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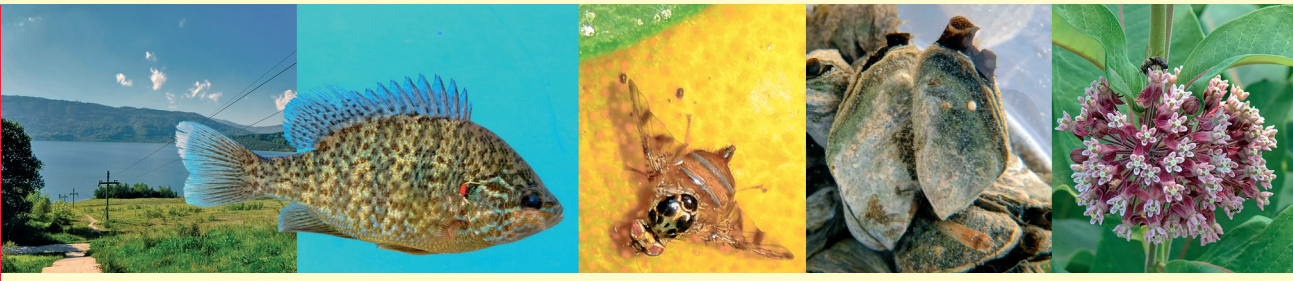

A special edition of the "REVIEW" dedicated to:

Joint ESENIAS and DIAS Scientific Conference and 9th ESENIAS Workshop

Species, ecosystems and areas of conservation concern under threat from the invasive alien species

03–06 September 2019

Book of Abstracts

Ohrid, Republic of North Macedonia
2019

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Public Institution Galicica National Park
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EDITORS:
Sasho Trajanovski, Teodora Trichkova, Rumen Tomov, Vladimir Vladimirov, Hristina Kalcheva, Konstantin Zdraveski

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Zdravko Hubenov, Bulgaria
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Contents

KEYNOTE PRESENTATIONS

PRESENTATIONS

Topic 1: Invasive alien species traits and trends

TOPIC 6: MANAGEMENT AND SHARING OF IAS DATA

TOPIC 7: OTHER TOPICS

POSTERS

TOPIC 1: INVASIVE ALIEN SPECIES TRAITS AND TRENDS

Topic 2: Vectors and pathways for invasive alien species introductions

Topic 3: The Danube River as invasive alien species corridor

Topic 4: Invasive alien species impact

Topic 5: Invasive alien species prevention and management

KEYNOTE PRESENTATIONS

Role of parasites in biological invasions

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The biological invasions are recognised as a major threat for biodiversity. However, their mechanisms are still poorly understood. Recent studies have focused on the role of parasites in the process of biological invasions. Several phenomena have been described during the last 15 years. These are: (1) 'Enemy Release', i.e. invaders dominate their local competitors because they have escaped from their enemies (including parasites and other pathogens) that used to control their abundance in the area of origin or because these pathogens in the area of introduction have lower impact on invaders than on competing local species; (2) 'Parasite Spillback', i.e. a non-indigenous species acts as a competent host for native parasites, thus contributing to the increase of infection rates and disease impacts on native host species; and (3) 'Parasite Spillover', i.e. invasive host bringing its specific parasites (also alien species) that can infect native populations susceptible to these pathogens. In the present report, these phenomena are illustrated on the basis of the current knowledge of the role of parasites in two relatively well-studied ongoing biological invasions in Europe: (1) the colonisation success of the American brine shrimp *Artemia franciscana* in hyperhaline wetlands in the Mediterranean Region and (2) the parasite-mediated interactions of the American pumpkinseed sunfish *Lepomis gibbosus* with native freshwater species across the continent. In conclusion, the present data suggest the importance of parasite-focused (or, more widely, pathogen-focused) studies of the process of biological invasions for better understanding of their mechanisms, as well as for the development of more efficient policy, prevention (or mitigation) plans and scientifically-sound risk assessment.

Key words: Biological invasions, parasites, enemy release, parasite spillover, parasite spillback.

