O6) FIRST RECORD OF <i>Pistia stratiotes</i> AND NEW RECORDS FOR <i>Heracleum mantegazzianum</i> IN MEĐIMURJE COUNTY (CROATIA)
12:45 – 14:30	Lunch Break
14:30 – 15:15	Keynote lecture  Johanna Witzell (K2) INVASIVE PESTS AND PATHOGENS AS ARCHITECTS OF FUTURE FORESTS



15:15 – 16:00	<p style="text-align: right;">Chairperson: Dinka Matošević</p> <p>15:15 <u>Dinka Matošević</u>, Johanna Witzell, Benno Andreas Augustinus, Martina Kičić, Mariella Marzano (O7) Urban Tree Guard - SAFEGUARDING EUROPEAN URBAN TREES AND FORESTS THROUGH IMPROVED BIOSECURITY</p> <p>15:30 <u>Francis Maire</u> (O8) CANKER STAIN DISEASE: A THREAT TO PLANE TREE (<i>Platanus</i> sp.) POPULATIONS</p> <p>15:45 <u>Nina Šajna</u>, Mirjana Šipek, Eva Horvat, Željka Zgorelec, Aleksandra Perčin (O9) EDGE EFFECTS IN FOREST FRAGMENTS EMBEDDED IN THE HUMAN-DOMINATED LAND</p>
16:00 – 16:45	<p style="text-align: center;">Poster Session &amp; Coffee Break</p>
16:45 – 18:15	<p style="text-align: right;">Chairperson: Nenad Jasprica</p> <p>16:45 <u>Petra Kutleša</u>, Una Mršić, Zrinka Domazetović (O10) EFFECTIVE MANAGEMENT OF FUTURE BIOLOGICAL INVASIONS – SUPPORT AND IMPLEMENTATION OF POLICY IN CROATIA</p> <p>17:00 <u>Patrizia Digiovinazzo</u>, Mattia Bertocchi, Sergio Canobbio, Fabrizio Oneto, Dario Kian (O11) THE PARTICIPATIVE APPROACH OF THE LIFE IP GESTIRE 2020 PROJECT FOR THE CONTROL OF INVASIVE SPECIES IN THE LOMBARDY REGION, ITALY</p> <p>17:15 <u>Una Mršić</u>, Petra Kutleša, Zrinka Domazetović (O12) MANAGEMENT ACTIONS FOR CONTROLLING POPULATIONS OF PRIORITY INVASIVE ALIEN SPECIES IN CROATIA</p> <p>17:30 <u>Božena Mitić</u>, Dinka Matošević, Petra Kutleša, Diana Vlahović, Dario Hruševar, Martina Cigrovski Mustafić, Valentina Borak Martan, Dalibor Vladović, Igor Boršić (O13) FUN WITH BENEFITS - IAS BIOBLITZ IN CROATIA</p> <p>17:45 <u>Valerija Hima</u>, Valentina Borak Martan, Martina Cigrovski Mustafić, Tanja Mihinjač (O14) CODES OF CONDUCT – A WAY TO PREVENT THE INTRODUCTION AND CONTROL SPREAD OF IAS</p> <p>18:00 <u>Sonja Rozman</u>, <u>Ana Dolenc</u> (O15) PRESENTATION OF NEW PROJECT LIFE ORNAMENTALIAS</p>
19:00 - 22:00	<p style="text-align: center;">Beervative evening</p>

**Tuesday 28<sup>th</sup> November**

08:30 – 09:00	Registration
09:00 – 10:30	<p style="text-align: right;">Chairperson: Ante Žuljević</p> <p>09:00 <u>Ante Žuljević</u>, Petra Lučić, Ivan Cvitković, Marija Despalatović (O16) MARINE BROWN ALGAE <i>Styopodium schimperi</i> IS GOING TO BE THE MOST INVASIVE ALIEN SPECIES IN THE ADRIATIC SEA</p> <p>09:15 <u>Nikola Zorić</u>, Tomislav Krcivoj, Andrija Jukić, Dinka Matošević (O17) PEST ON THE MOVE: FIRST RECORD OF CITRUS LONGHORN BEETLE (<i>Anoplophora chinensis</i>) IN FOREST AREA IN CROATIA</p> <p>09:30 <u>Najla Baković</u>, Dorotea Kiš, Daniela Klaić Jančijev, Ema Svirčević, Tajana Uzelac Obradović (O18) A CONTRIBUTION TO THE KNOWLEDGE OF THE DISTRIBUTION OF <i>Ophraella communa</i> IN SAMOBOR MUNICIPALITY (ZAGREBAČKA COUNTY, CROATIA)</p> <p>09:45 <u>Ivan Budinski</u>, Ivana Selanec, Gjorge Ivanov, Ivan Grubišić, Matija Marek (O19) THREE INVASIVE SPECIES OF SMALL CARNIVORES IN CROATIA; PRESENCE AND CONTROL</p> <p>10:00 <u>Matej Vucić</u>, Ivan Špelić, Tanja Mihinjač, Ivan Beno, Dušan Jelić (O20) THE OCCURRENCE OF INVASIVE FISH SPECIES IN THE KRKA RIVER</p> <p>10:15 <u>Sanja Gottstein</u>, Franka Prevedan, Zlatko Mihaljević (O21) AMPHIPOD INVASION PATHWAYS IN THE HYDROELECTRIC POWER PLANT SYSTEMS OF THE DRAVA RIVER, CROATIA</p>
10:30 – 11:15	Poster Session & Coffee Break
11:15 – 12:00	<p style="text-align: center;">Keynote lecture</p> <p style="text-align: center;">Denis Kutnjak (K3) NOVEL APPROACHES FOR DISCOVERY AND DETECTION OF MICROBES ASSOCIATED WITH INVASIVE ALIEN SPECIES</p>
12:00 – 12:30	<p style="text-align: right;">Chairperson: Sandra Hudina</p> <p>12:00 <u>Ljudevit Luka Boštjančić</u>, Caterina Francesconi, Lena Bonassin, Christelle Rutz, Odile Lecompte, Miklós Bálint, Kathrin Theissinger (O22) ARE RNA VIRUSES A NOVEL THREAT FOR NATIVE FRESHWATER CRAYFISH POPULATIONS?</p> <p>12:15 <u>Caterina Francesconi</u>, Ljudevit Luka Boštjančić, Lena Bonassin, Leonie Schardt, Christelle Rutz, Odile Lecompte, Miklós Bálint, Klaus Schwenk, Kathrin Theissinger (O23) CHARACTERISATION OF PATHOGENICITY FACTORS OF A COLLECTION OF <i>Aphanomyces astaci</i> STRAINS</p>

12:30 – 14:15	Lunch Break	12:30 – 13:15 Round Table (In Croatian) „OD EGZOTIČNOG DO INVAZIVNOG“ Odgovorno vlasništvo – važna karika u kontroli IAS
14:15 – 15:30	Chairperson: Ivana Maguire	
	<p>14:15 <u>Lukáš Veselý</u>, Fabio Ercoli, Martin Bláha, Timo J. Ruokonen, Antonín Kouba, Miloš Buřič (O24) INVASIVE SIGNAL CRAYFISH MODIFIED TROPHIC NICHE WIDTH AND FOOD SOURCE UTILIZATION OF NOBLE CRAYFISH IN SYMPATRIC LOCALITY</p> <p>14:30 <u>Filip Ložek</u>, Marek Let, Antonín Kouba, Miloš Buřič, Martin Bláha (O25) OVERLOOKED BIODIVERSITY DEPLETION: SIGNAL CRAYFISH AS A MENACE FOR EUROPEAN ECTOSYMBIONT</p> <p>14:45 <u>Michael O. Aluma</u>, Katrin Kaldre, Lilian Pukk (O26) eDNA-BASED DETECTION OF <i>Astacus astacus</i>, <i>Aphanomyces astaci</i> AND INVASIVE ALIEN CRAYFISH SPECIES IN ESTONIAN WATER BODIES</p> <p>15:00 András Weiperth, <u>Martin Bláha</u>, Zsombor M. Bányai, Árpád Ferincz, Jiří Patoka, Béla Urbányi, Antonín Kouba (O27) “NEW KIDS ON THE BLOCK”: CRAB SPECIES INTRODUCTIONS APPEAR IN EUROPEAN INLAND WATERS</p> <p>15:15 <u>Jernej Košir</u>, Nina Šajna (O28) NEW OCCURRENCES AND THE LATEST REPORTS ON THE DISTRIBUTION OF THE NORTH-AMERICAN SIGNAL CRAYFISH IN RIVER DRAVA IN SLOVENIA</p>	
15:30 – 16:00	Coffee Break	
16:00 – 16:45	Chairperson: Sanja Gottstein	
	<p>16:00 <u>Sandra Hudina</u>, Nina Marn, Ines Haberle, Ana Dobrović, Tin Klanjšček (O29) COMPARISON OF PHYSIOLOGICAL PERFORMANCE BETWEEN INVASIVE AND NATIVE CRAYFISH SPECIES IN A CHANGING ENVIRONMENT</p> <p>16:15 <u>Luka Petrokov</u>, Sandra Hudina, Ivana Maguire, Paula Dragičević, Leona Lovrenčić, Dora Pavić, Kathrin Theissing, Ljudevit Luka Boštjančić, Lena Bonassin, Caterina Francesconi, Ana Bielen (O30) OOMYCETE ISOLATES ORIGINATING FROM THE CUTICLE OF NATIVE AND INVASIVE CRAYFISH SPECIES IN CROATIA</p> <p>16:30 <u>Matej Vucić</u>, Ivana Maguire, Leopoldina Dakić, Sandra Hudina (O31) FIRST APPLICATION OF ENVIRONMENTAL DNA FOR THE DETECTION OF INVASIVE SIGNAL CRAYFISH IN CROATIA</p>	
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48. Sven D. Jelaska  
THE DEVIL IS IN THE DETAILS (OR LACK OF THEM) – A CASE OF DEVIL’S FINGERS (*Clathrus archeri*) AN ALIEN, POTENTIALLY INVASIVE, FUNGUS PROTECTED IN CROATIA



**PLENARNA PREDAVANJA**

**KEYNOTE LECTURES**

## K1

### INVASIVE PLANTS AND GLOBAL CHANGE DRIVERS INTERACT TO ALTER COMMUNITIES AND ECOSYSTEMS

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Introduction of species to non-native ranges worldwide shows no sign of letting up, and many ecosystems are now subject to multiple plant invaders. Moreover, ecological stress caused by the interaction of invasive plants and other global change drivers such as climate change, anthropogenic disturbance, emerging pathogens, and other factors is having potentially profound effects on native ecosystems. Although invaders and other ecological stressors often occur simultaneously, how they interact to impact native systems is poorly understood. I'll discuss results from three projects where we have evaluated interactions between plant invaders and other global change drivers: 1) A longer-term field experiment testing how drought and invasion (by the non-native perennial grass *Imperata cylindrica*) interacted to determine effects of a third stressor (fire) on longleaf pine (*Pinus palustris*), the foundation species for a threatened fire-dependent ecosystem in the Southeast USA; 2) A field experiment and modelling to test the effects of an emerging foliar fungal pathogen on the abundance and competitive effects of the invasive annual grass *Microstegium vimineum* in Indiana, USA; and 3) A field study and growth chamber experiment to assess if urbanization has caused evolution of an invasive forb in Croatia to better tolerate future climate conditions. Altogether, these projects show that climate change + fire, emerging pathogens, and urbanization can each enhance or alter the effects of invasive plants on native communities and ecosystems. They also highlight the need for longer-term, multi-factorial, manipulative studies that can generate data to accurately forecast ecological outcomes of interacting drivers of global environmental change.

Keywords: climate change; ecological stressor; emerging pathogens; fire; synergy; urbanization

## **K2**

### **INVASIVE PESTS AND PATHOGENS AS ARCHITECTS OF FUTURE FORESTS**

Johanna Witzell

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Invasive pests and pathogens, introduced through globalization and trade, have the potential to catalyze profound and lasting ecological transformations in forests. Their impacts challenge the critical role that forests play in supporting biodiversity and providing numerous ecosystem services. The invasive organisms often target dominant tree species, causing significant shifts in tree species composition and consequently altering the forest's structure, canopy dynamics, biodiversity, and ecosystem functions. Furthermore, the damage inflicted by invasive pests can disrupt nutrient cycling, impact soil properties, and trigger cascading effects throughout the forest ecosystem. Beyond their ecological impact, invasive pests as architects of future forests have far-reaching socioeconomic consequences. Changes in forest composition can deeply affect human livelihoods, the timber industry, and the carbon sequestration capacity of forests, all of which have wide-ranging economic and environmental implications. Understanding the dynamics of invasive pests in forest ecosystems is crucial for the development of effective management and mitigation strategies aimed at reducing their long-term impacts. Addressing the challenges posed by invasive pests in forest ecosystems necessitates the implementation of integrated pest management strategies, early detection methods, ongoing monitoring, and conservation efforts that consider both ecological and socioeconomic dimensions. By recognizing the potential role of invasive pests in shaping the forests of the future, we can better prepare to manage and adapt to the changing nature of these invaluable ecosystems while promoting sustainable use and conservation of forests.

Keywords: introduced pests, outbreaks, epidemics, tree species, sustainable forest management

### K3

#### NOVEL APPROACHES FOR DISCOVERY AND DETECTION OF MICROBES ASSOCIATED WITH INVASIVE ALIEN SPECIES

Denis Kutnjak<sup>1</sup>, Katarina Bačnik<sup>1</sup>, Sandra Hudina<sup>2</sup>, Ivana Maguire<sup>2</sup>, Ana Bielen<sup>3</sup>, Dora Pavić<sup>3</sup>, Leticia Botella<sup>4</sup>, Jiří Patoka<sup>5</sup>, Antonín Kouba<sup>6</sup>

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Host-associated microbial and viral communities have recently been highlighted as one of the factors influencing the success of the invasive species. They can influence the invasion process by either preventing or facilitating the establishment or spread of the introduced species. Some of these microbes can be pathogenic and may severely threaten native hosts - a mechanism known as pathogen spillover. Conversely, native pathogens already present in the area of introduction may infect introduced host species, which is known as pathogen spillback. Such transmissions may significantly modify local host-pathogen dynamics, resulting in increased epidemiological risk to agriculture and aquaculture, wildlife/ecosystems, and human health (zoonotic diseases). The risks and impacts arising from co-transported known and novel pathogens remain largely unexplored, unlegislated, and difficult to be detected and determined. To be able to discover and detect such microbes, which are often yet unknown or are unexpected to be associated with non-native species, sensitive and generic detection methods are needed. Among such methods, high-throughput sequencing (HTS) based metagenomics offers unique opportunities for comprehensive detection of a broad range of microbes and viruses from different sample types. The generic nature of HTS is especially important in the field of virus discovery, due to the lack of universal marker genes among virus taxa. The knowledge about the presence and role of viruses in association with non-native species has been scarce so far. We have previously characterised the virome of one of the most successful invasive species of freshwater invertebrates in Europe, the signal crayfish (*Pacifastacus leniusculus*), identifying novel and divergent signal crayfish associated RNA viruses along its invasion range. Then, we have focused on three popular exotic crayfish species, which are imported to Europe through pet trade. Pet trade is one of the major invasion pathways, however its risks related to the disease emergence and outbreaks are largely understudied. Using HTS-based metagenomic approach we detected several known and novel RNA and DNA viruses in tested samples. Using these examples, we will discuss the use of the state-of-the-art approaches for detection of microbes associated with non-native species and the outlooks for future research on this topic.

Keywords: high-throughput sequencing, viruses, crayfish, spillover, pet trade, pathogens

**USMENA PRIOPĆENJA**

**ORAL PRESENTATIONS**

## O1

### IMPACTS BY INVASIVE PLANT SPECIES IN EUROPE

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Despite the threat that invasive species pose to biodiversity and ecosystems, the impacts they have can vary widely across invasive species and invaded sites. We present the first harmonized database that compiles scientific evidence of the ecological impacts of invasive plant species at continental scale. We summarize results from 266 publications reporting 4,259 field studies on 104 invasive species in 29 European countries. For each study, we recorded whether the effects were statistically significant and noted their direction (i.e. decrease or increase in the response variable when compared to uninvaded sites). We classified studies based on the impacts on the levels of ecological organization (species, communities and ecosystems), taxa and trophic level. Notably, one third of the studies focused on five invasive species (*Reynoutria japonica*, *Impatiens glandulifera*, *Solidago gigantea*, *Carpobrotus edulis*, *Robinia pseudoacacia*). More than half of the studies were conducted in temperate and boreal forests and woodlands, and temperate grasslands. Impacts on native plants were more frequently studied than impacts on other taxa and trophic groups. Overall, 43% of the studies reported significant impacts, with more significant decreases (26%) than increases (17%) in the response variables. Significant impacts were more frequent on communities than on species or ecosystems, and on plants than on animals or microbes. This database is of interest for academic, management and policy-related purposes.

Keywords: context-dependence, diversity, ecological organization, European Regulation on IAS, trophic level

## O2

### INVASION RISK OF THE CURRENTLY CULTIVATED ALIEN FLORA IN SOUTHERN AFRICA IS PREDICTED TO DECLINE UNDER CLIMATE CHANGE

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Alien species can have massive impacts on native biodiversity and ecosystem functioning. Assessing which species from currently cultivated alien floras may escape into the wild and naturalize is hence essential for ecosystem management and biodiversity conservation. Climate change has promoted the naturalization of many alien plants in temperate regions, but whether outcomes are similar in (sub)tropical areas is insufficiently known. In this study, we implemented species distribution models in BIOMOD2 platform to evaluate the current naturalization risk of 1,527 cultivated alien plants in 10 countries of Southern Africa and to assess how their invasion risk might change due to climate change. We assessed changes in climatic suitability across the different biomes of Southern Africa. Moreover, we assessed whether climatic suitability for cultivated alien plants varied with their naturalization status and native origin. The results of our study indicate that a significant proportion (53.9%) of the species are projected to lack suitable climatic conditions in Southern Africa, both currently and in the future. Based on the current climate conditions, 10% of Southern Africa is identified as an invasion hotspot (here defined as the top 10% of grid cells that provide suitable climatic conditions to the highest numbers of species). This percentage is expected to decrease slightly to 7.1% under moderate future climate change and shrink considerably to 2.0% under the worst-case scenario. This decline in climatic suitability is observed across most native origins, particularly under the worst-case climate change scenario. Our findings indicate that climate change is likely to have an opposing effect on the naturalization of currently cultivated average plants in (sub)tropical Southern Africa compared to colder regions. Specifically, the risk of these plants' naturalizing is expected to decrease due to the region's increasingly hot and dry climate, which will be challenging for the persistence of both native and alien plant species.