Oceanisation of the Black Sea fish fauna

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The colonisation of the Black Sea by Mediterranean species (a process of Mediterranisation) started between 7–12 thousand years ago and continues to this day. Now, about 80% of the Black Sea fish fauna consists of species considered to be 'Mediterranean immigrants'. At least 10 Mediterranean fish species have spread their range from south to north in the Black Sea unaided in the last decades, e.g. the chestnut goby (*Chromogobius quadrivittatus*), the bamboo fish (*Sarpa salpa*), and the gilt-head bream (*Sparus aurata*). However, when analysing the 'Mediterranean immigrant' fauna we found many species related to the Boreal-Atlantic group. Among them are the seabass (*Dicentrarchus labrax*), the pipefish (*Syngnathus typhle*), and the Montague's blenny (*Coryphoblennius galerita*). A process, similar to the Mediterranisation, is known from the Baltic Sea, where massive introduction started about 10–15 thousand years ago. This still ongoing process has been termed as 'Oceanisation'. Therefore, we propose to use the term 'Oceanisation' instead of 'Mediterranisation'. The main factor, which has stimulated the Oceanisation process is the salinity intruding into the Black Sea over the last decades.

Key words: Range expansion, neobiota, geological history.

An international collaborative project documenting the parasites of *Dreissena* spp. mussels throughout Eurasia

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North American freshwater ecosystems have been ravaged by high densities of two invasive bivalve species from Eurasia, *Dreissena rostriformis bugensis* and *Dreissena polymorpha*. In addition, the fouling of infrastructures by these bivalves has had an economic impact in the billions of dollars. Unfortunately, there is currently no environmentally safe and economically feasible method of controlling them throughout infested waterbodies. In an attempt to develop such a control agent, a project is now underway examining parasites in Eurasian *Dreissena* populations. Several new parasites have already been discovered and will be evaluated for their virulence and host specificity. It is timely that this invasive species conference is being held in the Balkans since a very high priority of this project is to sample the parasites from *Dreissena* spp. endemic to the Balkans (e.g., *D. blanci*, *D. carinata*) and nearby Turkey (e.g., *D. caputlacus*, *D. anatolica*). These samples will be particularly valuable because North American dreissenid populations have not likely encountered the parasites from these latter four *Dreissena* spp., and thus infection may prove highly virulent to them. This project is an ambitious and challenging one and the collaborators participating in it will be highlighted in this presentation as their diverse expertise brings valuable contributions to it.

Key words: *Dreissena*, biological control, parasites.

Invasive alien plants with negative agricultural impacts in the EPPO region

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The European and Mediterranean Plant Protection Organization (EPPO) is an intergovernmental organisation responsible for cooperation in plant health between 52 member countries. Traditionally, EPPO has given priority to pests of cultivated plants (including insects, nematodes, fungi, bacteria, viruses), though in the early 2000s, EPPO started to work more specifically on invasive alien plants. The EPPO A1/A2 Lists of pests recommended for regulation as quarantine pests currently includes 29 invasive alien plant species. These include four A1 species (species currently absent from the EPPO region) and 25 A2 species (present locally in the EPPO region). The listing of A1 and A2 pests is based on technical justifications (i.e. Pest Risk Analysis) and follows a meticulous approval procedure. Using these 29 species as examples, this presentation will review the principal entry and spread pathways for invasive alien plants into the EPPO region. An analysis of the likelihood of establishment based on the species life forms will be presented. Examples will be given of the recent use of species distribution modelling to predict the current and future (based on climate change scenarios) establishment and regions most at risk from the species within the EPPO region. Invasive alien plants can have an array of negative impacts on the habitats they invade. Such impacts include negative impacts on biodiversity and related ecosystem services, infrastructure, agriculture and socio-economic impacts. An assessment of impacts for these species will be presented along with pest risk management measures that can act to prevent the introduction, establishment and spread of invasive alien plant species which have been recommend for regulation as quarantine pests in the EPPO region.

Key words: Pest risk analysis, risk management, non-native invasive plant, yield loss.

ESENIAS and DIAS activities towards protection of threatened species, ecosystems and areas of conservation concern against invasive alien species

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According to a recent report of the Institute of Environmental Protection and IUCN SSC Invasive Species Specialist Group, invasive alien species (IAS) are the 3rd most severe threat to European threatened (red listed) species, after dams and water management, and agricultural forestry effluents. One out of five threatened species in Europe is directly affected by IAS. The IAS Regulation (EU) No 1143/2014 explicitly focuses and requires the assessment of IAS impact on threatened species, as well as on species protected under Birds and Habitats Directives, red listed and protected habitats and sites. Here, we present the ESENIAS and DIAS activities towards protection of threatened species, ecosystems and areas of conservation concern against IAS.

The East and South European Network for Invasive Alien Species (ESENIAS) has been active since 2011. Currently, the network has 15 member countries and one invited country (Georgia). In the implementation of the aims of ESENIAS several joint research projects have been undertaken in the region. Within the ESENIAS-TOOLS project, a special case study focused on Assessment of the impact on alien species on the biodiversity and endemism on ancient Balkan lakes, on the example of Lake Ohrid, known as a hotspot of biodiversity and endemism, harbouring unique flora and fauna. Furthermore, a new project has just launched entitled 'Invasive and alien species a real threat for the ancient Lake Ohrid' funded by UNESCO. This project aims at evaluation of the actual state of IAS in Lake Ohrid and its watershed and development of appropriate management measures.

The Danube Region Invasive Alien Species Network (DIAS) was established in 2014 and includes member countries from the Upper, Middle and Lower Danube River basin, as well as adjacent Black Sea region. In the implementation of its mission, DIAS also carries out a number of activities towards IAS protection of the numerous threatened species and Natura 2000 sites along the Danube River. Within the Joint Danube Survey 4 (2019) an individual IAS programme has been designed and implemented at country levels. Some preliminary results under the project 'Study and assessment of ecological state of the Bulgarian sector of the Danube River within the frame of the JDS4 in 2019' for Bulgaria will be presented.

Some of the most recent activities in the two regions focus on awareness raising and involvement of citizen science in solving IAS issues, undertaken under the COST Action CA 17122 'Increasing understanding of alien species (AS) through citizen science' (Alien CSI) and related initiatives at national level**.**

Key words: IAS regional networks, East and South Europe, Danube Region, threatened and protected species and habitats, project activities.

Acknowledgements: We acknowledge the financial support of the National Science Fund of Bulgaria under the projects No KP-06-COST-13 and KP-06-COST-14.

Distribution of invasive alien species of Union concern (EU Regulation 1143/2014) across Europe with emphasis in the ESENIAS region

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Invasive Alien Species (IAS) constitute one of the most important threats to biodiversity, causing severe ecological and socio-economic impacts. Under the EU Regulation 1143/2014 on IAS, European Member States must prevent the introduction and spread of IAS of Union concern, enforce effective early detection and rapid eradication mechanisms on new introductions, and adopt management measures for species already widely spread. Thus, detailed and up to date spatial information on the IAS of Union concern across Europe is crucial for the implementation of the IAS Regulation. In the current work, the geographical distribution of the Union concern IAS (49 taxa) across Europe with emphasis on the ESENIAS region is provided by the European Alien Species Information Network (EASIN), resulting from an assessment of data aggregated from a network of data sources. In addition, we analysed the species' traits, concluding that most of them have been primarily settled in Europe through escapes linked to introductions for ornamental purposes, botanical gardens, zoos and aquarium trade before the 1950's. Within the ESENIAS region, the higher number of species has been introduced and spread in Italy (33 taxa), Hungary (23), and Romania (16), while the least introductions took place/happened in Montenegro (3 taxa), Albania (4), and North Macedonia (4). Several species are already rather widespread across the ESENIAS region (e.g. *Pseudorasbora parva, Trachemys scripta, Impatiens glandulifera*, *Asclepias syriaca*). However, the majority of the species has been rarely found (e.g. *Eichhornia crassipes*) or is still absent (e.g. *Microstegium vimineum, Heracleum persicum, Lysichiton americanus*). Still, the latter needs to be considered with caution due to large information gaps on the spatial information for several countries and IAS, which can be filled by means of increased monitoring efforts, and with the contribution of citizens to IAS reporting. It is expected that the smartphone application 'Invasive Alien Species Europe', which allows citizens to report the presence of the 49 species listed as IAS of Union concern, will contribute to the monitoring of IAS of Union concern across Europe.