Keywords: biological invasion, ornamental plants, climate change, habitat suitability, invasion risk, naturalization success

### O3

#### **LIFE CONTRA *Ailanthus* – ESTABLISHING CONTROL OF INVASIVE ALIEN SPECIES *Ailanthus altissima* IN CROATIA**

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*Ailanthus altissima* (tree of heaven) is a tree species native to eastern China and North Vietnam, where it grows as a natural component of broadleaf forests. Because of its decorative leaves, fast growth, resistance to herbivores, and low environmental requirements it was used in horticulture, landscaping, habitat restoration, soil erosion control, and medicinal and chemical industry. To date, *Ailanthus* has invaded all continents except Antarctica and is considered one of the worst invasive plant species in Europe. In Croatia, *Ailanthus* is widespread, but it is particularly frequent in the Mediterranean region. The LIFE CONTRA *Ailanthus* project aims to establish control over *Ailanthus* in four Natura 2000 sites (in NP Krka and the Pelješac peninsula) and the historic cities of Dubrovnik, Ston and Mali Ston in Mediterranean Croatia through targeted eradication actions. Based on the initial mapping of infestation, *Ailanthus* was removed by mechanical (cutting and felling of trees, pulling the shoots) or chemical methods (cutting down the tree and applying herbicide). To evaluate the project impact, monitoring of the removal of *Ailanthus* and other biodiversity components (plant and soil communities, pollinators, tufa) is conducted throughout the duration of the project. At the national level, the project aims to prevent further introductions and spread of *Ailanthus* by raising public awareness on IAS, training local stakeholders on removal and developing and implementing a national protocol for *Ailanthus* removal. In this presentation we discuss the results and future plans of the project.

Keywords: Tree of heaven, LIFE programme, eradication, Natura 2000



## O4

### MODELLING THE POTENTIAL SPATIAL DISTRIBUTION OF INVASIVE PLANT IN SLOVENIAN FORESTS: A RISK MAP OF *Phytolacca americana*

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Forests are important ecosystems which are under threat by climate and global change. One of the threats is the appearance of invasive alien plant species. Some are already established, while others are in the process of naturalization. Although forests are a relatively stable ecosystems, extreme weather events make them more open and thus more vulnerable to invasion by alien plants. We created a risk map for American pokeweed (*Phytolacca americana*), a species that has been spreading rapidly over the past decade. We build a logistic regression model (GLM) based on observations conducted in the project LIFE ARTEMIS. Eleven environmental variables were used to determine habitat characteristics. We created a model for the whole territory of Slovenia and separately for the forests in Slovenia. The latter model was created because variables specific to forests were included (e.g., forest restoration, logging intensities, and share of spruce monocultures). For all of Slovenia, land use, elevation, distance to water, distance to railroad, geology, and solar radiation were included, with only elevation, distance to water, and railroad being significant. For the forest model, % of spruce, geology, disturbance, elevation, distance to water, railroad, road, and solar radiation were included, with only the latter two being non-significant. The risk map shows that the higher occurrence probability is mainly in the east and west and in the central part of Slovenia at lower elevations. Due to the increasingly intensive spread of American pokeweed, it is important to monitor and predict the spread of this species using risk maps. Inclusion of even more specific forest variables would provide a better understanding of pokeweed's continued spread in forests.

Keywords: American pokeweed, distribution modelling, forests, forest disturbance

## O5

### RESURVEY OF VEGETATION PLOTS IN OAK FORESTS (SLOVENIA) REVEALS INCREASING SPREAD OF NEOPHYTES

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Resurvey of historical vegetation plots can provide important insights into the temporal dynamics of non-native plant species. We resurveyed permanent vegetation plots in managed *Quercus robur* (QR) and *Q. petraea* (QP) forests that were originally sampled 30 years ago. Nine different sites in Slovenia were revisited in 2023 and 45 plots (20 × 20 m) were resurveyed following the original methodology. The main aim was to evaluate the long-term magnitude and direction of change in understory vegetation. One of the significant patterns was the increased frequency and cover of non-native plants, especially in QR plots. In the early 1990s, only four neophytes were recorded with low abundance, representing less than 2% of the total species pool in the understory layer. In 2023, the total number of neophytes increased to 21 species, 15 herbaceous and six woody species. This increase was significant in QR but not in QP plots. The most frequent species were *Impatiens parviflora* (present in 14 plots), *Solidago gigantea* (13), *Erigeron annuus* (7) and *Erechtites hieraciifolius* (7). In some QR plots, communities were strongly dominated by tall-statured invasive neophytes, representing up to 22.1% of the total understory cover. Observed increase of neophytes was triggered by progressive canopy mortality in the overstory layer. Mature QR trees exhibited profound crown defoliation or complete dieback, which altered the ecological conditions at the forest floor. Additional factor were forest management interventions causing soil disturbance. Rapid colonization of canopy gaps by herbaceous neophytes can be also explained by their functional traits as the most abundant neophytes were competitive ruderals with high dispersal capacity and acquisitive resource-use strategy. Due to climate change and forest disturbances, the spread of neophytes is expected to intensify in the future in Slovenian oak forests as well as in other forest vegetation types.

Keywords: *Quercus robur*, *Quercus petraea*, canopy mortality, long-term vegetation changes, understory layer

## O6

### **FIRST RECORD OF *Pistia stratiotes* AND NEW RECORDS FOR *Heracleum mantegazzianum* IN MEĐIMURJE COUNTY (CROATIA)**

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Invasive alien species are one of the major causes of biodiversity loss across the EU. They can also cause significant damage to human health and the economy. The list of invasive alien species of Union concern (“the Union list”) comprises species whose potential adverse impacts across the European Union are such that concerted action across members states is required. The 88 Species are on Union Concern List today. The first records of *Pistia stratiotes* L. (Araceae) and new occurrences of *Heracleum mantegazzianum* Sommier & Levier (Apiaceae), both species on the list of invasive alien species of European Union concern, are reported for the first time in Međimurje. The species *Pistia stratiotes* L. (native to South America, free-floating, aquatic macrophyte, present on all continents, except Antarctica). It occurs occasionally and casually in many countries in the EU, but it is established only in thermally abnormal waters in Slovenia, France and Germany. Floristic research in the fish pond in Hodošan was carried out during the summer (August and September) of 2023. A big colony of plants was found. The location of the investigated site was recorded with a GPS Receiver. Although the exact introduction pathway is not known, several possible pathways were taken into consideration and discussed. Immediate control and eradication measures were implemented on infested site. *H. mantegazzianum* (native to the Caucasus mountains in south west Russia and Georgia) was recorded again after ten years in Žabnik, and also found at a new site in Mursko Središće in 2022. Initially, the species was brought to Northern Ireland as an ornamental plant in parks and gardens. Its seeds are dispersed by wind and water, meaning that it can travel relatively easily in the right conditions. Therefore, immediate control and eradication measures were implemented on two sites.

Keywords: plants, IAS, eradication, water pathway, introductions of new species, freshwaters

## O7

### **Urban Tree Guard - SAFEGUARDING EUROPEAN URBAN TREES AND FORESTS THROUGH IMPROVED BIOSECURITY**

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Green infrastructure, including urban forests, has been proposed by European Commission as a strategy to support climate adaptation capacity and sustainable development in the urban areas where over 70% of the EU's population live. Alarming, the green infrastructure and especially its characteristic elements, trees, are increasingly threatened by alien pests (insects and pathogens) that are introduced via trade and transports. In a new environment, these pests may become invasive, causing devastating environmental and economic losses, and threatening also unique cultural values such as those linked to veteran trees. The current biosecurity system fails to capture alien pests that often also benefit from the altered climate. New tools and better integration of different knowledge pools are urgently needed to support better biosecurity in urban settings. COST action (an interdisciplinary research network that brings researchers and innovators together to investigate a specific topic (funded by the EU) brings together a pan-European and international network of scientists and stakeholders to meet this challenge. The network 1) Collects, shares and harmonizes scientific and stakeholder knowledge, 2) Accelerates development of innovative technological tools and solutions for biosecurity purposes, 3) Informs policy and support implementation of the EU plant health regime while providing science-based recommendations for decision makers, especially at operational levels, 4) Fosters an inclusive and open research environment, with explicit support to young professionals, and 5) Increases European competitiveness in the field of biosecurity, improving also the quality of everyday life for people, especially urban dwellers, in Europe and beyond. A co-created Wiki database, teaching tools for education in urban forest health, and a decision support tool will ensure the long-term impacts of the Action.

Keywords: alien invasive pests and pathogens, cooperation, networking, stakeholders, urban forest health

**O8**

**CANKER STAIN DISEASE : A THREAT TO PLANE TREE (*Platanus* sp.) POPULATIONS**

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Canker stain disease caused by *Ceratocystis platani* is a serious threat for plane tree (*Platanus* sp.) populations. The fungus reaches all *Platanus* species, and can cause significant damages on urban and natural populations of plane tree. In France, the disease has killed hundreds of thousands of planes trees since the end of World War II. On the Canal du Midi, since 2006, year of introduction of the disease, it was cut 30,000 plane trees out of the 42,000 that shaded the Canal. In Lyon the Parc de la Tête d'Or has lost half of its plane in 20 years. In Greece the natural population of oriental plane trees, along rivers, is decimated by the fungus. Million of *Platanus orientalis* are concerned. The mains vectors are human activities connected to infected tools, water and beetles. For now, there is no curative methods, only prophylactic actions can prevent or limit the spread of the disease. *C. platani* is a quarantine organism in Europe and outbreak management is complex and very expensive (from 1500 to 4500 € to cut down an infected tree, depending on the case). It is necessary to alert countries, not yet affected by the disease, to implement preventive measures like prohibiting the importation of plane tree species from infected countries, and make it mandatory to disinfect tools when working on or near plane trees. Like the other species, plane trees are efficient carbon pumps that we need to fight global warming.

Keywords: *Ceratocystis platani*, *Platanus*, Urban trees, canker stain

## O9

### **EDGE EFFECTS IN FOREST FRAGMENTS EMBEDDED IN THE HUMAN-DOMINATED LAND**

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Among biodiversity loss drivers habitat fragmentation results in several evidently negative effects: smaller habitat area, larger edge, and increased isolation. While natural edges are regarded as ecotones increasing biodiversity, the human-induced and maintained edges are more likely to allow additional biodiversity loss drivers to operate from the edge into the fragment's interior. Three of these drivers are invasive alien species (IAS), land use, and pollutants because human-maintained edges are expected to exhibit conditions less favorable for native species and are under strong impact of what kind of human activities are undergoing in the fragment's surroundings. The impacts of these drivers are not expected to be equally strong for all drivers. Therefore, we evaluated impacts along the edge – to – interior gradients by recording plant species, anthropogenic disturbance, and soil pollutants. Here, we present an overview of our studies on forest fragments on the river plains of the Drava and Mura in Slovenia and partly in Croatia and discuss recent results quantifying edge effects. We are going to describe differences if fragments are embedded in agricultural or peri-urban areas; stress the importance of edge orientation and plant diversity on invasion by IAS; and evaluate how IAS, their invasion severity, and reaching depth are related to anthropogenic disturbances and surrounding land use.

Keywords: Drava River, flora inventory, invasive alien species, soil properties

## O10

### **EFFECTIVE MANAGEMENT OF FUTURE BIOLOGICAL INVASIONS – SUPPORT AND POLICY IMPLEMENTATION IN CROATIA**

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Invasive alien species (IAS) pose one of the major threats to global biodiversity. Numerous IAS strategies and action plans at both European and global levels are available to address the threat of IAS to the environment. Additionally, several scenarios focused on biological invasions have been recently developed to assist decision-makers in forming a strategy for future biological invasion management, taking into consideration various environmental and socio-economic drivers until 2050. Furthermore, the IPBES Assessment Report on invasive alien species and their control has been adopted. This report synthesizes global knowledge on the trends, drivers, and impacts of biological invasions and provides policy recommendations for the effective management of biological invasions. This IPBES Report should also contribute to achieving Target 6 of the Kunming-Montreal Global Biodiversity Framework, which aims to reduce the rate of introduction and establishment of invasive alien species by at least 50% by 2030. In this presentation, we will discuss the Croatian implementation of IAS legislation and its contribution to efforts to combat biological invasions and the negative impacts of IAS on biodiversity and ecosystem services. We will examine Croatia's response to biological invasions through legislation, such as the Act on IAS and the Nature Protection Strategy and Action Plan of the Republic of Croatia for the period 2017-2025, and how we can ensure compliance with the European and global vision of effective management approaches to biological invasions.

Keywords: global vision, threat, driver, biodiversity, legislation

## O11

### THE PARTICIPATIVE APPROACH OF THE LIFE IP GESTIRE 2020 PROJECT FOR THE CONTROL OF INVASIVE SPECIES IN THE LOMBARDY REGION, ITALY

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After almost 8 years the Lombardy regional government is currently ending the EU-funded Life Integrated Project called Gestire 2020, aiming to improve the management effectiveness of Natura 2000 sites and their linking Green Networks. Our presentation shows the results of the regional planning and the restoration projects to reduce the presence of the invasive plant species. The specific Action A5 allowed the drafting of 8 protocols to reduce the presence of invasive alien plant species of Union concern, while Lombardy Region has passed a law that includes a black list of more than 130 invasive species, both plants and animals (dgr 2658/2019). Lombardy Region co-financed with Life funds more than 25 projects against IAS, for example the restoration of woods vegetation, or the edges of rivers and pools, reducing invasive alien species (e.g. *Impatiens glandulifera*, *Lagarosiphon major* or *Ludwigia exapetala*) and restoring with native ones. Many of the restoration project above mentioned were carried out thanks to the support of Technical Facilitators (TFs), an important innovation of this Life project. TFs are experts available for stakeholders (such as managing bodies, land owners, farmers) to identify funds focused on the biodiversity conservation (the so called complementary funds). The main objectives are: (i) to research of funding opportunities; (ii) to foster the network between local and central authorities; (iii) to help the stakeholders on drawing up biodiversity projects; (iv) to support Life Project Actions. Thanks to Life IP Gestire 2020, a regional task force is active to collect all reports regarding IAS. Even if the Life IP Gestire 2020 will conclude at the end of 2023, the commitment to preserve biodiversity and to contrast IAS will be carried out thanks to a new inter-regional project called NatConnect 2030, co-funded by the new European Programme called Strategic Nature Project (SNAP).

Keywords: Technical Facilitators, restoration projects, black list of invasive species



**O12**

## **MANAGEMENT ACTIONS FOR CONTROLLING POPULATIONS OF PRIORITY INVASIVE ALIEN SPECIES IN CROATIA**

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Once invasive alien species (IAS) are established, appropriate management measures must be taken as soon as possible to mitigate their negative impacts. There are various methods to eradicate, control or contain IAS, but eradication should be encouraged whenever possible. However, eradication is highly dependent on the abundance of, and area size occupied by IAS. Therefore, prioritization of IAS and availability of resources are most important for effective management. In Croatia management plans have been adopted for five IAS from the Union list– two vascular plants (*Asclepias syriaca* and *Impatiens glandulifera*) and three animals (*Pacifastacus leniusculus*, *Trachemys scripta* and *Herpestes javanicus*) for the period of ten years. Its implementation has started in 2022. The Ministry of Economy and Sustainable Development and the Environmental Protection and Energy Efficiency Fund have planned a public call for direct funding of projects “Control of populations of priority invasive alien species” intended for public institutions for nature protection. In this presentation, we will present the preparation of management options for these calls and ongoing activities for eradication and control of priority IAS. We will also report on the support and involvement of local communities in IAS management and the importance of public awareness activities to address the threat of invasive alien species in ongoing projects.

Keywords: Union list, threat, resources, eradication, public

## O13

### FUN WITH BENEFITS - IAS BIOBLITZ IN CROATIA

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BioBlitz is a form of short-term research in a certain area with the participation of interested citizens, i.e., the collection of data on (bio)diversity, led by scientists with the help of the citizens. The first simultaneous European BioBlitz, with the aim of detecting invasive alien species (IAS), took place in 2022, under the auspices of the COST action Alien-CSI project and, regardless of the completion of the project, continued in 2023. Croatia also participated in this event both years, with an emphasis on the detection of invasive alien plants. In 2022, only continental Croatia was covered, and in 2023, the action was extended to the entire country. Taxa were recorded through the official mobile application "Invasive species in Croatia" (<https://invazivnevrste.haop.hr/>; in Croatian). During BioBlitz 2022, a total of 196 findings of 13 taxa were reported, and during 2023, 398 findings of 28 invasive alien taxa were reported. The most frequently recorded findings were for the following species: Japanese knotweed, daisy fleabane and tree of heaven. In this presentation, a more detailed analysis of the collected data will be discussed. Actions like this, which encourage the education of the wider community, especially the young population, can play a key role in research, monitoring, and the discovery of new (invasive) species in an area. Therefore, in the future, we are also planning a more comprehensive practice of the IAS BioBlitz action, with the inclusion of a larger number of participants, as well as a greater number of invasive alien taxa.

Keywords: citizen science, species recordings, invasive alien plants, mobile application, non-native taxa

**O14**

**CODES OF CONDUCT – A WAY TO PREVENT THE INTRODUCTION AND CONTROL THE SPREAD OF INVASIVE ALIEN SPECIES**

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Invasive alien species (IAS) are the subset of alien species that are known to establish and spread outside their natural range, causing negative impacts on biodiversity and also on human health. Many human activities facilitate the transport, introduction, establishment and spread of invasive alien species. Prevention is the most cost-effective option and thus crucial for managing the threats from invasive alien species. Therefore the Council of Europe, basing its work on the Bern Convention and with the technical support of the International Union for Conservation of Nature (IUCN) Invasive Species Specialist Group, drafted the series of voluntary codes of conduct, covering a number of activities which are potentially responsible for the introduction of alien species, such as recreational boating, botanical gardens, horticulture, hunting, international travel, plantation forestry, pets, protected areas, e-commerce, recreational fishing, zoological gardens and aquaria. The objectives of the codes of conduct are to increase the level of awareness of all stakeholders, encourage them to adopt to best practices and avoid bad practices, educate them about practices that can lead to the introduction of alien species into natural habitats, and provide clear and simple information about legal obligations and restrictions for each sector. Additionally, it is equally important to raise the awareness of public, especially regarding responsible behavior, emphasizing that abandoning, releasing into nature or enabling the escape of alien species is socially unacceptable behavior.

Keywords: IAS, Bern convention, voluntary instruments, prevention

**O15**

**PRESENTATION OF NEW PROJECT LIFE ORNAMENTALIAS**

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In the presentation the new LIFE project Prevention and management of adverse impact of ornamental invasive alien plant species on endangered habitat types and species of EU importance – LIFE OrnamentalIAS will be presented. The focus of the project are ornamental plants. Many invasive alien plants (IAP) have been introduced as ornamental plants and their spread into nature threaten species and habitats of EU importance. LIFE OrnamentalIAS tackles ornamental IAP on three levels of management: prevention, early warning–rapid response (EWRR) and management measures. Prevention is addressed through awareness rising and supported by communication with stakeholders and general public to diminish new introductions of ornamental plants into nature from urban areas and garden waste disposal. Therefore, an assessment of invasiveness of available ornamental plants and code of conduct will be prepared with participation of stakeholders. More efficient garden waste management will be developed, and research on alternative use of IAP material will be conducted. The EWRR will be upgraded in the agriculture and water management sector by educating river water protection supervisors and agricultural consultants. Upgraded EWRR system will prevent further spread of IAP and therefore halt and reverse loss of wildlife habitats and species and enable successful eradication or at least management of the IAP. Effective methods of management of IAP will be upgraded. Key activities will be included to different plans. Results will be transferred to other sectors and will be an important basis for further research and development. Slovenia – Croatia transnational knowledge transfer and common development of the activities are an important part of the project. The consortium is consisted of ten partners from different sectors from Slovenia and Croatia, the Institute of the Republic of Slovenia for Nature Conservation is a lead partner. The project started on October 2023 and will last for six years.

Keywords: invasive alien species, ornamental plants, water management, agriculture, wildlife habitats protection

## O16

### **MARINE BROWN ALGAE *Styopodium schimperi* IS GOING TO BE THE MOST INVASIVE ALIEN SPECIES IN THE ADRIATIC SEA**

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*Styopodium schimperi* (Kützing) Verlaque & Boudouresque, 1991 is a marine brown alga of Indo-Pacific origin that is detected for the first time within the Mediterranean Sea in Israel in 1973. Its first record in the Adriatic Sea was in 2020 around the island of Vis, Middle Adriatic. To date, this is the only area where it has been found and also represents the northernmost record for the Mediterranean Sea. In 2020, it was detected as a sporadic alga on several locations. In the following two years, it demonstrated an exceptional and impressive expansion. The number of thalli increased from a total of 20 in 2020 to several thousand in 2022 on the same inspected transects. Together with robust dimensions of 40 cm, it became a dominant species of the rocky bottom between 5 and 20 m depth. With the aim to quantify *S. schimperi* coverage and the impact on native algal species, in spring 2022, 33 photo-quadrat images (50 × 50 cm<sup>2</sup>) were collected along a 100 m extent and 10 m deep reference line that was placed on the rocky bottom parallel to the shoreline. After dividing the initial photo-quadrat into six sub-quadrats, the average percent cover (25%, 50%, 75% and 100%) per present species was estimated. Coverage of the *S. schimperi* that exceeding 75% was recorded on more than half of the analyzed photo-quadrats, resulting in a drastic reduction of native algal species. Coverage of 100% was associated with complete displacement of native erect algae. This study demonstrates a distinct shift from native infralittoral erect algae to the complete dominance of *S. schimperi* that appeared in just a two years. Considering such as fast expansion with a significant impact on native species, *S. schimperi* might soon become the number one invasive species of the shallow rocky bottom in the Adriatic Sea.

Keywords: marine macro algae, impact on native species, Lessepsian migrant, photo-quadrats

**O17**

**PEST ON THE MOVE: FIRST RECORD OF CITRUS LONGHORN BEETLE (*Anoplophora chinensis*) IN FOREST AREA IN CROATIA**

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In recent years, the alien invasive Citrus Longhorn Beetle (CLB), *Anoplophora chinensis*, has emerged as a significant threat to trees and forest ecosystems. Our study was designed to assess the presence and distribution of CLB in a forested area in Biograd, Jankolovica in Croatia. This region is noteworthy because it is part of a demarcated zone that is currently under targeted eradication efforts for this invasive alien species. To achieve accurate detection, we employed Lindgren multifunnel traps that were coated with fluon to maximize insect capture. These traps were baited with multiple attractants to increase the chances of attracting CLB. The traps were strategically placed near the trunks of host trees and were monitored over a three-month period to capture possible seasonal variations. The study successfully confirmed the presence of CLB making this the first documented case of its kind in forest area in Croatia. This result is important as it underscores the necessity for ongoing surveillance, especially in areas not traditionally associated with CLB. It also calls for adaptive management strategies that can be applied to control the spread of this alien invasive species. The findings of this study contribute valuable data that can be applied for future pest management both locally and globally.

Keywords: alien invasive species, pest management, pheromone traps, eradication efforts

**O18**

**A CONTRIBUTION TO THE KNOWLEDGE OF THE DISTRIBUTION OF *Ophraella communa* IN SAMOBOR MUNICIPALITY (ZAGREBAČKA COUNTY, CROATIA)**

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The species *Ophraella communa* has been recorded in many locations in continental Croatia, but detailed data on its distribution are still lacking. The aim of this research was to determine the distribution of the species *O. communa* in the wider area of Samobor municipality. Research was carried out by selecting transects and points where the presence of *O. communa* and other arthropods was recorded. The first sighting of this species was recorded in August 2023 near the road that had been under renovation for more than a year. Research conducted in September 2023 showed that all developmental stages of *O. communa* were present within a radius of 1 km from the first observation. Noticeable damage was noted on *Ambrosia artemisiifolia*, and only a few non-infested plants were recorded. Apart from *O. communa*, other arthropods have been found on *A. artemisiifolia*. Among them, we can single out the observation of larvae of *Harmonia axyridis* feeding on the eggs of *O. communa*, which indicates a quick response of the ecosystem to the introduction of this alien species. *O. communa* was recorded in all investigated localities, which indicates a longer presence of this species in the research area. The distribution of *O. communa* in Croatia and the interactions between mentioned invasive and native species should be further studied.

Keywords: *Ambrosia artemisiifolia*, *Harmonia axyridis*, invasive animals, predation

**O19**

**THREE INVASIVE SPECIES OF SMALL CARNIVORES IN CROATIA; PRESENCE AND CONTROL**

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Mapping and literature review for three small carnivores, all of them invasive species of Union concern according to EU legislation, was conducted in Croatia during 2020. The species researched were small Indian mongoose, raccoon and raccoon dog. The main field methodology were camera traps but also collecting observations from the locals, especially about road kill. Small Indian mongoose was purposely introduced to the island of Mljet in 1910 and subsequently, using individuals from that successfully established population, to several different localities, including the mainland and even Hercegovina area. The species is spreading fast in the warm coastal areas and has established along the coastline south of Neretva River. Only males were registered north of Neretva River which reflects stronger dispersion drive of males but also the species potential to finally cross the only obstacle on the spreading north along the Adriatic coast. Raccoon and raccoon dog populations in Europe originated from introductions in several countries and are spreading fast, however avoiding the warmer climate in the southern Europe. There is a long list of observations of raccoon and raccoon dog in Croatia, many of them confirmed by samples or footages, but reproduction and/or permanent presence was not confirmed. All three species are considered dangerous for small vertebrate communities, being able to cause species extinctions, and are considered harmful by hunters because of negative impact on small game. Change in hunting legislation is needed to better register their presence and to control them. No organized control of those three species was conducted in Croatia until September of 2023 except some local efforts of hunters but the control programmes are in preparation.

Keywords: small Indian mongoose, raccoon dog, raccoon, camera traps, road kill



**O20**

## **THE OCCURRENCE OF INVASIVE FISH SPECIES IN THE KRKA RIVER**

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The Dinaric Karst is recognised as the European biodiversity hot spot. Its fauna and endemic species are concentrated in small areas with small population sizes. Knowledge about freshwater ichthyofauna of this area is poor, impacted by so-called Wallacean shortfall, because of poor knowledge of species' distribution. The Krka River is known for its exceptional richness in flora and fauna species, and endemic taxa. The Krka River has a total of 29 species of freshwater fish, of which 14 are classified as native to the region, whereas 15 species have been introduced. The research was carried out from 2017 to 2021. Aim of the study was to assess species composition and abundance of non-native and invasive fish species as well as their share in the biomass of Krka River ichthyofauna, as well as their impact on the native species. Non-native species have been identified in all habitats. Their presence in some areas exhibits a significant level of abundance. For instance, in Krka Monastery Lake, the proportion of non-native species amounts to 98.05% of the total species composition. The highest risk to the native fish fauna poses both invasive species like *Lepomis gibbosus* and *Ameiurus melas*, and species translocated from Danube drainage, such as *Cyprinus carpio*, *Silurus glanis*, *Perca fluviatilis*, *Tinca tinca*, and especially *Esox lucius*. During the two-year of targeted removal of invasive fish species from the Krka River, more than 200 kilograms of invasive fish were removed. *C. carpio* and *E. lucius* together provided a substantial amount of the total biomass, with individual specimens of *E. lucius* reaching weights of up to 17 kilograms. An analysis of the gut content reveals that the *E. lucius* has a diverse dietary preference, consuming a range of prey including invertebrates, other fish species, amphibians and birds. This dietary variety makes the *E. lucius* a key apex predator in the Krka River environment, compromising its biodiversity. Both the number and biomass of native fish species are declining.

Keywords: freshwater ecosystems, non-native fish, endemic species, *Esox lucius*

## O21

### AMPHIPOD INVASION PATHWAYS IN THE HYDROELECTRIC POWER PLANT SYSTEMS OF THE DRAVA RIVER, CROATIA

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The spreading of invasive aquatic invertebrates in European rivers represents a direct threat to native species and substantially impacts biodiversity and stability. Amphipods from altered and artificial habitats (reservoir, drainage ditches, tailrace canals and old river channel) of the three hydroelectric power plants (HEPP) of the Drava River in NW Croatia were seasonally collected for more than 20 years in a detailed monitoring program. The primary goals of this study were to determine (1) the structure, abundance, and species richness of native and invasive amphipod species, (2) spreading routes and dynamics, and (3) vectors of alien dispersion. We have compared amphipod assemblages collected from 17 study sites during the early invasive period from 2009 to 2012 with the progressive invasive period from 2016 to 2019. Altogether, seven species were recorded: four invasive species of the Ponto-Caspian origin (*Dikerogammarus vilosus*, *D. haemobaphes*, *D. bispinosus*, and *Echinogammarus trichiatus*), and three native species (*Gammarus fossarum*, *G. roeselii*, and *Synurella ambulans*). Among invasive species, the last belongs to newcomers to Croatia. The invasive species were recorded only in the Čakovec Reservoir during the early invasive period. During the progressive invasive period, the invasive species occupied all three HEPPs until the tailrace canal of the HEPP Varaždin. Tailrace canals and old river channels represent the sections with the highest abundance of invasive species, while drainage ditches were dominant by native species. The invasion of the killer shrimp *D. vilosus* into the HEPP system of the upper section of the Drava River in Croatia might have happened through the stony substrate of the tailrace canals. The highest frequency and abundance of the killer shrimp were recorded only during the early invasive period in tailrace canals and old river channels, which squeezed out populations of other invasive species, *D. haemobaphes* and *D. bispinosus*. The native species *G. roeselii* remains the dominant amphipod during the research period. A short overview of invasion biology and the history of amphipod invasion in the Drava River gave new insight into the possible invasion pathways.

Keywords: invasive species, native species, newcomer, early invasive period, progressive invasive period

## O22

### ARE RNA VIRUSES A NOVEL THREAT FOR NATIVE FRESHWATER CRAYFISH POPULATIONS?

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Mass mortality events among European freshwater crayfish populations are usually attributed to the invasive crayfish plague pathogen, *Aphanomyces astaci*. However, it has recently been shown that crayfish plague-like mass mortalities can also be caused by the RNA viruses, such as the Bunya-like Brown Spot Virus (BBSV). To this date, 32 viral pathogens affecting 10 freshwater crayfish species have been described. Only a minority of them with RNA genome. Unfortunately, our knowledge of viral pathogens in freshwater crayfish is limited to pathogenic viruses affecting aquaculture relevant species. Thus, the present viral diversity associated with freshwater crayfish is mostly unknown. To address this issue, we conducted a wide meta-transcriptomic screening of 15 publicly available transcriptome assemblies from 8 freshwater crayfish species. Identification of the potential RNA viruses was conducted with multiple BlastN searches against the NCBI non-redundant protein and RefSeq viral genome databases. Clusters of viral origin were annotated with InterPro5 to extract the phylogenetically informative RNA dependent RNA polymerase (RdRp) domain. In total 119 unique viral clusters were identified. The majority of the identified contigs were classified as Picornavirales (91), followed by the RNA viruses classified in a novel monophyletic clade (13). This group was not present in the transcriptomes of the invasive North American crayfish species. Our preliminary results suggest we are underestimating the considerable diversity of the RNA viruses in freshwater crayfish. Furthermore, we are yet to grasp the effect of RNA viruses on freshwater crayfish and their impact on ecosystems. With the continued introduction of novel RNA viruses carried by invasive alien freshwater crayfish species, we might expect to record a higher number of mortalities among European crayfish populations in the future.

Keywords: meta-transcriptomics, novel pathogens, RNA virome, high-throughput sequencing

O23

### CHARACTERISATION OF PATHOGENICITY FACTORS OF A COLLECTION OF *Aphanomyces astaci* STRAINS

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Introduced into Europe from North America, the crayfish pathogen *Aphanomyces astaci* is considered one of the 100 worst invasive species worldwide. Due to multiple introductions, several *A. astaci* strains are present in Europe, generally belonging to four main mitochondrial haplogroups (i.e., haplogroup A, B, D and E). As one of the main causes of European crayfish population decline, *A. astaci* has attracted the attention of the scientific community for the past two centuries. However, several aspects of its biology are still unknown, from its ability to persist and adapt to new hosts, to the variable virulence observed in recent years. In this study, we used 14 *A. astaci* strains isolated both in North America and in Europe to investigate phenotypical patterns that can be associated with the pathogen's virulence. For each strain, we assessed pathogenicity factors (i.e., growth and sporulation rates) and virulence towards the European crayfish species *Astacus astacus*. These experiments showed a high variability in virulence, growth rate and motile spore production, while the total sporulation rate was more stable across strains. Surprisingly, growth and sporulation rates were not significantly correlated with virulence. Furthermore, none of the analysed parameters, including virulence, was significantly different among the tested *A. astaci* haplogroups (i.e., haplogroup A and B). Our results indicate that each strain is defined by a characteristic combination of strength of their pathogenicity factors, which are modulated by the interaction of the strains with different hosts. Consequently, canonical mitochondrial markers, often used to infer the pathogen's virulence, are not efficient tools to characterise *A. astaci* strains. As the diversity of *A. astaci* in Europe is bound to increase due to translocation of new carrier crayfish species from North America, a deeper understanding of *A. astaci*'s virulence variability and its ability to adapt to new hosts is urgently needed.

Keywords: crayfish plague, virulence, sporulation rate, growth rate, phenotypical diversity

**O24**

## **INVASIVE SIGNAL CRAYFISH MODIFIED TROPHIC NICHE WIDTH AND FOOD SOURCE UTILIZATION OF NOBLE CRAYFISH IN SYMPATRIC LOCALITY**

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Invasion of non-native species in the ecosystem with the presence of native species with similar functional traits, habitat usage, and feeding habits puts pressure on native species population. In crayfish, studies dealing with sympatric crayfish populations containing native and non-native species are scarce, and more is known about sympatric crayfish populations consisting of non-native species. Such a situation is usually caused by the presence of crayfish plague pathogen (*Aphanomyces astaci*, Schikora, 1906) in non-native species, which is lethal for native crayfish species. Thus, the ability to predict the effect of new invaders on the native crayfish community and the whole ecosystem is limited. In this study, feeding habits of native noble crayfish (*Astacus astacus*, L. 1758) and non-native signal crayfish (*Pacifastacus leniusculus*, Dana 1852) living in sympatric and allopatric populations in Křesánovský brook (Czech Republic) were compared. Using stable isotopes analysis (SIA), shifts in feeding habits in allopatric and sympatric population were compared. SIA results showed that juvenile and adult noble crayfish who lived in allopatric sites had wider trophic niche than juvenile and adult signal crayfish who lived in allopatric sites. However, when both species lived in sympatric sites, the trophic niche width of adult noble crayfish and juvenile signal and noble crayfish were dramatically shrunk. Nevertheless, in adult signal crayfish no changes among allopatric and sympatric populations were observed in trophic niche width. In addition, high trophic niche overlap among juveniles and adult crayfish was observed regardless of species. To sum up, although signal crayfish had lower trophic niche width in the allopatric site in comparison to noble crayfish, they kept the same trophic niche and utilized the same food source regardless of the presence of noble crayfish, making signal crayfish problematic for noble crayfish population regardless of presence crayfish plague.

Keywords: stable isotopes, crayfish, carbon, nitrogen

**O25**

**OVERLOOKED BIODIVERSITY DEPLETION: SIGNAL CRAYFISH AS A MENACE FOR EUROPEAN ECTOSYMBIONT**

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Invasive species pose a formidable threat to indigenous biodiversity, particularly in freshwater ecosystems. While the decline of native European crayfish has received considerable attention, the fate of their associated biota remains underexplored. Branchiobdellids, annelid ectosymbionts of crayfish, are compelled to switch host species following the displacement of native species by invasive counterparts. Field observations unveiled reduced branchiobdellid abundance and their cocoon presence on alien signal crayfish (*Pacifastacus leniusculus*) relative to native noble crayfish (*Astacus astacus*) in a coexistence scenario within a small foothill stream. Two additional localities, formerly inhabited by noble crayfish but now dominated by signal crayfish, exhibited a complete absence of previously recorded branchiobdellid populations. Subsequent laboratory investigations involved individual infestations of signal crayfish and noble crayfish with *Branchiobdella parasita* or *Branchiobdella pentadonta* in separate aquaria. These experiments unveiled a markedly elevated probability of branchiobdellid survival on noble crayfish for both symbiont species. This divergence in survival outcomes may be attributed to the heightened and more efficient grooming behavior exhibited by signal crayfish, potentially linked to their smoother cuticular surfaces. The combination of field observations and controlled laboratory experiments underscores the limited adaptive capacity of branchiobdellids in response to host species alternation. Given the ongoing regression of native European crayfish populations, our findings point to the potential vulnerability of native branchiobdellids as the next taxa facing decline due to the presence of invasive crayfish species.