Key words: Invasive alien species, EU Regulation, Union concern, citizen science, smart app.

PRESENTATIONS

TOPIC 1: INVASIVE ALIEN SPECIES TRAITS AND TRENDS

Invasive alien species introduction and spread, biological and ecological traits; characteristics of recipient environment; invasive alien species and climate change

Distribution of the invasive amphipod species *Pontogammarus robustoides* (Sars, 1894) in the inland waters of Turkey

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Thirteen Ponto-Caspian amphipod species belonging to seven genera have been recorded from Turkey. One of them is *Pontogammarus robustoides*, which is known as an invasive Ponto-Caspian species in several European countries. The native distribution area of this species covers brackish and freshwater lakes around the Black Sea, including the rivers Volga, Don, Dnieper, Dniester, and the Danube. The presence of *P. robustoides* in Turkey was reported for the first time in 1964 from lakes Apolyont, Iznik, Sapanca, and Manyas. During the last 55 years, the species has been recorded from 12 different lakes and dam lakes located in the Marmara, Aegean and Thrace regions of Turkey.

In this study, materials collected during different study periods were examined and *P. robustoides* was detected from eight new localities: lakes Akgöl and Poyrazlar, dam lakes Demirköprü, Çayboğazı and Gördes, and rivers Çekerek, Kocaçay and Bakırçay. *Pontogammarus robustoides* was also recorded in Lake Sapanca, from where it has been previously reported in 1964. In addition, in this study *P. robustoides* is reported for the first time from the Central Anatolia and Mediterranean regions of Turkey.

Several authors have reported that *P. robustoides* has expanded its local distribution area over the past three years using the river systems. Our results also indicated that *P. robustoides* has invaded many freshwater systems in Turkey. However, this species has not yet been reported from eastern and southeastern regions of Turkey; therefore, detailed studies on the pathways of introduction and spread of the species and its population control are needed.

Key words: Invasive amphipod, *Pontogammarus robustoides*, Turkey.

Acknowledgements: This study was supported by the Eskişehir Osmangazi University Scientific Research Projects Committee (Project numbers: 201319A106, 201319D21 and 201619A224) and TUBITAK project 117Y347.

Updated list of host plants of tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Is there any threat to biodiversity?

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The tomato leafminer *Tuta absoluta* (Lepidoptera: Gelechiidae) is one of the worst invader affecting vegetable crops. As its name describes, this pest initially fed only on tomato, but since the species started to spread into new territories, new hosts have been reported. Most probably, as in the case of other invasive species, the tomato leafminer has expanded its geographic range in a short-term response to climate change. These changes have also affected the species feeding habits and biology and ecology features.

Our work summarised the available data, listing all types of host plants of the tomato leafminer mentioned to date, and classifying them by: continent; role – primary, alternative, wild; environmental significance; type – plant, diet or commodity, etc. Some of the sources used focused on the morphologic characteristics and biochemical composition of the host plant species. In the preliminary study, out of the 39 host plant species reported at a worldwide scale, 22 have also been present in Romania, many of them as wild plants. Updated knowledge about the potential host range of a threatening pest is mandatory for the Plant Health key actors, such as: decision-makers, inspection bodies, and agribusiness associations, to better organise the national inspections and surveys and to provide accurate information about cultural control recommendations to farmers.

Key words: *Tuta absoluta*, host plants, wild plants, biodiversity.

Acknowledgements: This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI-UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0301/ 28PCCDI, within PNCDI III.