Keywords: aquatic invasions, decapods, branchiobdellids, commensals

**O26**

**eDNA-BASED DETECTION OF *Astacus astacus*, *Aphanomyces astaci* AND INVASIVE ALIEN CRAYFISH SPECIES IN ESTONIAN WATER BODIES**

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The noble crayfish *Astacus astacus*, which is the only native freshwater crayfish species in Estonia, is now threatened following the introduction of invasive non indigenous crayfish species (NICS) and crayfish plague *Aphanomyces astaci*. Between 2008 and 2017, *Pacifastacus leniusculus*, *Faxonius limosus* and *Procambarus virginalis* were detected in Estonia through trapping, which is done annually to monitor noble crayfish and detect, control and eradicate NICS. Early detection of invasive NICS is critical for the conservation of the endangered species, but is challenging with trapping only. Recent studies show that modern molecular methods, such as environmental DNA (eDNA), have emerged as promising tools in the monitoring of invasive species and pathogens with potential to detect aquatic organisms occurring at low densities. Thus, we undertook a pilot study to detect the noble crayfish pathogen *A. astaci* and the spread of invasive NICS in 13 Estonian water bodies using the eDNA method. We used species-specific qPCR assays to screen for the presence of eDNA from *A. astacus*, *P. leniusculus*, *A. astaci*, *F. limosus* and *P. virginalis*. Our results were compared and verified with trapping data from annual crayfish monitoring. We detected eDNA from *A. astacus* in one water body, *P. leniusculus* in five and *F. limosus* in three water bodies consistent with the trapping data. *A. astaci* eDNA was detected in one water body while *P. virginalis* was not detected. Our results show that the eDNA method is reliable in water bodies with moderate crayfish populations and inconclusive in those with low densities. We conclude that when the eDNA method is employed, it will enhance the use of traps in the detection, monitoring, control and/or eradication of invasive NICS.

Keywords: environmental DNA, NICS, crayfish plague, monitoring, trapping

O27

## “NEW KIDS ON THE BLOCK”: CRAB SPECIES INTRODUCTIONS APPEAR IN EUROPEAN INLAND WATERS

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Ornamental aquaculture and the related pet industry are known to be important sources of non-native species worldwide. An increasingly important introduction pathway has developed around intentional and unintentional releases of originally pet-traded organisms. Non-native ornamental decapod crustaceans, especially freshwater crayfish and shrimps have been recently detected in European inland waters, mostly in urban areas. In their shadow, the popularity of freshwater crabs has substantially increased during the last decades. In the temperate zone, thermal waterbodies are attractive places for irresponsible owners to release their freshwater pets. Our survey of Hungarian thermal and urban waters in the whole territory of the country revealed “new kids on the block”, the crabs (Decapoda: Brachyura). Several ornamental but also edible species have been found. The only species recorded regularly during the last decade was the *Eriocheir sinensis* in the Danube River. Interestingly, marine species *Calinectes sapidus*, *Cancer pagurus*, and *Carcinus maenas* were also found together with land species *Cardisoma armatum*, freshwater species *Limnopilos* cf. *naiyanetri* and unidentified species from the family Parathelphusidae. Findings on these releases are often first records on national, but also continental level. Both *Cancer pagurus* and *Calinectes sapidus* are thought to be escapees or releases from the restaurants at the side and main arms of the River Danube in Budapest. They are unable to reproduce in freshwater habitats and likely do not represent a permanent threat to native species and local ecosystems, as suggested by the large number of dead specimens found after the first appearance. *Carcinus maenas* can tolerate a wide range of salinities but is also unable to complete its lifecycle in freshwaters. The possible environmental consequences of the three other recorded ornamental crab species remain questionable. Further monitoring of this locality and better education of the general public regarding the risks associated with the release of non-native species is strongly recommended.

Keywords: Brachyura, ornamental species, pet trade, thermal waters, urban waters



**O28**

**NEW OCCURRENCES AND THE LATEST REPORTS ON THE DISTRIBUTION OF THE NORTH-AMERICAN SIGNAL CRAYFISH IN RIVER DRAVA IN SLOVENIA**

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The North-American signal crayfish (*Pacifastacus leniusculus*) has been recorded in many European countries. It is a very problematic invasive species because it transmits the crayfish plague, a fungal-like parasite lethal to native European crayfish species and because it negatively affects aquatic communities. We are going to present new distribution data and report that the population in the river Drava in Slovenia is increasing. Until our study, *P. leniusculus* distribution in the river Drava was known only from Dravograd at the Austrian border downstream to the artificial accumulation lake at Ptuj. Here we report results of recent surveys of *P. leniusculus* in the river Drava river in Slovenia – a survey area expanding over 142 km of the river from the Austrian to the Croatian border – using submerged crayfish traps and visual inspection in 29 locations in July and August 2022 and 2023. Additionally, we surveyed 19 tributaries of the river Drava. Environmental conditions monitoring included water temperature, pH, flow measurement, substrate, and surrounding terrestrial habitat type. Our results show, that in the river Drava *P. leniusculus* preferred sites with less silt, animals were found in 20 locations, and among these 3 locations were new. No specimens were found in the tributaries. The distribution of sexes was 40% male and 60% female, however, more males were recorded downstream. Our results show persistent and vital populations of *P. leniusculus* with expanding invasion front in the river Drava.

Keywords: freshwater, crayfish, IAS spread, new occurrences

O29

## COMPARISON OF PHYSIOLOGICAL PERFORMANCE BETWEEN INVASIVE AND NATIVE CRAYFISH SPECIES IN A CHANGING ENVIRONMENT

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The maintenance of healthy freshwater ecosystems depends on keystone species like crayfish. However, due to climate change and invasions by non-indigenous crayfish species (NICS), the majority of Europe's native crayfish species are in decline and becoming more and more endangered. The success of invasions by NICS largely depends on differences in ontogeny between the native species and the invaders and the effects that environmental change will exert on it. Here, we used Dynamic Energy Budget (DEB) models to investigate such differences. DEB models capture the dependence of metabolism, and therefore, ontogeny, on environmental conditions. We developed DEB models for two vulnerable and endangered native European crayfish, *Astacus astacus* and *Austropotamobius torrentium*, and for two successful NICS, *Pacifastacus leniusculus* and *Procambarus virginalis* and used developed models to predict individual growth and reproduction under temperature and food availability changes. This research identified *P. virginalis*, in spite of its smaller size, as the superior competitor to native species by a large margin—at least when considering metabolism and ontogeny. Our simulations showed that climate change is set to increase the competitive edge of *P. virginalis* even further. Finally, we discussed conservation implications of our study and the important role that predictive models can have in adaptive management and decision-making in nature conservation and ecosystem restoration.

Keywords: invasion potential, life history traits, ontogeny, standard DEB model, freshwater crayfish

Acknowledgement: This research has been supported by Croatian Science Foundation (HRZZ) [installation grant HRZZ-UIP-2017-05-1720].

**O30**

## **OOMYCETE ISOLATES ORIGINATING FROM THE CUTICLE OF NATIVE AND INVASIVE CRAYFISH SPECIES IN CROATIA**

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Numerous oomycetes species have been observed with colonizing the crayfish cuticle. However, the effects of many of these organisms on crayfish hosts are not well understood. This research's aim was to examine the diversity of oomycete isolates found in both native and invasive crayfish species' exoskeletons. Live crayfish were caught at seven different sites in Croatia from five different crayfish species that were either confirmed as, or are possible carriers of *A. astaci*. Oomycetes were cultivated from pereopods and ventral abdominal cuticle inoculated on PG1 solid growth media with antibiotics (ampicillin and oxolinic acid), with hyphal transfers to new media till pure cultures were obtained. Identification of the isolates to species level was acquired by sequencing of the internal transcribed spacer (ITS) region, then followed by phylogenetic analysis. We detected four oomycete species originating from two crayfish species, out of which two belonged to the genus *Saprolegnia* (three *S. australis* isolates and two *S. turfosa* isolates, all originating from *P. leniusculus*) and two of which were from the genus *Aphanomyces* (two *A. astaci* isolates originating from *A. astacus* and five isolates from *P. leniusculus*, 15 *A. repetans* isolates originating from *A. astacus* and 25 isolates from *P. leniusculus*). Based on previous studies, some of the detected species are saprophytic (*S. turfosa*, *A. repetans*), while others are opportunistic (*S. australis*) or primary pathogens (*A. astaci*, the causative agent of crayfish plague). Since they were sometimes found on the same host individual (as with *A. astaci* and *A. repetans* from the same *P. leniusculus* individual) further *in vivo* studies are required to inspect their effects on crayfish hosts, with it being either individually or in combination.

Keywords: crayfish exoskeleton, oomycetes, *Aphanomyces*, *Saprolegnia*

Acknowledgement: This study was supported by Ministry of Science and Education, Republic of Croatia and German Academic Exchange Service (DAAD).

## O31

### FIRST APPLICATION OF ENVIRONMENTAL DNA FOR THE DETECTION OF INVASIVE SIGNAL CRAYFISH IN CROATIA

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Despite occupying less than 1% of the Earth's surface, freshwater ecosystems house approximately 10% of all documented species. Nowadays, many of native freshwater species are threatened, amongst other, by introduction non-native and invasive species which have put native species within these habitats in danger. Effective management of biological invasions depends on the detection in the early stage of invasion. However, to detect invasive species at low abundance in freshwaters, methods like hand catching or trapping have certain limitations. Environmental DNA has proven to be an efficient and reliable method to detect aquatic species, becoming more reliable than the traditional methods. eDNA has already been successfully used for native and invasive freshwater crayfish detection, even when at low abundances. Therefore, eDNA-based methodologies are well-suited for detection of invaders at early stage of establishment. During 2023 we performed eDNA-based survey for detection of invasive crayfish *Pacifastacus leniusculus* in rivers Mrežnica, Korana and their tributaries. Water samples were collected at 10 locations, in sites upstream or downstream from their former invasion fronts. Filtering was conducted directly in the field and samples were transported to the lab where single-target qPCR analysis was performed. This is the first study to implement eDNA method for detection of invasive crayfish species in Croatia. Results showed the presence of signal crayfish upstream from the localities where it was previously recorded, showing the expansion of the invasion front. These results provide new insight on the range expansion of the signal crayfish, and will guide current signal crayfish control efforts, providing the information on which areas management activities should be focused. Additionally, new data on the distribution of signal crayfish may also be utilized for quick management measures to protect the local native crayfish species.

Keywords: *Pacifastacus leniusculus*, invasion front, eDNA, native crayfish

**POSTERSKA PRIOPĆENJA**

**POSTER PRESENTATIONS**

## P1

### **OCCURRENCE OF TWO INVASIVE FRESHWATER FISH SPECIES *Pseudorasbora parva* AND *Lepomis gibbosus* IN LOWLAND STREAMS AND CANALS**

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Invasive alien species can become one of the major stressors affecting local native freshwater fish communities. Five invasive freshwater fish species on the European list of invasive alien species of Union concern are currently found in Croatia: pumpkinseed *Lepomis gibbosus*, topmouth gudgeon *Pseudorasbora parva*, black bullhead *Ameiurus melas*, eastern mosquitofish *Gambusia holbrooki* and Chinese sleeper *Perccottus glenii*. Of all these species, pumpkinseed and topmouth gudgeon are most abundant and widespread in the Sava River basin in continental Croatia, but data on their habitat preferences in this area are lacking. Electrofishing survey was conducted from June 2019 to September 2020 at 111 locations in 84 different streams and canals for which sufficient data on freshwater ichthyofauna were lacking. Physical and chemical water parameters and morphological stream characteristics were also recorded. The probabilities of occurrence of the species studied as a function of habitat characteristics were modelled using a generalised linear model, and the selection of the best models was based on an information-theoretic approach. The occurrence of topmouth gudgeon was detected at 33 locations, while this of pumpkinseed at 22 sites. The probability of topmouth gudgeon occurrence was the highest in rich communities of slow-flowing watercourses. Because efficient management and eradication of such widespread species is virtually impossible, efforts should be directed at maintaining streams with natural hydrological regimes suitable for native specialist species where topmouth gudgeon is least likely to occur. The probability of occurrence of pumpkinseed increased with stream or canal depth, and no other habitat characteristic was found to be significant, making the occurrence of this species in streams and canals difficult to predict. Because this species is known to be lymnophilous, future studies should target such habitats to better understand its habitat preferences in this area.

Keywords: Croatia, Sava River basin, fish ecology, habitat preferences

## P2

### INVASIVE FISH SPECIES OF THE VILLAGE KRIŽNICA

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For the Old-Drava project, LIFE13NAT/HU/00388, ecological monitoring of the old course of the Drava River was carried out with an emphasis on Natura 2000 habitats and species. The goal of the project was to describe and monitor changes in forest and water communities and map Natura 2000 habitats in the old course of the Drava River in Križnica. Fish monitoring was conducted in 2019 and 2020 at three locations: Crni jarak, old course of the Drava River and Graba. Fish sampling was performed using an electronic impulse device from a rubber boat powered by an electric motor or by directly entering the water stream in fishing boots. All caught fish were returned to the place of catch, while invasive species were removed under the supervision of fish wardens. During 2019, a total of 23 different species of fish were caught of which 30.43% were invasive fish species: *Carassius auratus*, *Carassius gibelio*, *Hypophthalmichthys molitrix*, *Pseudorasbora parva*, *Neogobius fluviatilis*, *Lepomis gibbosus* and *Ameiurus melas*. While in 2020, a total of 19 different species of fish were caught of which 26.31% were invasive fish species: *Carassius gibelio*, *Pseudorasbora parva*, *Neogobius fluviatilis*, *Lepomis gibbosus* and *Ameiurus melas*. Such a large proportion of invasive species is probably caused by introduction as a result of human activities and the relatively low density of predatory fish species. We assume that chemicals that were used in agricultural production were washed and caused the death of fish and the degradation of aquatic vegetation. We recommend annual monitoring of fish populations in the area and monitoring of physical and chemical parameters of the water with an emphasis on dissolved oxygen and nutrients, in order to determine the causes of fish deaths in the old course of the Drava River. We also recommend conducting activities to raise public awareness about invasive species in the region.

Keywords: electrofishing, river, monitoring, Drava

### P3

## INVASIVE MOLLUSCS, FISH AND CRAYFISH IN THE DOBRA RIVER BASIN (CROATIA)

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The distribution and density/abundance of invasive aquatic animals (fish and macroinvertebrates) were studied from 2012–2023 in the basin of the karst Dobra River in central Croatia, including three reservoirs. The following methods were used: hand net, Ekman grab and quadrat census for molluscs, snorkelling and LiNi traps for crayfish, electrofishing and nets for fish. The seven recorded alien species belong to four taxonomic groups: Decapoda (1 species), Bivalvia (2 spp.), Hydrozoa (1 sp.) and Actinopterygii (3 spp.). The zebra mussel *Dreissena polymorpha* invaded the entire downstream course from the reservoir Lešće in the Gojačka Dobra River. Its abundance increased from 2016 to 2023 at all studied sites. Fish monitoring revealed the presence of three invasive species in the reservoir Lešće (*Carassius gibelio*, *Lepomis gibbosus*, *Oncorhynchus mykiss*). In 2018 and 2019 population explosions of the freshwater jellyfish *Craspedacusta sowerbii* were recorded in the Lešće Reservoir. In 2023, the invasive signal crayfish (*Pacifastacus leniusculus*) was found for the first time. It was already abundant at one site, with the upstream (13.5 rkm) and downstream (5.7 rkm) front of its distribution. In 2023, the Asiatic clam *Corbicula fluminea* was found in 5.7 km of the lower reach, still at a low to moderate density. Future studies should focus on the dispersal dynamics and ecological impact of invasive mussels, fish and crayfish in the Dobra River basin.

Keywords: distribution, abundance, non-native, aquatic species, river, reservoir



#### P4

### **A REGIONAL STRATEGY FOR THE CONTRASTING OF ALIEN CRAYFISH SPECIES: THE APPROACH OF THE LOMBARDY REGION, NORTHERN ITALY**

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The main threats for the freshwater crayfish (*Austropotamobius pallipes*, an “endangered” species according to IUCN, *International Union for Conservation of Nature*) come from the invasions of alien crayfish species and the diseases they carry, in particular the crayfish plague (*Aphanomyces astaci*). This problem adds up to others such as, e.g., the fragmentation of habitats and the introduction of salmonids into streams and water pollution. For these reasons in the Lombardy Region, northern Italy, various Life projects contributed to the development of a conservation strategy for *A. pallipes*. The strategy is aimed at the support for a healthy metapopulation in the *Natura 2000* sites of the piedmont and alpine area. The main action is directed to the prevention of the contact with alien crayfish that have invaded the lowland area carrying the disease. This strategy has been implemented by concrete actions within the *Life IP Gestire 2020* project and it is based on various actions: (1) monitoring of native and alien crayfish populations in order to maintain an updated knowledge of their distribution and to identify potential contact areas; (2) the support to *A. pallipes* populations, with actions including habitat restoration, restocking of populations where necessary, reintroduction of the species in case of local extinctions; (3) the containment and localized eradication of invasive alien species where their distribution range is expanding towards native crayfish populations; (4) raising awareness about correct human behaviors to be adopted to prevent the species from being at risk. The strategy must also deal with climate change, and, thus, a continuous flow of information is necessary for future planning to that effect. Since the *Life IP Gestire 2020* will conclude at the end of 2023, the *NatConnect2030* project will give the opportunity to follow up on these actions starting from 2024.

Keywords: endangered biodiversity, alien species, native crayfish, alien crayfish, conservation strategy

## P5

### DOES CRAYFISH PLAGUE OUTBREAK SIGNIFICANTLY INFLUENCE THE GENETIC DIVERSITY OF A NOBLE CRAYFISH POPULATION?

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Natural populations could experience drastic decline if diseases are introduced. One of diseases that has caused devastation of native European crayfish populations is the crayfish plague. This lethal disease is caused by pathogenic oomycete *Aphanomyces astaci*. It was introduced to Europe by North American crayfish species in the 19th century, and since then it has been causing devastation of native crayfish species. In the focus of this study is a native crayfish species *Astacus astacus* (noble crayfish) that is distributed in continental part of Croatia. During the last decades significant declines of its populations were recorded, and one of the principal reasons is the crayfish plague. The aim of this study is to evaluate the consequences of crayfish plague outbreak on the genetic variability of the noble crayfish population from the gravel pit Motičnjak. This gravel pit is situated in the north-west Croatia, and it was excavated on an oxbow of the Drava River. It is presumed that the noble crayfish population in Motičnjak is a remnant of the native populations previously broadly distributed in this region. Population was sampled three times during a period of six years, including one occasion of crayfish plague outbreak. This time-frame enabled us to compare the genetic diversity before (2016), during (2018) and after the outbreak (2022). Fifteen microsatellite loci were used to assess genetic diversity of the population. The results show that genetic diversity has not significantly changed during the study period, and no consistent signs of a genetic bottleneck, caused by crayfish plague, have been observed. However, after the crayfish plague outbreak, a decrease in the number of private alleles was recorded. Obtained results are discussed from the conservation point of view.

Keywords: *Astacus astacus*, genetic variability, *Aphanomyces astaci*, Croatia

## P6

### **CONTROL AND SANCTIONING OF ILLEGAL ACTIVITIES WITH INVASIVE ALIEN SPECIES FROM THE UNION LIST IN CROATIA**

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There are currently 88 invasive alien species (IAS) on the list of Invasive Alien Species of Union concern (Union list). They are strictly regulated in the European Union by the Regulation (EU) 1143/2014 on the prevention and management of the introduction and spread of invasive alien species. This includes restrictions on their keeping, breeding, import, transport, sale, reproduction, cultivation, growing and release into the environment. Member States shall take all necessary measures to prevent their introduction or spread. In this presentation, we will present illegal activities involving alien and invasive alien species, focusing primarily on online trade, as many IAS are sold online, such as pet and aquarium species, horticultural and agricultural species, live food and bait. The inspection was conducted primarily for trade in exotic pets such as the red-eared slider (*Trachemys scripta*) and coati (*Nasua nasua*). The number of people who are accessing and using e-commerce will continue to increase, so it is important to prepare new management and policy approaches to prevent IAS online trade in the future. The implementation of the Action plan on the pathways of unintentional introduction and spread of invasive alien species through transport should help to raise awareness among sellers and customs officials and to develop regulatory tools for e-commerce.

Keywords: pathway, online trade, restrictions, inspection, *Trachemys scripta*

**P7**

## **CITIZEN SCIENCE - THE INVASIVE ASIAN TIGER MOSQUITO BRINGS SCIENCE TO THE PUBLIC**

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The invasive species *Aedes albopictus* was first recorded in Vukovar-Srijem county in 2016. Since then, it has successfully been expanding its range. In the period 2016 to 2019, from June to November, tiger mosquito eggs were sampled using oviposition traps in five cities of the county (Vinkovci, Vukovar, Ilok, Otok and Županja). The spread of the tiger mosquito and the increase in its abundance was noted. Since citizens may play a significant role in limiting the spread of this species, it was essential for experts to involve the general population in monitoring and control. The most practical method to educate the public and raise awareness is through the education system, particularly schools. In 2020, educational flyers, posters, and radio broadcasts were used as part of a platform for citizen education that had been formed in 2019. In 2020, 10 elementary and two secondary schools from Vukovar-Srijem county participated in the study. After attending the workshop, 328 pupils successfully carried out sampling using oviposition traps. Infestations were present in 53.05% of the traps. The project was extended to two new counties till 2022, Osijek-Baranja and Brod-Posavina. Results with 42.78% positive traps were obtained by 600 pupils from 20 elementary and three secondary schools that year. The project “Keep a bucket of water at bay to keep the sting away” currently covers 25 elementary and three secondary schools from six counties, including Osijek-Baranja, Vukovar-Srijem, Brod-Posavina, Varaždin, Sisak-Moslavina, and Zagreb. Our aim in the coming years is to raise the level of awareness about the importance of understanding the biology of the tiger mosquito and how citizens can have an influence on the control of its spread. Additionally, the aim includes making citizen science a nationwide project that carries out education in most counties, if not all of them.

Keywords: invasive species, oviposition traps, mosquito control, education, citizen science

**P8**

**APPLICATION OF STANDARD AND MODIFIED OVIPOSITION TRAPS IN THE MONITORING OF INVASIVE MOSQUITO SPECIES IN SLAVONSKI BROD**

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Mosquitoes can carry a variety of arboviruses that can cause different diseases in humans and animals. Monitoring of invasive mosquito species has been conducted in Croatia since 2016. In the same year, the Asian tiger mosquito (*Aedes albopictus* Skuse 1894) was recorded, followed by the Japanese mosquito (*Aedes japonicus* Theobald 1901) in 2017. In this study, standard and modified oviposition traps were used to monitor invasive mosquito species. During the spring-summer season in 2022, monitoring of the Asian tiger mosquito and the Japanese mosquito was carried out at 10 micro-locations in Slavonski Brod during 65 days. One standard oviposition trap and two modified oviposition traps were set up at each location. The first trap was modified in such a way that mouse trap glue was applied to the hardboard, and the second trap contained adhesive tape for catching flies. The advantage of these sticky traps is the reduction in time from species rearing to identification, as it avoids the entire process of complete metamorphosis. Moreover, they capture adult gravid females, which can contribute to reducing the population and preventing the spread of diseases. The results indicate the presence of both the Asian tiger mosquito and the Japanese mosquito. Using standard oviposition traps, 2840 eggs were collected. Using the trap that was modified with mouse trap glue, 32 adult gravid females were collected, and with the trap that was modified with adhesive tape for catching flies, 73 adult gravid females were collected. Monitoring is necessary every year to understand the temporal dynamics of the invasive mosquitoes - the Asian tiger mosquito and the Japanese mosquito - as well as to track their spatial distribution, given that they transmit various diseases that are dangerous to humans.

Keywords: *Aedes albopictus*, *Aedes japonicus*, mosquito monitoring, sticky ovitraps

**P9**

**MORPHOLOGICAL VARIABILITY AND SEXUAL SIZE DIMORPHISM OF BALKAN POPULATIONS OF SEED BEETLE *Megabruchidius dorsalis***

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*Megabruchidius dorsalis* (Fåhræus, 1839) is a seed feeding beetle developing inside the seeds of several *Gleditsia* species. Originally from Asia, it reached Europe in 1989 and has been expanding its range there ever since. Until now, it has been recorded in 22 European countries. We collected mature *Gleditsia triacanthos* pods at six locations in five Balkan countries and reared *M. dorsalis* beetles under laboratory conditions. We randomly selected 30 beetles from each location, approximately equal number of males and females. Beetles were photographed with a camera mounted to a stereomicroscope and five morphological parameters were measured for each specimen. Additional 15 beetles from each location were randomly selected for genetic analysis. Genomic DNA was extracted and two genes, cytochrome b and ribosomal 28S, were amplified with classic polymerase chain reaction. Products were purified and sequenced. Our results show great morphological variability of *M. dorsalis* in the studied area. However, no differences were found between populations in genetic analysis. We also show sexual size dimorphism with males being the larger sex. This is common for insects with reversed sex role that has been confirmed for *M. dorsalis* before. We also detected a latitudinal cline in body size, as specimens decreased in size towards the south. One of the main factors determining the body size of seed feeding beetles is seed quality and size. One possible explanation for latitudinal body size cline could be seed size but this should be checked in the field. Here we show interesting information about body size variation, sexual size dimorphism and latitudinal body size cline of Balkan populations of *M. dorsalis*. For future research, we propose an improved population genetic analysis and inclusion of beetle fresh weight variable in morphological analysis.

Key words: alien species, body size, latitudinal cline, genetic analysis, Europe

**P10**

**INVASIVE ALIEN SPECIES IN MEDITERRANEAN AGRICULTURE IN ZADAR COUNTY REVEALED BY PREDATORY ARTHROPODS AND DETECTED USING eDNA TECHNIQUE**

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Carabid beetles, spiders, centipedes and harvestmen are among the dominant predatory arthropods in agroecosystems and therefore can be significant in controlling the density of pest populations. Nowadays, with the development of environmental DNA (eDNA) techniques, *in situ* analyses of very complex trophic interactions among invertebrates have been intensified contributing to the knowledge of trophic ecology. To analyse predator-prey field interactions within MEDITERATRI project (HRZZ), predatory carabids, harvestmen, centipedes and spiders were collected in olive groves and vineyards in Zadar County, Croatia, in 2018 and 2019. DNA extracted from their guts was screened using Polymerase Chain Reactions (PCR) with general arthropod primers and predatory excluding primers, and sequenced using Illumina High Throughput. Besides, field diversity of potential prey groups was screened by inspecting animals collected using entomology net, pitfall traps, yellow sticky traps and by hand. Prey consumed by harvestman and carabids belonged to various invertebrates, including important pest species among which was a newcomer, alien invasive *Laodelphax striatellus* (Auchenorrhyncha), known as a vector of some phytoplasmas. The species' DNA was detected in the guts of *Leistus* spp., which were among the dominant carabids in the field and had the broadest prey range. This is the first evidence of *L. striatellus* presence in Croatia, and at the same time the first evidence of the species being consumed by generalist predator in its new areal. It was not detected in morphologically inspected samples, since many juvenile hemipterans have been collected which we were not able to identify to species level. Harvestmen were preying on eggs or larvae of invasive *Aedes albopictus*, a mosquito being spread nowadays across the whole country, as was confirmed in spider by previous study at the same location. The results support the importance of preserving predatory fauna within agroecosystems and importance of promoting pest biocontrol by natural enemies. Also, state-of-the-art techniques can help in the detection of invasive newcomers in agricultural sites.

Keywords: *Aedes albopictus*, biocontrol, DNA metabarcoding, *Laodelphax striatellus*, trophic interactions

## P11

### STATUS OF INVASIVE ASIATIC STRING COTTONY SCALE *Takahashia japonica* IN THE WIDER PULA AREA

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Scale insects (*Hemiptera*, *Coccoomorpha*, *Coccidae*) are among the most common conquerors of new geographic areas and are the second largest group of alien insects in Europe. This group includes the Asiatic string cottony scale, *Takahashia japonica* (Cockerell, 1896), whose natural habitat is in East Asia. The first finding of the species in Europe was recorded in Italy in 2017 and in the UK the following year. In Croatia, the species was first recorded in 2019 in Istria in the area of the city of Pula on six hosts belonging to the genera *Acer*, *Morus* and *Albizia*. During 2020, this scale insect was systematically controlled at six locations in Pula. In 2021, during monitoring no presence was detected. During 2022 and 2023 it was again detected at two locations where previous control was carried out. However, the species has also spread to a new area, in the municipality of Medulin 8 km from Pula, on *Acer*, *Prunus* and *Magnolia*. The search campaign for the eradication of *T. japonica* included scientists, professional services, citizens and the media. The eradication was carried out in accordance with the recommendations: cutting and removal of branches on infected trees and chemical treatment with pesticides. The effect achieved is the reduction of infection in most trees, but not the complete extinction of pests. Monitoring and control are carried out continuously. If *T. japonica* continues to spread further, it will be necessary to assess the level of risk that this species poses to native flora, and containment measures will be necessary.

Key words: control, monitoring, scale insect, *Takahashia japonica*



**P12**

**ADDITIONAL RECORD OF THE LIONFISH *Pterois miles* IN CROATIAN WATERS (EASTERN ADRIATIC): ARE THERE ANY REASONS FOR CONCERN?**

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The Mediterranean Sea, connecting the Indo-Pacific and Atlantic oceans, is characterized as a global marine invasion hotspot, due to a multitude of human pathways and vectors such as shipping, aquaculture, tourism, and the opening of the Suez Canal, which have led to the introduction of nearly 700 alien species into the Mediterranean Sea. Among the species introduced, the scorpaenid fish *Pterois miles* (Bennett, 1828), originating from the Indo-Pacific, is considered one of the worst invasive species in the Mediterranean Sea. Once established, its populations can have damaging effects on native communities, resulting in biodiversity loss, habitat degradation, and economic effects on the fishing industry and marine-based activities. One specimen of *Pterois miles* (TL = 28.1 cm; W = 317 g) was caught by underwater gun on 15 August 2023 near Račišće (Island Korčula, southern Adriatic) (42.978813<sup>0</sup> N, 17.019692<sup>0</sup> E). This represents the first record based on a caught specimen of this species and second at all for Croatian waters. Previous record was based on visual census and underwater photography near island Vis (Komiža) at a depth of 15 m on 13 August 2021 (the northernmost record for the Adriatic Sea). According to the attachments and information about records in local newspapers and web portals with photos of the species (citizen science), it seems that the abundance of this species is significantly higher. Although there is still no confirmation of the establishment of the population, there is an urgent need to educate divers, fishers and the wide public about the matter and to develop legal protocol for eradication. Moreover, a Croatian network for collecting and exchanging information about the fish spotting targeted for divers and fishers should be established. Due to climate change it could be expected that the sea temperature of the Adriatic will rise in the future making it more suitable for the establishment of the lionfish and formation of dense populations.

Key-words: Lionfish, invasion, ESENIAS; climate change; Adriatic

**P13**

**LESSEPSIAN MIGRANT DUSKY SPINEFOOT *Siganus luridus* FROM SOUTH ADRIATIC SEA**

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The dusky spinefoot (*Siganus luridus*) is a lessepsian migrant that was recorded for the first time in the Adriatic Sea in 2010 (Polniato et al. 2010.). The opening of the Suez Canal in 1869 resulted in the migration of about 383 marine species from the Red Sea to the Mediterranean Sea; a phenomenon known as Lessepsian migration (Streftaris et al. 2005). Four species of the genus *Siganus* exist in the Red Sea, of these, *S. rivulatus* Forsskål, 1775 and *S. luridus* Rüppell, 1828 have invaded the Mediterranean through the Suez Canal and established in the eastern Mediterranean (Bariche 2005). In recent years it has been represented in a significant number in the area of the east side of the southern Adriatic. In the Donji Molunat bay we recorded large number individuals caught with seine net. *S. luridus* juveniles (n=127) were collected during October in 2019. and October and November 2020. (n=56) in Donji Molunat bay. Juveniles were collected with seine net at a depth between 2-15 m. Mean body weight was  $3,84\pm 0,45$  g and total length was  $64,1\pm 0,57$  mm during 2019 and body weight  $3,59\pm 0,37$  g and total length  $66,0\pm 0,75$  mm during 2020. Individuals were transported to the laboratory without mortality during transport. Under controlled conditions this species showed good adaptation and growth on different types of food, although the preferred diet was of plant origin. In the coming years, it will be necessary to monitor the spread of this species in the Adriatic Sea, the possible establishment of stable populations and its impact on autochthonous herbivorous species.

Keywords: fish species, Adriatic Sea, new record, *Siganus*

**P14**

**INTERDISCIPLINARY ASSESSMENT OF THE POPULATION STATUS OF *Callinectes sapidus* IN THE ADRIATIC SEA**

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The Atlantic blue crab, *Callinectes sapidus* Rathbun, 1896, originates from the western Atlantic Ocean and has been introduced in the Mediterranean and Adriatic Sea. This species exhibits significant expansion potential within Mediterranean and exerts an impact on native species and fisheries. The presence of the Atlantic blue crab in Croatian part of Adriatic Sea has been confirmed since 2004. Between June 2022 and January 2023, we conducted fishery-dependent surveys in the Neretva River estuary and the Mirna River estuary (Croatia) based on monthly sampling. In the Neretva estuary, blue crab specimens were captured using traps, pots, and fishing gigs, while in the Mirna estuary, trammel nets were employed for sample collection. Laboratory analyses were conducted, encompassing measurements of carapace length and width, weight, determination of sex, and assessment of sexual maturity stage for a total of 233 specimens. Specimen carapace width ranged from 9.9 to 19.6 cm, with weights ranging from 70 to 540 g. On average, females were found to be statistically larger than males. The sex ratio did not exhibit statistical significance, with males constituting 49.3% and females 50.7% of the samples. The presence of females with external eggs was observed exclusively in June and September, with the highest number of females exhibiting developing or mature gonads recorded in June. Within the scope of this research, local ecological knowledge was obtained from commercial fishermen via questionnaire concerning the blue crab, with a particular focus on the species' significance in the fishery sector. Notably, the market and consumer preferences for this species remain underdeveloped in Croatia. Respondents indicated that substantial quantities of blue crab could potentially be harvested if measures were put in place to facilitate and organize its entry into the market.

Keywords: invasive species, decapoda, LEK, fishery

**P15**

**OCCURRENCE OF THE INVASIVE BLUE CRAB *Callinectes sapidus* ALONG THE WESTERN COAST OF ISTRIA**

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The blue crab, *Callinectes sapidus* Rathbun, 1896, is a species native to the western Atlantic coast. It is believed to have been introduced into the Mediterranean Sea via ballast waters. In the Adriatic Sea, the first confirmed record of the species was in 1949. On the eastern coast of the Adriatic Sea, it was first observed at the mouth of the Neretva River in 2004, and its presence has been documented along the entire coast since then. In the northern part of the Adriatic, along the western coast of Istria, according to local fishermen's observations, the blue crab has been present since at least 2013/2014. Over the past two years, efforts have been made to monitor the species, and the growing occurrence of blue crabs has been documented. From Cape Kamenjak in the south of Istria to the mouth of the Mirna River in the north, the species has been recorded at 9 localities, mostly characterised by muddy/sandy bottoms and a frequent inflow of fresh water. Given the invasive nature of the species and the potential damage it causes to the ecosystem, most of the research is focused on the Special Ornithological Reserve Palud - Palù near Rovinj, where additional efforts are made to control the blue crab population. In 46 field trips here, 858 blue crab specimens were captured using traps and manual collection, of which 72.8% were males, 26.8% were females, and the gender of the remaining 0.3% could not be determined. Visual observations suggest a much higher presence of the species. In 2023, 6.7 times more specimens were captured compared to 2022, and the blue crab was observed at a greater number of locations. All of this indicates that the blue crab is spreading along the western coast of Istria and has established a stable population.