Parasite community of the invasive Chinese sleeper (*Perccottus glenii*) in the western Ukraine

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The Chinese sleeper (*Perccottus glenii* Dybowski, 1877) is one of the most successful alien species in Europe. This is an Asian invasive fish species, which was first registered in Ukraine in the city of Lviv in 1980. In 2018–2019, during a study of the fish fauna around Lviv (western Ukraine), 72 specimens of *P. glenii* were caught and analysed for parasites. The fish were studied at four localities in the basins of the Dniester and Bug rivers. In total, six taxa of parasites were registered, among them: one species of ciliates, one cestode, one acanthocephalan, one bivalvia, one parasitic copepode, and one monogenean. The cestode *Nippotaenia perccotti* and monogenean *Gyrodactylus perccotti* were the most widespread parasites in the studied territory.

Key words: Invasive fish, *Nippotaenia perccotti, Gyrodactylus perccotti,* Dniester River basin, Bug River basin, Lviv.

Age and growth of native and translocated populations of the marine fish *Atherina boyeri* Risso, 1810, in Turkey

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The sand smelt, *Atherina boyeri*, is a short-lived euryhaline fish, inhabiting mainly coastal and estuarine waters. It has also been illegally translocated into inland freshwater lakes and reservoirs for fisheries purposes in Turkey and has become an invader in fresh waters. The aim of this study was to evaluate the adaptation potential of the sand smelt through comparing the growth performance of translocated inland water populations with natural marine populations. The sand smelt samples of marine populations were obtained from the Mediterranean and Black Sea, Sea of Marmara, Aegean Sea, and Lake Köyceğiz lagoon. The samples of translocated inland populations were obtained from two reservoirs: Aslantaş and Hirfanlı Dam, and from two freshwater lakes: Eğirdir and İznik.

The total length and the body weight of the studied specimens ranged between 21–143 mm and 0.04–19.52 g, respectively, in the sea populations; 28–97 mm and 0.12–6.60 g, respectively, in the lagoon; and 24–116 mm and 0.08–10.94 g, respectively, in the inland populations. The *b* value estimated from the length–weight relationships was not significantly different between the sea and inland populations. A positive allometric growth pattern was observed in the inland water and lagoon populations. The *k* values of the von Bertalanffy equation ranged between 0.16–0.55 in the sea populations; 0.23–0.49 in the inland populations; and 0.29 in the lagoon population. The mean value of condition factor ranged between 0.25–0.85 in the marine populations; 0.31–1.02 in the lagoon; and 0.21–0.97 in the inland populations. The results suggested that the sand smelt exhibit similar growth performance in the marine and inland waters studied. Despite the fact that the sand smelt is an euryhaline fish, the inland fresh waters are not natural habitats of this fish. Since adaptation to quite varying salinities requires extra energetic cost, the growth in freshwater populations may be expected to decrease. Yet, the similar growth performance of the sand smelt populations among sea, brackish and freshwater environments suggested that this species is successful in adaptation to various environmental conditions, which favours its invasion potential.

Key words: Sand smelt, invasive fish, inland populations, age, condition.

Acknowledgements: This study was funded by the Scientific and Technological Research Council of Turkey (TÜBİTAK) with Project Number: TOVAG-114O809.

Spatial and temporal characterisation of alien and native fish assemblages in the Manavgat River Estuary (Antalya, Turkey)

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Seasonal changes in abundance, species composition, and life-style categories of the fish assemblage in a shallow Mediterranean estuary of Anatolia are described. Fish were sampled seasonally by different nets in the Manavgat River Estuary from November 2014 and June 2017. Water quality parameters were measured at each survey site at the start of each field sampling. Relation to environmental parameters were studied using Canonical correspondence analysis.

A total of 7804 individuals of 33 species were captured. The alien and native fish belonged to 16 families. *Liza aurata*, *Liza saliens*, *Alburnus baliki*, and *Mugil cephalus* were the dominant species and comprised over 75% of the total number. The fish fauna included 23 marine, eight freshwater, one migrant, and one brackish species.