Key words: Atlantic blue crab, alien species, non-native, north Adriatic, ornithological reserve

P16

## PRELIMINARY DATA ON THE DIET OF THE INVASIVE ATLANTIC BLUE CRAB (*Callinectes sapidus*) IN THE SPECIAL ORNITHOLOGICAL RESERVE PALUD - PALÙ IN ISTRIA

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The Atlantic blue crab (*Callinectes sapidus* Rathbun, 1896) has been increasingly observed in the northern Adriatic Sea in recent years, especially in habitats such as river estuaries and coastal lagoons with freshwater inflow. The abundance of this invasive species has escalated in the broader area of the Po River estuary in Italy, leading to significant disruptions in the local fishing industry. Given its growing presence in some coastal protected areas on the western coast of Istria, such as the special ornithological reserve Palud - Palù, a preliminary study was conducted to assess the diet composition of the blue crab to determine its impact on the reserve's ecosystem, particularly on birds. From May to October 2022, a total of 79 blue crab specimens were collected and their stomach contents were analyzed. In 85% of the specimens, stomach contents were detected, including detritus and unidentified materials, and 21 prey taxa. The most represented prey taxa belonged to bivalves, predominantly *Mytilus galloprovincialis*, *Anomia* sp., *Litophaga litophaga*, and *Ruditapes decussatus*, as well as the Carditidae family. Fish was also significantly present. The remaining stomach contents consisted of gastropods, crustaceans and insects. These preliminary data suggest their negative impact on economically important, protected, and native bivalves' species. Their feeding habits also affect various other taxa such as fish, invertebrates, and plants. Through this diverse diet, they represent a significant component of interspecific competitive interactions with many species, which can subsequently affect the preservation of native bird fauna. Therefore, it is important to regularly monitor the blue crab population in the special ornithological reserve Palud - Palù and consider the implementation of available measures to prevent their entry into the protected area, as well as the regular removal and prevention of fertilized females from leaving the reserve to prevent the spread of blue crabs into adjacent areas.

Kew words: the Atlantic blue crab, diet composition, special ornithological reserve Palud – Palù

**P17**

**OCCURRENCE OF WARM-WATER AFFINITY GELATINOUS ZOOPLANKTON SPECIES IN THE ADRIATIC SEA IN THE LAST THREE DECADES**

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Analysis of plankton samples from the southern Adriatic from 1993 to 2022 revealed significant changes in the community of gelatinous zooplankton. Sixteen species were detected in the Adriatic Sea for the first time, while three species reappeared after years of absence. Of these newly recorded species, eleven were thermophilic, and were recorded during the periods from 2001 to 2007 and from 2013 to 2022. Their occurrence is directly related to the strong influx of water from the eastern Mediterranean into the Adriatic and to the fact that the warming of the Adriatic has accelerated, especially in recent decades. Of the thermophilic species recorded, *Ferosagitta galerita*, *Lensia subtiloides* and *Paracytaeis octona* originate from the Indo-Pacific and most likely entered the eastern Mediterranean as Lessepsian migrants. The same pathway of introduction probably applies to other eight recorded warm-water species with circumglobal distribution. In general, warming in the Adriatic Sea, especially in the last decade, favours the establishment of populations of tropical, potentially invasive, zooplankton species. We therefore emphasise that monitoring activities that include less well-studied organism groups such as gelatinous zooplankton are important to establish baselines for the detection of non-indigenous species at an early stage of their colonisation.

Key words: gelatinous zooplankton, Lessepsian migrants, warming, Adriatic Sea

**P18**

**APPLICATION OF METABARCODING IN DETECTING NON-INDIGENOUS COPEPOD *Pseudodiaptomus marinus***

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The free-living pelagic copepod *Pseudodiaptomus marinus* Sato, 1913, native to the northwestern Pacific Ocean, is the species that is probably spreading most rapidly in European and neighbouring waters. The primary vector of introduction is ballast water, while secondary dispersal by local ship traffic and coastal circulation could promote further spread. To test metabarcoding as a tool for detecting *P. marinus* and to determine its abundance levels, we seasonally sampled various coastal areas, such as the Mljet Lakes National Park, protected area of Mali Ston Bay, the protected Lake Mir on the island of Dugi otok, the Pag channel and Novigrad Sea. Samples were taken with a Nansen net with 200 µm mesh size in duplicate tows: one for analysis of species abundance and composition under binocular, while the other was preserved in ethanol for DNA extraction and metabarcoding. Metabarcoding was performed using mlCOLintF-XT- jgHCO2198 primer pair which amplified a part of COI gene about 300 bp in length. *P. marinus* was detected in Mali Ston Bay in all seasons only by metabarcoding, but not by microscopy. Although this species was found in the surrounding area (Ploče harbour and Neretva river), this is its first detection in Mali Ston Bay. The present work confirms the high sensitivity of metabarcoding and its suitability for early detection of non-indigenous species. Its capacity to detect individuals with low relative abundances, as well as their early life stages (eggs or naupliar larvae), which are difficult to identify using conventional methods such as microscopy, can be a valuable tool for plankton monitoring.

Keywords: Croatian coast, ballast water, Copepoda, plankton, comparative study

## P19

### APPLICATION OF METABARCODING IN DETECTING NON-INDIGENOUS ZOOPLANKTON SPECIES IN THE ADRIATIC

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We used the COI metabarcoding approach to assess it as a tool for detecting non-indigenous gelatinous zooplankton species entering the Adriatic. Duplicate samples were collected at a coastal Lokrum station (100 m deep) from the bottom to the surface using a Nansen zooplankton net with a 200 µm mesh size. Samplings were conducted monthly from March 2021 to February 2022. One of the samples was preserved in formalin for species abundance and composition analysis under binocular, while the other was preserved in ethanol for DNA extraction and metabarcoding. Metabarcoding was performed using mlCOIintF-jgHCO2198 primer pair, which amplified a part of the COI gene about 300 bp in length. Out of five non-indigenous species detected by microscopy, only one was recorded in metabarcoding data. On the other hand, the metabarcoding approach detected two new gelatinous zooplankton species for the Mediterranean, which couldn't be verified by microscopy. Our results suggest that metabarcoding can detect non-indigenous species, but it is not a reliable tool if it is not tuned to specific species. Detection relies on both the abundance of the target species and the level of identity between the primers and the COI sequence of the target species.

Keywords: metabarcoding, zooplankton, Adriatic Sea, non-indigenous species



## P20

### WHAT IS THE ORIGIN OF THE RARE DINOFLAGELLATES IN THE SOUTHERN ADRIATIC SEA IN 2023?

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A few rare dinoflagellate species were found in samples collected in the open southern Adriatic Sea in spring - summer 2023 using Niskin bottles and plankton net. In this study, the samples were collected at four stations in the southern Adriatic Sea (P-1200, P-300, P-150, and P-100; the numbers indicate the maximum station depth). A total of 49 phytoplankton samples and four net samples were analyzed. All species have been previously recorded for the Adriatic and Mediterranean Sea. The rare species found are *Ceratoperidinium margalefii* A. R. Loeblich, *Tripos rotundatus* (Jørgensen) F. Gomez, *Pselodinium vaubanii* Sournia and *Amphisolenia globifera* F. Stein. These species can be considered as rare dinoflagellate species in the southern Adriatic Sea due to their percentage of occurrence (< 5%) in the analyzed samples. The highest abundance of *C. margalefii*, *P. vaubanii*, *A. globifera* were 20, 20 and 10 cells L<sup>-1</sup>, respectively. One individual cell of the species *T. rotundatus* was found in all net samples. The origin of the dinoflagellates could be related to the different water masses entering the southern Adriatic Sea. The BiModal Oscillating System (BiOS) has an influence on the water masses entering the southern Adriatic Sea. According to the hydrographic data, the cyclonic phase of the BiOS was observed during the study period. The cyclonic phase of the BiOS means the intrusion of the saltier, denser, and nutrient-poor Levantine Intermediate Water, while the anticyclonic phase means the intrusion of the water from the Ionian Sea diluted by the Atlantic Water with lower salinity and density, but nutrient-rich. The BiOS also has an influence on the thermohaline properties and biodiversity in the southern Adriatic Sea.

Keywords: microscopy, phytoplankton, taxonomy, water masses

## P21

### IS THE NUMBER OF ALIEN PLANT SPECIES IN REGIONAL FLORAS OF POLAND STILL INCREASING?

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Increasing human pressure on ecosystems and the resulting environmental changes has enabled many species of alien origin to increase their range of occurrence and to enter new areas, and as a consequence, cause environmental and economic losses. However, as some researchers point out, based on the data contained in the database of the Alien Species First Record, there is a downward trend in the number of new alien species recorded over the last three decades (Haubrock et al. 2023). In testing the validity of this hypothesis, this study aimed to collect data from the last decade and to quantify the appearance of new alien plant species (APS) in the flora of central region of Europe, within the borders of Poland. An additional goal was to collect data on species that continue to increase the number of locations in the country, taking into account the time intervals that have passed since their first record. Data included in the analysis come from a study: *The establishment and spread of alien plant species (kenophytes) in the flora of Poland*, published in 2005 by B. Tokarska-Guzik. These data were supplemented from the checklist of APS for Poland, published in 2012, *Distribution atlas of vascular plants in Poland: appendix* (2019) and other published and unpublished materials, including our own data collected during field research. The analysis of the data gathered, confirmed that the number of new species of alien plants in the country, also ones which were first recorded in the period 2012-2023, are still increasing, and that this group includes species classified as invasive alien species (IAS) in the European Union and not previously found in the wild (except for cultivation) in Poland. During the analysed period, several dozen new species were confirmed, including among others: *Cabomba caroliniana*, *Dittrichia graveolens*, *Egeria densa*, *Grindelia squarrosa*, *Lysichiton americanus*, *Miscanthus sacchariflorus*, *Phytolacca americana*, *Pistia stratioides*, *Solidago ×niederederi* and *Cochlearia danica*. The results show that the most critical pathways of introduction and spread for APS are horticulture and the transport networks (e.g., roads, rail, and canals/rivers).

Haubrock P.J., Balzani P., Macêdo R., Tarkan A.S. 2023. Is the number of non-native species in the European Union saturating? *Environmental Sciences Europe* 35:48

Keywords: checklist, first record, new species, IAS, pathway

**P22**

**THE IMMEDIATE SURROUNDINGS AS A SOURCE OF THE GROWING THREAT POSED BY INVASIVE ALIEN PLANT SPECIES TO PROTECTED AREAS – A CASE STUDY FROM THE EXAMPLE OF TWO POLISH NATIONAL PARKS**

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The magnitude of climate change, changes in land use and abandonment, expansion of the transport network, and the introduction of alien plants for economic and horticultural purposes, favour their spread, including into naturally valuable areas. Limiting the possibility of the emergence and further spread of new alien plant species, including invasive ones (IAS-P) in a specific area, requires collection of detailed data on both their current occurrence and the pathways of their intentional or unintentional introduction. The aim of the study was to assess the threat posed by IAS-P to valuable natural areas depending on the specific environmental conditions in which the area is located. The model research areas were two national parks in southern Poland: Ojcow NP and Magura NP. Data on the occurrence of IAS-P were collected within the two areas and within their immediate vicinity, with particular emphasis on banks of watercourses, communication lines, wasteland and built-up areas, including home gardens and landscaped green areas. Among several hundred alien species confirmed, there are several species which threaten native species and natural habitats. These include species that pose a threat to the EU in general (*Heracleum sosnovskyi*, *Impatiens glandulifera*) and to Poland in particular (species of the genus *Reynoutria*=*Fallopia*) and those identified as invasive, based on scientific sources (e.g., species of the genus *Solidago* or *Rudbeckia laciniata*). At the same time, outside the boundaries of national parks, the occurrence of species that pose a potential threat to these areas (including *Celastrus orbiculatus* and species of the *Miscanthus* genus) has been confirmed. The data analysis showed potential sources of IAS-P propagule spread, and possible routes and vectors of their migration. The data collected will be used to develop remedial actions and conduct training and educational activities to increase the awareness of local communities.

The study is co-financed by Financial Mechanism 2014-2021 under the “Environment, Energy and Climate Change” Programme EEA for the action aimed at “Increasing the protection of ecosystems against invasive alien species” within the project: Integrated Approach to the Protection of Ecosystems Against Invasive Alien Plant Species in Southern Poland – IAS/EcoSystemCARE.

**Keywords:** occurrence, introduction, IAS, pathway, nature conservancy

**P23**

**RESPONSE OF THE INVASIVE ALIEN PLANT *Duchesnea indica* TO COMPETITION, LIGHT AND NUTRIENT AVAILABILITY**

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The Indian mock strawberry (*Duchesnea indica* (Andrews) Focke) is a perennial herbaceous plant that was introduced to Europe for horticultural purposes at the beginning of the 19<sup>th</sup> century. In the second half of the 19<sup>th</sup> century, *D. indica* had already formed in Europe wild growing populations. Nowadays, *Duchesnea* has a global distribution and is a successful invader able to establish in various environmental conditions including open habitats such as lawns and meadows, ruderal sites, at the forest edge and under a closed canopy in the understorey. The aim of this research was to determine the growth of the *D. indica* clones in the absence and the presence of intra- and interspecific competition, respectively, and exposed to different intensities of light and nutrients (either low or high). In the spring of 2022, we established a pot experiment to assess the effect of above listed environmental factors. At the end of the summer, we determine several morphological (number and size of leaves, petiole length, number of stolons, ramets and flowers, above and below ground biomass) and ecophysiological parameters (chlorophyll fluorescence and leaf chlorophyll content). These parameters determine plant fitness in terms of the survival and reproductive success of a plant (genotype) in a given environment. We hypothesised that *D. indica* has the best fitness in the absence of competition and in a high-light and nutrient environment. We confirmed the best fitness of *D. indica* in the absence of competition. The effect of the inter- and intraspecific competition remains unclear due to high plant mortality. We recorded the greatest growth of leaves, fruits, stolons and ramets, and the greatest biomass if clones were exposed to high light and soil nutrients. The clones in the shade invested the most energy in the length of the petiole while the production of the fruits was reduced.

Keywords: plant fitness, morphological characteristics, ecophysiological characteristics, reproductive success

**P24**

### **IS *Prangos trifida* POPULATION IN CROATIA NATIVE OR INTRODUCED?**

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*Prangos trifida* (Mill.) Herrnst. & Heyn (Apiaceae, Apioideae) is a plant species from the western Mediterranean region, occurring in Albania, France, Italy, Portugal, Spain and "Yugoslavia". The first record of *Prangos trifida* in Croatia was recently reported (Pandža and Jasprica 2023). This species was found on a small islet in the southern part of the Kornati National Park (Dalmatia). It occurs in the vegetation of the class *Crithmo-Staticetea* Br.-Bl. in Br.-Bl. et al. 1952. In July 2023, the population consisted of 30 individuals. The species was not found during a survey of the surrounding islands of the Kornati archipelago. It is unclear whether this population is native or introduced. The population of *P. trifida* found in Croatia lies between those reported from the province of Liguria (north-eastern Italy), and Montenegro and southern Albania. The Ligurian population was found at an altitude of 800 to 1600 m a.s.l., while in Albania it occurs within the community dominated by *Buxus sempervirens* L. at 980 m a.s.l. Although some recent studies reject, at least in part, a role of anemochory in the dispersal of Apioideae fruits, we consider both zoochorous dispersal modes (endozoochory, epizoochory) possible because (i) the islet is a nesting site for gulls, (ii) the area lies on one of the most important migration routes in the region, (iii) the area includes habitats important for the conservation of migratory bird species, (iv) the influence of environmental drivers (e. g. wind frequency) and habitat conditions on plant survival should not be ignored.

Keywords: ecology, Middle Adriatic islet, NE Mediterranean, vegetation

**P25**

## **NEOPHYTES IN THE KORNATI NATIONAL PARK, CROATIA**

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According to literary sources, 650 taxa (species and infraspecific units) have been recorded in the Kornati National Park (KNP). In this area, human activities have created new anthropogenic habitat types, which - intentionally or accidentally - paved the way for the introduction of non-native species of flora. Field research was conducted from 2016 to 2023 at 119 sites on islands and islets in the KNP: Kornat, Smokvica, Ravni Žakan, Lavsa, Piškera, Levrnaka and Vela Panitula. The aim of the survey was to complete the list of neophytes within the KNP boundaries in order to take measures to control them. The largest number of neophytes was found on the islets of Smokvica and Ravni Žakan (each 11 taxa) and on the island of Kornat in the settlements of Opat (17), Šipnate (10) and Suha Punta (9). The most abundant taxa (found in 9-12 localities) are: *Conyza sumatrensis* (Retz.) E. Walker, *Parthenocissus quinquefolia* (L.) Planchon and *Euphorbia prostrata* L. The *Conyza* species and *Ailanthus altissima* (Mill.) Swingle have the densest populations. So far, 56 taxa of neophytes have been identified in the KNP based on data from the literature and our own field research, representing 8.62% of the total flora. Owners of gardens and catering establishments should avoid introducing alien species. Education and awareness-raising among property owners are key to preventing and further spreading alien species.

Keywords: diversity, Middle Adriatic islets, NE Mediterranean, vascular plants

P26

## TERRESTRIAL INVASIVE ALIEN PLANTS OF IMPORTANT LANDSCAPES IN VIROVITICA-PODRAVINA COUNTY, CROATIA

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Four important landscapes of the Virovitica-Podravina County are protected in multiple ways and are part of the Natura 2000 ecological network: the Mura-Drava Regional Park, the Mura-Drava-Danube Biosphere Reserve and the European Green Belt. During 2022. an extensive field inventory of terrestrial habitats was conducted from July to October. The presence of 19 invasive alien plants was recorded in 1107 localities within approximately 1285 ha. In our research we did not confirm the presence of *Galinsoga ciliata* and *Veronica persica*, which were listed among the 14 invasive alien plants previously recorded (mostly in 2019-2021 period) for a wider area encompassing four important landscapes. Among the 19 species we recorded, seven are new findings for this area: *Acer negundo*, *Ailanthus altissima*, *Amorpha fruticosa*, *Asclepias syriaca*, *Bidens frondosa*, *Panicum dichotomiflorum* and *Robinia pseudoacacia*. Of these, *A. altissima* and *A. syriaca* are on the „List of invasive alien species of Union concern“, as well as *Impatiens glandulifera* which was recorded previously, and confirmed in this survey. The most abundant species found in the largest number of localities, present in all important landscapes, is *Solidago gigantea*. As much as 18 invasive alien plants were found in the important landscape Križnica, followed by 17 species in the Jelkuš, while 13 and 10 species were found in Širinski otok and Vir, respectively. Analysis of recorded invasive flora showed that therophytes are the most frequent life form, competitive and competitive-ruderal Grime's strategies are equally dominant, and habitats such as forests and agricultural areas were the most invaded. Ellenberg's indicator values revealed that recorded invasive species prefer more light and nutrients in the soil. Given the fact that seven new invasive alien plants have been recorded, two of which are on the EU list of concern, and that these important landscapes also have freshwater habitats prone to invasive species, continuous monitoring of invasive species in these areas is necessary, with appropriate management plans for their control and/or eradication.

Keywords: black list, Drava River, habitats, inventory

**P27**

## **MONITORING AND CONTROL OF INVASIVE *Ludwigia peploides* IN POŽEGA-SLAVONIA COUNTY**

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*Ludwigia peploides* (Kunth) P. H. Raven was introduced to Europe as an aquatic ornamental plant. Due to the invasiveness and the potential danger to native species, Croatia is obliged (Regulation EU 1143/2014) to quickly eradicate this species and prevent its further spread. Therefore, this project was designed with the aim of collecting knowledge about this species and developing methods for its removal and population control. The project will be implemented in the Ilova River near Kaniška Iva (Garešnica), where the first occurrence of *L. peploides* in Croatia was documented in 2018 by Sedlar and Buzjak. Although it is not known how the species reached the territory of Croatia, we assume that it happened due to the transport of fish to the ponds. Namely, the river is rather canalized and surrounded by artificial ponds. Unlike 2018 research, according to which the plant appeared on only 2 km of the river course, our research shows that it has spread to almost 10 km. Furthermore, previous observations showed that the plant appeared in many scattered places, forming dense floating mats with an area of approximately 1 m<sup>2</sup>. On the contrary, the surface of floating mats increased up to 20 m<sup>2</sup> with a tendency for further expansion. In addition to determining the current distribution of the species, it is necessary to develop successful removal methods that will not cause further spread of plant fragments. Moreover, it is necessary to increase public awareness, as well as inform the scientific community, to prevent further spread of the species.

**Keywords:** freshwater aquatic plant, IAS eradication, mechanical control, prevention of spread, *Ludwigia peploides*, floating primrose



**P28**

**MONITORING THE IMPACT OF *Ailanthus altissima* REMOVAL ON NATURA 2000 HABITAT TYPES (62A0 AND 91F0) WITHIN KRKA NATIONAL PARK**

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This research is part of the LIFE CONTRA *Ailanthus* project, aimed at establishing control of the tree of heaven (*Ailanthus altissima*) in Mediterranean Croatia. The aim of the research is to monitor the vegetation and ecological changes before, during and after the removal of this invasive species within the two Natura 2000 habitat types in Krka National Park: 62A0 Eastern sub-Mediterranean dry grasslands (*Scorzoneretalia villosae*) and 91F0 Riparian mixed forests along the great rivers (*Ulmenion minoris*). During the summer of 2022, a preliminary field survey was conducted, resulting in the establishment of 36 permanent monitoring plots, 30 within habitat type 62A0 and 6 within habitat type 91F0. For each habitat type, half of the permanent plots contained tree of heaven plants, while the others were used as control. Plot sizes varied from 100 m<sup>2</sup> for grasslands to 400 m<sup>2</sup> for forests. The monitoring methodology is based on phytosociological relevés and recording the abundance of tree of heaven shoots in the tree, shrub, and herb layers. This will enable the analysis and comparison of tree of heaven plant density, ecological indicator values (EIV), the proportion of plant species according to their life strategy (CSR), species richness, biodiversity indices, and other parameters of the permanent plots throughout the project's duration. The results of the first year of research (before removal) show significant differences between the control and tree of heaven plots within habitat type 62A0 considering EIV for light availability and soil nitrogen, as well as the share of competitors and stress-tolerant species.

Keywords: tree of heaven, invasive plant species, phytosociology, Ecological network, Mediterranean region

**P29**

**ALIEN PLANTS OF THE SPECIAL RESERVE PANTAN (DALMATIA)**

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Pantan is a special ornitho-ichthyological reserve in Dalmatia (southern Croatia), stretching over about 40 hectares near the town of Trogir. In previous floristic research, 380 plant taxa (species and infraspecific taxa) were recorded in this area. During additional fieldwork in 2022 and 2023, carried out by the authors of this study, 50 more vascular plant taxa were found, bringing the total number of taxa recorded for this area to 430 so far. However, of the total number of recorded plant taxa, as many as 47 (11% of the total vascular flora) refer to alien species (cultivated, casual, naturalised or invasive taxa). This shows the enormous anthropogenic influence on the native flora and vegetation of this protected area, and thus its threat from the further introduction of alien species. We will therefore present a full analysis of all alien plant taxa recorded, focusing on their potential invasiveness, which could provide guidance for the management of alien plants in this protected area.

Keywords: Croatia, eastern Adriatic, invasive alien plants, NE Mediterranean, non-native flora

**P30**

## **INVASIVE PLANTS IN THE AREA OF KRIŽNICA (NORTHERN CROATIA)**

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Members of the Natural History Society "Drava" carried out ecological monitoring of the old course of the Drava River with an emphasis on Natura 2000 habitats and species for the purposes of the OldDrava project, LIFE13NAT/HU/000388 in the period from 2016 to 2019. The goal of the project was to describe and monitor changes in forest and water communities and map Natura 2000 habitats in the area of the old course of the Drava River in Križnica. Water habitats - Natura area 3150 - Natural eutrophic waters with Hydrocharition or Magnopotamion vegetation were recorded in the Graba and Old Drava localities. A greater coverage of invasive species such as *Ailanthus altissima* (Mill) Swingle and *Phytolacca americana* L. - American kermes was observed along the river bank. After the construction of the dam, invasive taxa such as *Ambrosia artemisifolia* L.- ambrosia, *Solidago canadensis* L. - Canadian goldenrod and *Echynochystis lobata* (Michx) Torr et Gray- prickly cucumber, which suppress the autochthonous taxa, inhabited the coastal area of Crni Jarak.

Keywords: River Drava, monitoring, water habitats, plants

## P31

### PRELIMINARY SURVEY OF INVASIVE ALIEN PLANTS IN SESVETE (NORTH-WESTERN CROATIA)

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Sesvete is a district in the eastern part of Zagreb and occupies a quarter of the total area of the city. Due to its size and traffic importance, it is extremely exposed to the introduction of invasive alien species. A preliminary survey of invasive alien plants in Sesvete was conducted during the year 2012. The sites were mapped and enlisted in the Flora Croatica database. The habitats were classified according to the Habitat Classification of the Republic of Croatia. In the investigated area, 112 plots (250x250 m<sup>2</sup>) were investigated and 32 invasive plants were recorded at 370 GPS sites. The largest number of them belong to the family Asteraceae (38%), followed by Poaceae (13%). Invasive plants of that area are mostly of American origin (68%), belong to the therophyte life form (47%), and are spread equally by zoochory (24%) and anemochory (22%). The most common invasive plants in the Sesvete area were *Erigeron annuus*, *Conyza canadensis*, *Sorghum halepense* and *Ambrosia artemisiifolia*, which were recorded at 123 sites (33,1% of the total number of sites). One to four invasive plants were recorded on 55% of the investigated plots, and only a smaller number of plots (11.6%) had more than 10 invasive plants per plot. Invasive plants occupied plots with 2-3 habitat fragments (74%), while plots with 5 or 6 habitat fragments were present in the smallest percentage (5%). The most common habitat type with recorded invasive plants (42.86%) in Sesvete was the J.2.2 habitat type - urban residential areas, followed by I.2.1, mosaics of cultivated areas (15.76%). This was the first organized survey of the invasive flora of Sesvete, which pointed to the need for more intensive monitoring, which we are planning for a period of 15 years, in order to control the spread of alien invasive species in the city of Zagreb.

Keywords: continental Croatia, non-native plants, spatial distribution, floristic analysis

**P32**

**POTENTIALLY INVASIVE NON-NATIVE ORNAMENTAL TREES IN URBAN PARKS OF ZAGREB: *A PRIORI* CATEGORISATION**

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Parks and gardens are one of the main routes of deliberate introduction of non-native ornamental plants, some of which might become invasive. To date, no complete list of non-native ornamental plants has been compiled for Croatia nor has a risk screening of their invasiveness in the country been done. To achieve calibration of the risk outcomes, the screened species need to be categorised a priori as 'invasive' or 'non-invasive'. To this end, the present study used a four-step protocol (Vilizzi et al., 2022) to classify 44 non-native ornamental trees (39 species, one subspecies and four hybrids) from ten urban parks in Zagreb. Out of 44 taxa of non-native ornamental trees, 35 taxa were invasive: 28 of them belonging to the angiosperms and seven taxa to the gymnosperms. The invasive taxa with the highest number of individuals in researched parks were: *Aesculus hippocastanum* (320) and *Platanus x acerifolia* (302). There is no park without invasive ornamental trees. Furthermore, the parks with the highest number of invasive taxa are the parks called „Trg Stjepana Radića“ with 25 taxa and „Trg kralja Petra Krešimira IV.“ with 20 taxa of trees. In conclusion, it is assumed that the outcomes of this study will contribute to knowledge of the invasiveness of ornamental trees in urban parks in Zagreb in order to identify potential invasion threats at an early stage and to enable prioritisation measures and management decisions aimed at preventing or mitigating the environmental and socioeconomic impacts of biological invasions.

Keywords: horticulture, invasiveness, non-native species, ornamental plants

**P33**

**PRELIMINARY RESEARCH OF INVASIVE PLANTS IN DIFFERENT HABITATS IN THE CITY OF OSIJEK**

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In ecosystems affected by invasions, interactions occur not only between invasive species, but also with all other co-existing species. As a result, their interconnected dynamics play an important role in the establishment, invasion and eventual dominance of some invasive species in ecosystems. The main objective of this study was to identify invasive plants, their spatial distribution, abundance and temporal trends in an urban environment. In the city of Osijek, 20 permanent observation plots, each measuring 5 x 5 metres, were studied in two field cycles from April to August 2023. A complete list of flora was compiled for each plot. Additionally, plots were divided into a grid of 25 equal quadrants, in which the absolute abundance of the invasive plants present was recorded. The preliminary results revealed a total of 167 taxa in the study area, with 17 of them classified as invasive. Among invasive taxa, 13 were identified at the species level, while 4 were identified at the genus level. Another field trial is planned for the 2023 growing season to collect more data for investigating whether there are patterns of co-occurrence of invasive plants and their potential interactions with neighbouring flora. This research is of great importance as there is hardly any data on invasive plant species in Osijek. It will not only provide valuable spatial data on the invasive flora, but also give basis for research of their interactions in the context of community composition.

Keywords: invasive plants spatial distribution, urban habitats

**P34**

## **THE OCCURRENCE OF INVASIVE ALIEN SPECIES (IAS) IN PROTECTED HISTORIC TOWN CENTRES AS A SOURCE OF THREAT TO NATURAL HABITATS**

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Cultural and historical parts of cities often include areas of collapsed or severely neglected buildings, which in Croatia is particularly visible in the areas affected by the earthquakes of 2020 and 2021, and where invasive plants can occur. Establishment of IAS in urban historic centres is not considered to be a significant problem because the majority of IAS plants are successfully controlled by regular mowing and clearing procedures. However, property-unmanaged sites in historic town centres can become a focal point for the spread of IAS to natural habitats. The goals of this study were to investigate occurrence and spread of invasive plants in urban historic centre and their potential impact on buildings and structures. For the purposes of this study, the area of the historical centre of the city of Karlovac, which is under the protection of the Ministry of Culture, and the surrounding area of the uninhabited periphery towards the rivers Kupa and Korana were observed. We surveyed the same sites from 2016 onwards and analysed changes in the diversity of IAS plants, with focus on woody species. A total of five invasive plant species were recorded. The invasive species whose numbers increased till 2023 are: *Acer negundo* L. (208), *Robinia pseudoacacia* L. (195) and *Ailanthus altissima* (Mill.) Swingle (5). We also detected occurrence of two perennial taxa: *Reynoutria* sp. and *Amorpha fruticosa* L.. After mapping of IAS plants, potentially critical points and corridors of expansion were determined. It is necessary to monitor the identified corridors in order to prevent spread of problematic species. Management of invasive plants in culturally protected centre of Karlovac should continue to consist in removal and safe disposal of the target species.

Keywords: IAS, protected cultural property, Karlovac, prevention of IAS plants spread

**P35**

**SPREAD AND POSSIBILITY OF CHEMICAL CONTROL OF *Reynoutria* spp. IN URBAN AREAS**

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*Reynoutria* spp. was introduced to Serbia several decades ago as an ornamental garden plant. Regardless of its large presence, especially in Western Serbia, there is still no developed awareness of its harmfulness. Mowing using trimmers and rakes is a widely used weed control measure in urban areas. Due to ignorance of the biology of this species, this method of suppression caused its gradual but unstoppable spreading. Application of herbicides as an effective control measure of this species in urban areas was done through the trials in 2020 in the territory of the municipality of Čačak using herbicides glyphosate, triclopyr, and flazasulfuron and their combination. The results obtained show that it is best to start the treatment in the spring, when the plants are 10-15 cm tall, and when the treatments are repeated until the end of the season. Dry plants can be removed after treatment and in this way the population can be partially controlled. The choice of herbicide and the amount of application depends on the age of the population. Treating adult plants that have been in one place for several years (even decades) is very complicated, because the underground mass is huge and the sprouting potential is very high. The treatment must be continued on the same surface the following year, and even when it seems that the plant is destroyed, it is necessary to monitor the situation, because the rhizomes can remain dormant for a long time, and then reactivate. Due to the complexity of biology and the suppression of *Reynoutria*, it is recommended that the companies for the maintenance of urban greenery adopt special regulations and instructions for the method of suppression and control of the spread of this plant.

Keywords: mowing, herbicides, glyphosate, triclopyr, flazasulfuron



**P36**

## **POTENTIAL ENERGY PRODUCTION OF INVASIVE PLANT SPECIES IN THE ZADAR AREA**

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Globalization enables the spread of invasive alien plants, posing a major biodiversity threat. Simultaneously, environmental pollution from non-renewable energy sources surges worldwide, driven by growing energy demands. The biomass of invasive plant species can potentially be used for energy production purposes. The city of Zadar and its surroundings, with their climatological predispositions as well as the seaport and airport, roads, and railways, are an area where there is a potential possibility of the uncontrolled introduction and spread of invasive plant species. In this research, invasive flora was inventoried in the area of the city of Zadar and its surroundings (Crno, Babindub, Kožino, Petrčane, Bibinje, Sukošan, Zemunik donji). Except for information on life form, life duration, floral element, flowering time, habitat, and region of occurrence, for each of the 20 invasive plant species that were found, the negative impacts, as well as their usage possibilities with an emphasis on energy efficiency, were determined. The most common species were *Robinia pseudoacacia* L., *Parthenocissus quinquefolia* (L.) Planchon, *Broussonetia papyrifera* (L.) Vent and *Coryza sumatrensis* (Retz.) E. Walker. Most plant species were recorded in highly anthropogenic areas and ruderal habitats along roads, meadows, while a smaller number was recorded in parks, private gardens, along beaches and in ports. For each plant species, location and total number of findings were listed, and its energy value was determined based on the literature research. Managing invasive species incurs significant financial burdens, exceeding billions annually worldwide. In Europe alone, spending from 1960 to 2020 is estimated at \$140.2 billion. A sustainable solution involves eradicating invasive plant species biomass while using it for energy production, providing both effective biomass disposal and an additional source of income for ongoing invasive species management.

Keywords: invasive species, biomass, negative effect, usage possibilities, energy potential

**P37**

## **LIFE PROJECT ORNAMENTALIAS IN CROATIA**

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Many invasive alien plant species (IAP) have been introduced as ornamental plants and their spread into nature could be one of the main threats for biodiversity. The aim of the paper is to represent the LIFE project OrnamentallIAS, which will be conducted in cooperation with Slovenian and Croatian partners. The Faculty of Agriculture Zagreb and Zeleni Prsten are responsible for activities in Croatia. One of the initial activities in Croatia will be the analysis of the current status of ornamental IAP in public and private green spaces, as well as those on the Croatian market. The next step will be the preparation of three lists of plants: black (invasive), orange (potentially invasive) and white (non-invasive) plants. Those lists will be the base for Codex of ornamental plant introduction and will offer a list of alternative plant species. At least 6 demonstration plots of non-invasive ornamental plants will be designed and planted at Faculty of Agriculture and municipalities in Croatia. Apart from that, laboratory analyses of functional, nutritive and energetic value of IAP residues will be conducted, for the purpose of innovative circular economy solutions. Development and testing of a proposal for the early warning and rapid response protocol for invasive alien plants in agricultural and waterside lands in Slovenia and Croatia will be developed for Slovenia and transferred to Croatia. Additionally, habitat restoration through the removal of the Himalayan balsam (*Impatiens glandulifera* Royle) alongside the Bregana river will be implemented by Zeleni prsten Public Institution of Zagreb County. A long-lasting cooperation between 10 partners from Slovenia and Croatia in this project will influence the perception of invasive ornamental plants and increase the interest among the general and professional public for planting non-invasive alternatives to prevent the introduction of IAP into natural habitats.

Keywords: invasive species, ornamental species, alternative plant species, usage possibilities

**P38**

**USES OF INVASIVE PLANT SPECIES BLACK LOCUST (*Robinia pseudoacacia*, FABACEAE) IN NORTHWESTERN CROATIA**

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*Robinia pseudoacacia* L. is a fast-growing deciduous tree originally from North America and has been imported in Europe since the early 17<sup>th</sup> century. In Croatia, it's a highly invasive species. Using semi-structured in-depth interviews and the snowball technique, we investigated the ethnobotanical use of *R. pseudoacacia* in the study area of Hrvatsko Zagorje. The results show that *Robinia* is the fourth most used species (81% of respondents). The uses are different: edible - fresh flowers are mixed in pancake batter and fried in a pan, a sweet syrup (with sugar) is still prepared as a refreshing drink, and nectar from fresh flowers is often sucked as a children's snack. Dried flowers are used as a relaxing tea. The wood of the *Robinia* is used as firewood and as a material for making tools, especially stakes in vineyards and vegetable gardens. It's also a very good honeybee pasture. *Robinia* honey is known for its medicinal properties, it relieves nervousness and insomnia, lowers insulin consumption, helps with bronchitis, digestion, allergies, cardiovascular system, gynaecological diseases, has anti-inflammatory and antipyretic effects, it's also used in aromatherapy. In Croatia there are also *Robinia* cultivars used in ornamental horticulture and planted in protected areas (e.g. *R. pseudoacacia* 'Umbraculifera' and *R. pseudoacacia* 'Inermis' in King Petar Krešimir Park IV or in Maksimir Park, Zagreb). Also planted in natural sites as hedges for protection from crosswinds. Cultivation is allowed in Croatia only in the form of plantations as short rotation plantation, in agriculture for soil recovery and bioenergy production (biomass, pellets). In summary, due to the positive economic but negative ecological impacts of *Robinia*, conflicts of interest exist between nature conservation, forestry, timber industry, urban planning, beekeepers and the public when setting management priorities, and their populations need to be kept under control.