Regarding the alien fish species, 382 individuals, belonging to the following 10 species were caught: *Carassius gibelio*, *Gambusia holbrooki*, *Liza carinata*, *Oncorhynchus mykiss*, *Pseudorasbora parva*, *Siganus rivulatus*, *Sillago suezensis*, *Sphyraena chrysotaenia*, *Upeneus moluccensis*, and *Upeneus pori*. Four of the alien species were freshwater (*C. gibelio*, *G. holbrooki*, *O. mykiss*, and *P. parva*), while six were Red Sea immigrant fish (*L. carinata*, *S. rivulatus*, *S. suezensis*, *S. chrysotaenia*, *U. moluccensis*, and *U. pori*). *Oncorhynchus mykiss* had the highest population abundance (37.4%) among all alien species. The indexes of species richness, Shannon-wiener diversity, and evenness showed a consistent seasonal pattern.

Key words: Fish assemblages, functional guilds, alien fish, endemic fish, endangered fish.

Acknowledgements: This research was financially supported by the TÜBİTAK (Scientific and Technological Research Council of Turkey) under the Project numbered KBAG, 114 Z 259.

Diversity and distribution of alien and native fish species in the Göksu River Estuary (Mersin, Turkey) in relation to some water quality parameters

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Seasonal changes in abundance, species composition, and life-style categories of the fish assemblage in a shallow Mediterranean estuary of Anatolia are described. Fish were sampled seasonally by different nets in the Göksu River Estuary from November 2014 and June 2017. Water quality parameters were measured at each survey site at the start of each field sampling. Relation to environmental parameters were studied using Canonical correspondence analysis.

In total, 5005 individuals from 32 species were captured. The alien and native fish belonged to 16 families. *Liza aurata*, *Liza saliens* and *Mugil cephalus* were the dominant species and comprised over 70% of the total number. The fish fauna included 21 marine, seven freshwater, two migrant, and two brackish species.

Regarding the alien fish species, 214 individuals belonging to five species (*Carassius gibelio*, *Gambusia holbrooki*, *Liza carinata*, *Oreochromis niloticus*, and *Sillago suezensis*) and five families (Cyprinidae, Poeciliidae, Mugilidae, Cichlidae, and Sillaginidae) were caught. Of them, three species (*C. gibelio*, *G. holbrooki*, and *O. niloticus*) were freshwater, and two species (*L. carinata* and *S. suezensis*) were Red Sea immigrant fish. *Gambusia holbrooki* had the highest population abundance (77.6%) among the alien species. The indexes of species richness, Shannon-wiener diversity, and evenness showed a consistent seasonal pattern.

Key words: Alien fish, endemic fish, endangered fish, fish assemblages, functional guilds.

Acknowledgements: This research was financially supported by the TÜBİTAK (Scientific and Technological Research Council of Turkey) under the Project numbered KBAG, 114 Z 259.

New data on the invasive species *Sinanodonta woodiana* (Lea, 1834) (Bivalvia, Unionidae) on the territory of the Republic of Moldova

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Investigation of freshwater invasive species, particularly of those with high rate of invasive succes is of particular importantce for reducing the impact on native species. The aims of our study were to assess the current distribution and pathways and vectors of introduction of the invasive bivalve species *Sinanodonta woodiana* in the Republic of Moldova. The specimens of *S. woodiana* were collected from the six sampling points of the Lower Prut River basin of Moldova: Leova, Goteşti, Cahul, Lake Manta, Lake Beleu, and Cîşliţa-Prut. This area belongs to the Wetland Danube River Area of an international importance. All specimens were collected in the riverbed only in places with little or no current, in backwaters, and in lakes with clay soft sediment.

In Moldova, despite the introduction of herbivorous fish directly from Eastern Asia in the Dniester River basin and Prut River basin, including Costeşti-Stînca Reservoir in the Middle section of the Prut River, a stable population of *S. woodiana* was formed only in the Lower Prut River basin. Different factors, such as: hydrological regime – water intrusion of the Danube River, hydromorphological conditions – shallow lakes with silty-clay substrate and increase in the water temperatures up to 32°C, and fish hosting of the parasitising mussel larvae (glochidia) from the Danube Delta, have most probably contributed to the formation of a stable population of *S. woodiana* in the Prut River. We also report another possible vector of introduction of *S. woodiana* – via Mysidae. In our samples from the Cîşliţa-Prut, we found *Limnomysis benedeni* with attached glochidia of *S. woodiana*.

Key words: *Sinanodonta woodiana,* Moldova, distribution, pathways of introduction.

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Distribution of the invasive alien species *Ailanthus altissima* (Mill.) Swingle in the Bregalnica Region, North Macedonia

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The invasive alien woody species *Ailanthus altissima* (Mill.) Swingle (tree of heaven) was investigated in the Bregalnica Region, Republic of North Macedonia, on an area of about 4,666 km^2. Most of the research activities were conducted during the period 2016–2018. GPS coordinates were taken at all recorded localities of the species. Basic bio-ecological features of the highest individual trees were noted, and core samples for determining the age were collected for detailed analysis. All collected data were entered in an attribute database to be displayed on a map using QGIS software for the current distribution of the species in this region.

Our findings showed that there were single trees, groups and populations of *A. altissima* with different growth and distribution features, due to the diversity of the environmental conditions. This invasive species was found in urban and peri-urban areas, colonising disturbed spaces along main roads, and invading abandoned arable land. The species has been introduced deliberately as an ornamental tree or for erosion control, or planted by mistake by local population instead of other species (walnut).

Ailanthus altissima in the Bregalnica Region occupied SE to SW exposures at sites with an altitude of about 250 m to almost 1,000 m a.s.l., represented widely in the central part of the investigated area. The species was not dependent on the geology, nor pedology of the sites, and thrived on 13 soil types in the region. Concerning the climate characteristics, *A. altissima* was observed in three climate zones: continental-sub-Mediterranean area (up to 600 m a.s.l.), warm continental area (from 600 to 900 m a.s.l.), and cold continental area (from 900 to 1,100 m a.s.l.). The species was found in four forest communities: *Querco-Carpinetum orientalis macedonicum*, *Quercetum frainetto-cerris*, *Quercetum pedunculiflorae macedonicum*, and *Quercetum petraeae*. The extent of occurrence of the species was up to 1,100 m a.s.l., taking into account the current site conditions, climate zones, as well as tree's bio-ecological and environmental characteristics.

Key words: Invasive alien woody species, *Ailanthus altissima*, tree of heaven, distribution, Bregalnica Region.

Acknowledgements: This study is based on the Master's Thesis of Blagoj Nikolov entitled 'Distribution of the invasive woody species *Ailanthus altissima* (Mill.) Swingle in the Bregalnica Region', prepared under the mentorship of Asst. Prof. Dr.sc. Bojan Simovski, with the financial support by the Nature Conservation Programme in North Macedonia (a project of the Swiss Agency for Development and Cooperation SDC – Office in North Macedonia, coordinated by Helvetas Swiss Intercooperation, and Pharmachem in Skopje).

Morphoecological features of *Ailanthus altissima* (Mill.) Swingle in the Bregalnica Region, North Macedonia

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The Bregalnica Region in the Republic of North Macedonia is situated on an area of 4,666 km^2. The invasive alien woody species *Ailanthus altissima* (Mill.) Swingle (tree of heaven) is distributed mainly in the central part of this region. During the study conducted in the period 2016–2018, certain morphoecological characteristics of *A. altissima* were detected. GPS coordinates and bioecological features of the highest individual trees (diameter at breast height, height, diameter of the crown) from different locations were taken. Core samples for determining the age were analysed in the laboratory. Various site conditions in the investigated area were taken into account. The species occupied SE to SW exposures on 13 soil types, thrived in three climate zones, and was present in four forest communities.

Some specific characteristics of single trees, groups and populations of *A. altissima* in the Bregalnica Region were found. The lowest site where *A. altissima* grows subspontaneously was observed at 257.38 m a.s.l. near the village of Kadrifakovo, while the highest altitude was 999.97 m in the town of Pehchevo, where the species was introduced as an ornamental tree. The highest altitude where the species was recorded as subspontaneously growing alien was at 926.22 m a.s.l. near the town of Kochani in Osogovo Mountains, along the road to Ponikva Ski Centre. The highest individual of *A. altissima* was found in the Maleshevo part of the Bregalnica Region in the village of Pancharevo, with a height of 15 m. The oldest specimen was observed in Kochani – more than 85 years old tree, with the largest diameter at breast height of 86.5 cm, height of 14 m, and diameter of the crown of 15 m.