Keywords: allochthonous, edible use, ethnobotany, honeybee pasture, *Robinia pseudoacacia*

**P39**

**NEW ALIEN SPECIES IN THE FLORA OF CROATIA - *Diospyros virginiana***

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During field research in 2022-2023 on the island of Koločep, near the city of Dubrovnik, spontaneous occurrence of the non-native species *Diospyros virginiana* L. (Virginia dragoon or American persimmon) was observed outside the area of primary cultivation. This plant is an ornamental and food plant and part of the dendroflora of the park. On the part of the road between the two main settlements of the island (Gornje Čelo and Donje Čelo) *D. virginiana* appeared spontaneously on the eastern side of the road four years ago. It occurs in an agricultural habitat of an abandoned olive grove with an area of about 2900 m<sup>2</sup>. The area is no longer cultivated and is mainly covered with ruderal and weedy vegetation, with the herbaceous ground layer consisting of many species of the Apiaceae family. In the plot, *D. virginiana* has an average height of 1 to 2 meters, enveloping and smothering the remaining *Olea europaea* L. trees in the described area. The plant spreads vegetatively and has a very strong root system that extends laterally for several meters, completely covering the area. It also grows into a drywall structure along the road. The authors propose to include this species in the Flora Croatica database (Nikolić 2023) to provide a basis for future monitoring. We also believe that due to its invasive potential and the environmental damage it causes, the species should be eradicated from the area before it spreads to surrounding properties.

Keywords: environmental damage, potential invasive impact, spontaneous appearance, Virginia dragoon

**P40**

***Euphorbia hypericifolia* AND *Opuntia anahuacensis*: TWO NEW, POTENTIALLY INVASIVE SPECIES IN CROATIA**

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During last few decades, the spreading and findings of invasive species has become faster than ever. Many new non-native species in regional floras can escape the attention at the moment of their first introduction but it is usually easy to record their subsequent spreading and their invasiveness. Here we present two cases of new, potentially invasive, plant species for the Croatian flora. For *Euphorbia hypericifolia* L. (Euphorbiaceae), there is certainty that the introduction and initial spreading of this tropical and subtropical American species has started from the town of Šibenik in North Dalmatia. It was recorded in the Garden centre Dubrava for the first time in August 2022. Just one year later, in September 2023 it was found in Vodice, as well as in Podstrana near Split in central Dalmatia. *Euphorbia hypericifolia* is an annual species that is possibly unintentionally reproduced in nurseries within potted plants. On all localities it has been observed growing in urban ruderal vegetation and on roads along the seashore. For the moment, this non-native species is still not invasive but further spread could be expected. As far as the second case is concerned, *Opuntia anahuacensis* Griffiths (Cactaceae), given its extremely vast distribution in Croatia, it is difficult to ascertain when and where the process of naturalization took place. The native range of this coastal prickly pear is southeast Texas in southern United States, even though it could be possibly broader. Probably, it has been introduced as an ornamental plant and subsequently it started a rapid spread and soon became potentially invasive on the coastal part of Croatia and the islands (Istria, Kvarner and Dalmatia). Similarly, as what happened with other *Opuntia* species in Croatia, *O. anahuacensis* has been misidentified as the very similar and possibly related *O. stricta* (Haw.) Haw. but also as *O. lindheimeri* Engelm. As regards, research aiming at a better formalization of the differences with *O. stricta* (Haw.) Haw. are underway. Here we combine the results of our field observations with the records from the open data platform iNaturalist. The distribution map for these two new alien species in Croatia is given as well.

Keywords: Adriatic, American neophytes, flora, invasiveness, new species

**P41**

**THE AUSTRALIAN GOOSFOOT *Dysphania pumilio* (CHENOPODIACEAE), A NEWCOMER IN CROATIA**

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The clammy goosefoot, *Dysphania pumilio* (R. Br.) Mosyakin & Clemants (syn. *Chenopodium pumilio* R. Br.), originates from the Southern Hemisphere and is native to Australia and Tasmania. As an adventive and partially naturalised species, it occurs in Asia, Africa, South America and North America. It has been introduced to Europe since the late 18th century together with raw wool imported from Australia. The first introductions were registered in Central Europe (Germany and the Czech Republic), where Australian wool waste was deposited (near spinning mills and carding factories). Subsequently the species occupied a wider spectrum of disturbed or semi-natural habitats (waste disposal sites, railways, fields, pastures, river alluvia, trampled sites, ports) across numerous European countries and became naturalised, but apparently non-invasive. The plant is annual and produces a large number of seeds. The major ways of dispersal are epizoochory and anemochory, and through vehicles and agricultural machinery (through adhesion to tires) as well. The naturalisation of the species is supported by the abundance of long-lasting viable seeds, and seed dormancy that prevents germination in hostile conditions. The first record of *D. pumilio* in Croatia was in 2006 in Baška Voda (Dalmatia, Southern Croatia), however it passed under the radar of the Croatian botanical community and the species is currently not listed in the Flora Croatica Database. In 2021, a small population was observed in Zagreb and was monitored in the subsequent years. The population is stable, but still restricted to the pavement along the road with heavy traffic in the city centre, near the Botanical Garden and the railroad. Here the species successfully reproduces sexually, while performed relevés show that the species thrives here among other very common anthropophytic plants.

Keywords: anthropophytes, Australia, *Chenopodium pumilio*, naturalisation, Zagreb

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## DISTRIBUTION OF KUDZU VINE (*Pueraria montana* var. *lobata*, FABACEAE) IN CROATIA

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Kudzu vine (*Pueraria montana* (Lour.) Merr. var. *lobata* Maesen & S.M.Almeida ex Sanjappa & Predeep; Fabaceae) is invasive alien species of Union concern, according to the EU Regulation 1143/2014 on the prevention and management of the introduction and spread of invasive alien species. While its native distribution encompasses East and South-East Asia, it was introduced to other continents, including Europe, where it is present in Italy, Switzerland, Slovenia, Bosnia and Herzegovina, and Croatia. In the Flora Croatica Database it is listed as *Pueraria thunbergiana* Benth. (with the synonym *Pueraria montana* (Lour.) Merr.). In order to obtain and present the distribution of kudzu vine in Croatia we reviewed the literature and examined herbaria and relevant on-line databases. Kudzu vine was firstly recorded for Split (Central Dalmatia). In August 2018 it was discovered in Malinska on the island of Krk, where it covered an area of cca. 400 m<sup>2</sup>. Our recent field observations confirm that, in addition to Malinska, it is also present in Šestanovac (Central Dalmatia), with several plants that survived after they were cut, after being used on pergola over the café bar terrace for decades, the Trsteno Arboretum, where an area with the plant is regularly maintained so it has not spread over more than 50 m<sup>2</sup>, and Dubrovnik (South Dalmatia), where several individual plants are grown on pergola for providing shade. Additionally, four herbarium sheets of cultivated *P. thunbergiana* from Gruž near Dubrovnik collected by A. Ginzberger were found in WU herbarium, but it was not verified if the plant persists on this locality. Localities in Gradac and Seget (Central Dalmatia) were also recently discovered by other authors. Considering its ornamental uses in the past and its invasiveness, other, unknown localities of cultivated or naturalized kudzu vine could exist along the Croatian coast.

Keywords: invasive alien species, non-native species, *Pueraria lobata*, *Pueraria thunbergiana*, Union list

**P43**

**THE AFRICAN NIGER PLANT *Guizotia abyssinica* (ASTERACEAE) IN CROATIA – ALIEN INTRODUCED THROUGH THE BIRDSEED OR GREEN MANURE PATHWAY?**

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The Niger plant (*Guizotia abyssinica* (L.f.) Cass., Asteraceae), is herbaceous annual plant originating from Ethiopia (Eastern Africa) where it was domesticated from about 2000 BCE. Today, Niger plant is cultivated mainly as an oilseed crop (for human consumption and for industry) in Ethiopia, India, Bangladesh, Myanmar, and Nepal. In addition, Niger plant seeds are largely used as bird food worldwide (e.g. in the USA, it is the only imported wild bird food, with over 40,000 tons imported in a single year). The Niger plant is also used as a green manure for increasing soil organic matter, while in France, it serves as a cover crop. Rare attempts to cultivate this tropical crop in Russia, Germany, Switzerland, France and Czechoslovakia during 19th century ended unsuccessful (the same was with cultivation testing in Croatia in 1963). The first recorded wild-growing plant in Europe was in 1861 in Britain. Today, the species is a casual ephemerohyte in most of the central European countries and in Great Britain, while in southern Europe (Spain and Italy) it spreads spontaneously and became naturalised. It spreads mostly by disposal of the remains of seeds from many wild bird-feeders now commercially available. In Balkan Peninsula, only several specimens of *Guizotia abyssinica* were recorded in 1987, in Ornithological Reserve Krapje Đol in Lonjsko Polje Nature Park (Central Croatia) and these were assumed to originated from bird food. In the summer 2023 it was discovered on two field crops near village Donji Vukašinac (north of Čazma, Central Croatia), covering more than 50 % of the fields. The accompanying species *Phacelia tanacetifolia* Benth., *Raphanus sativus* L. var. *oleiformis* Pers., *Linum usitatissimum* L. and *Trifolium alexandrinum* L. clearly indicate that on this site the Niger plant originates from green manure seed mixture, and not from birdseed food.

Keywords: bird food, casual ephemerohyte, cover crop, cultivation, seed mixture



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### FIRST RECORD OF *Reynoutria sachalinensis* (POLYGONACEAE) IN SLAVONIA (EASTERN CROATIA)

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The spread of invasive alien species (IAS) is globally a large problem in nature conservation. Prevention, early detection and rapid response to spread are prioritized in national strategies against biological invasions. *Reynoutria sachalinensis* (F. Schmidt) Nakai (Polygonaceae) is a large, perennial herb originating from southeast Asia, exhibiting significant vegetative growth through branched underground woody rhizomes, with significant potential of spread via stem fragments and seeds. According to the current data, the species does not display invasive behaviour as its congeners *R. japonica* and *R. × bohemica*, however it provides pollen to male-sterile *R. japonica* resulting in the creation of the notorious hybrid, regarded as the most pernicious invader among the three. Modern studies show that historical herbarium records of *R. sachalinensis* in Croatia were erroneous due to the confusion with *R. × bohemica*, while the recent data reveal just a few naturalized populations in Gorski Kotar (Čabar and Gerovo) and Central Croatia (Stubica and Karlovac). In 2023 *R. sachalinensis* was recorded along the Dubnica River in the municipality of Sirač, as the first record from Slavonia. The population was vigorous, found along the maintained river banks, presumably functioning as a garden escapee. Regarding the small number of findings in Croatia, it is unclear whether the spread of the species is slow, or its arrival was far more recent than previously thought. Due to its potential for vegetative spread via stem fragments it should be maintained with caution, whereas periodic mowing might disperse the fragments into new areas.

Keywords: early detection, IAS, naturalisation, river banks, Slavonia

**P45**

**THE FIRST FINDING OF WEEDY PLANT SPECIES *Echinochloa colonum* IN MEDITERRANEAN BIOGEOGRAPHICAL REGION OF CROATIA**

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*Echinochloa colonum* (L.) Link (jungle rice) was first observed in Croatia in 2007 in the border area between the Medvednica Nature Park and the city of Zagreb. A year later, it was also found in the city of Zagreb. So far, these two observations, both located in the continental biogeographical region, were the only ones for Croatia. There are two possible explanations for the lack of data on the distribution of jungle rice on the Croatian territory: (i) either the plant is not naturalized and appears only sporadically (casual neophyte) or (ii) its distribution is overlooked due to its relative similarity to other *Echinochloa* taxa. Since the climate of continental part of Croatia is not quite suitable for the naturalization of jungle rice, it can be assumed that its occurrence in that area is casual. However, *E. colonum* is considered invasive for most of the tropical world (especially in rice plantations) and it may also act as an alternate host for many plant diseases. Jungle rice has also established several populations throughout other European Mediterranean areas, eg. in France, Greece, Italy, Spain, Cyprus, Turkey. Therefore, we consider the fact that the species was recorded for the first time in the Mediterranean region of Croatia as a warning. The species was noticed in July 2023 in the special ornitho-ichthyological reserve "Pantan" (43°31'44.4" N; 16°16'34.4" E) in Dalmatia (southern Croatia). In this work we will present and discuss its biology, similarities with other *Echinochloa* taxa and habitat preferences. Thanks to its great ability of vegetative and generative reproduction, the appearance of this species in our Mediterranean region may indicate an ecological and agronomic threat, and the possible beginning of its naturalization in Croatia. For this reason, the observation and monitoring of the distribution of this species is of particular interest.

Keywords: alien species, jungle rice, Poaceae, Split-Dalmatia County

**P46**

**THE FIRST FINDING OF WEEDY PLANT SPECIES *Glyceria striata* IN CONTINENTAL BIOGEOGRAPHICAL REGION OF CROATIA**

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*Glyceria striata* (Lam.) Hitchc. (fowl mannagrass) is a North American species, recorded in the Europe for the first time in the mid-19th century. In the last more than 150 years the species has spread from France to a larger number of European countries, growing primarily in semi-natural shaded habitats, e.g., bog springs, margins of water bodies, meadows and forests. Species is recognised as being potentially invasive in central Europe. In Croatia, *G. striata* was observed for the first in Alpine Biogeographical Region in 2015. Species was recorded in the Gorski Kotar region on four localities, in the border area between Slovenia and Croatia. In July 2023, the fowl mannagrass was recorded for the first time in Continental Biogeographical Region of Croatia, in the city of Zagreb. Precisely, the species was found in the Kraljevec Forest Park (45°50'08.4" N, 15°57'57.7" E), in the moist habitats within oak-hornbeam forests on deep nutrient-rich soils of the Balkans and Northern Italy [the alliance *Erythronio-Carpinion* (Horvat 1958) Marinček in Wallnöfer et al. 1993]. The largest population of fowl mannagrass was found alongside with *Equisetum telmateia* Ehrh., *Polygonum mite* Schrank, *Hypericum tetrapterum* Fr., and invasive taxa *Impatiens balfourii* Hook. f., *Juncus tenuis* Willd. and *Erigeron annuus* (L.) Desf. Unfortunately, the forest stand of Kraljevec Forest Park was partially devastated by the Teodor storm in 2013, which additionally contributed to the entry of numerous alien and invasive species. It is possible that this disturbance promoted the spread of *G. striata*, a naturalised neophyte at the studied site.

Keywords: alien species, fowl mannagrass, Kraljevec Forest park, Poaceae, city of Zagreb

**P47**

**THE NEW OBSERVATION OF INVASIVE ALIEN PLANT SPECIES *Solanum elaeagnifolium* IN CROATIA**

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*Solanum elaeagnifolium* Cav. (silverleaf nightshade) was first observed in Croatia on the island of Plavnik in 1976. Later, the same plant species was also noticed on the islands: Vir, Dugi otok and Vis; in Zadar, Šibenik and its surroundings, and around Metković. The silverleaf nightshade was unintentionally introduced from the southwest of the USA and northeast of Mexico. Under optimal conditions it grows up to 1 m high. In agriculture it is treated as a weed because it reduces the yield of cultivated plants either by competition for water and nutrients or by an allelopathic effect. Silver-leafed nettle is a source of some pathogenic viruses and a secondary host of harmful insects. So far, no fully effective removal method has been discovered. Mechanical, chemical (selective and non-selective systemic herbicides) and biological control are carried out. Here, we present the first finding of *S. elaeagnifolium* for the city of Split, the largest human population in Dalmatia. The species was noticed in July 2017 along the road (ruderal vegetation) in the area of the Karepovac garbage dump (latitude: 43° 52' 06" N, longitude: 16° 50' 55" E). Two years later we noticed it on Google Street View images of the same area (August 2019), where it still grows today with increased coverage. As the species is included in the Preliminary Checklist of Invasive Alien Plant Species (IAS) in Croatia, monitoring and surveillance of the range of this plant species is of particular interest.

Keywords: silverleaf nightshade, Solanaceae, Split-Dalmatia County, weeds

**P48**

**THE DEVIL IS IN THE DETAILS (OR LACK OF THEM) – A CASE OF DEVIL’S FINGERS (*Clathrus archeri*) AN ALIEN, POTENTIALLY INVASIVE, FUNGUS THAT WAS PROTECTED IN CROATIA**

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Devils’s fingers (*Clathrus archeri* (Berk.) Dring) is a saprobic fungus native to Australia and New Zealand, with some sources listing South Africa as well. Nowadays, it is present on all continents apart from the Antarctica, with Europe being most inhabited. It is believed that fungus came to Europe at the beginning of 20<sup>th</sup> century as unintentional introduction with sheep wool imported from Australia and New Zealand or with military equipment/personnel from Australia during the First World War. From France it spread gradually across Europe, with currently recorded observations from UK to Ukraine, and from Spain to Sweden. While there is obvious that this alien fungus has naturalised successfully in Europe, as with majority of non-pathogenic fungi we lack information on this fungus negative impacts, apart from simply occupying space and resources for native fungi, in order to classify it as an invasive species. In the scientific literature *C. archeri* was first mentioned for Croatia by Tkalčec et al. (Natura Croatica, 2005) based on their unpublished notes, but it was listed as early as in 1998 among the protected fungi in Croatia (Official Gazette NN 79/1998, NN 115/1998, NN 34/2002). In his note published in Šumarski list (2008), Kranjčev reports on hundreds of *C. archeri* individuals in *Pinus strobus* stands near Brodarovec in the vicinity of Ivanec (Hrvatsko zagorje). Based on data available in GBIF, iNaturalist and freely available/open access web sources, *C. archeri* is in Croatia recorded at: Papuk, Psunj, between Varaždin and Ivanec, southwest of Zagreb, around Karlovac, Ogulin, Blatuša, near Oprtalj in Istria and in northern part of Cres island. Unlike 25 years ago when we almost completely lacked information on its distribution (and origin), now we know it has wide distribution range in Croatia. In future, we should learn about its population size and impact.

Keywords: distribution, fungi, naturalisation, Octopus stinkhorn, protection, velika polipovka



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**BILJEŠKE**

**NOTES**











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