Two specific populations of *A. altissima* were of particular interest in this study. The first one was located near Kadrifakovo in Sveti Nikole area, within and nearby a culture of *Pinus nigra*. This population extended its area of occupancy 5.3 times for the period 2009–2016. The second population was located near the regional road to the town of Vinica and expanded 3.6 times its territory for the same period.

Key words: Invasive alien woody species, *Ailanthus altissima*, tree of heaven, morphoecological features, Bregalnica Region.

Acknowledgements: This study is based on the Master's Thesis of Blagoj Nikolov entitled 'Distribution of the invasive woody species *Ailanthus altissima* (Mill.) Swingle in the Bregalnica Region', prepared under the mentorship of Asst. Prof. Dr.sc. Bojan Simovski, with the financial support by the Nature Conservation Programme in North Macedonia (a project of the Swiss Agency for Development and Cooperation SDC – Office in North Macedonia, coordinated by Helvetas Swiss Intercooperation, and Pharmachem in Skopje).

General evaluation of the impact of invasive fish species on native freshwater fish fauna in Turkey

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Currently, about 380 fish species belonging to 16 orders and 32 families have been recorded in the inland waters of Turkey. Of them, 165 fish species (44.1%) are endemic. A total number of 30 inland fish species have been considered invasive and alien species. The invasive alien species have been introduced to the freshwater systems for varous purposes and through different pathways, such as aquaculture, biological control, pet trade, and fisheries. Some of the invasive alien species, such as *Pseudorasbora parva* and *Carassius gibelio*, have become dominant and have negatively affected the native fish populations. Three freshwater fish species, which are endemic in Turkey, are considered extinct according to the IUCN Red List 2019. The endemic fish species, *Alburnus akili*, *Pseudophoxinus handlirschi,* and *Alburnus nicaeensis*, which inhabited lakes Beyşehir, Eğirdir and İznik, respectively, have become extinct after the introduction of the invasive species, such as *Sander lucioperca* and *Atherina boyeri*.

Key words: Native freshwater fish, endemic fish, invasive fish, Turkey.

Variations in the population parameters of invasive Rapa whelk stocks since three decades in the Black Sea, Turkey

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The Rapa whelk, *Rapana venosa*, is still the most important invasive alien species in the Black Sea. Because of no major predators in the basin, the impact of the Rapa whelk on the ecosystem has continued. At the same time, this species has created new economic incomes for the small scale fishery in the region. According to our observations and surveys, the population structure of the Rapa whelk has shown a wide range of variations in the abundance, growth, sex composition, and landings, due to a lack of prey, fishing strategies and the effect of climatic changes on the ecosystem. In this presentation, we aimed to give some brief information about the variations in the population parameters during the last three decades, mainly based on our surveys. For this propose, some comparative analyses were made, related to the Rapa whelk growth, size frequency distribution, average size, abundance, sex ratio, and landings.

Key words: *Rapana venosa*, abundance, growth, sex composition, population parameters, Black Sea.

New data on the distribution of some alien insect species in Bulgaria

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More than 290 insect species with alien origin have been reported in Bulgaria until 2019 and this number continues to increase. Of them, only 142 species have been confirmed as established. The occurrence in the field of the rest of reported species is still uncertain. Most of them are present only in containment facilities as pests on stored products or in greenhouses. Some of them are household pests. In addition, there are only single reports for detection of some alien species in Bulgaria.

During the period 2016–2019, more than 30 sites in urban areas and their surroundings covered by natural vegetation and ornamental plants were surveyed to assess the distribution of alien insect species, which establishment has been still not confirmed in Bulgaria. Here, we present new data on the current distribution of the following species in Bulgaria: *Acizzia jamatonica*, *Cacopsylla pulchella*, *Cydalima perspectalis*, *Dasineura gleditchiae*, *Halyomorpha halys*, *Metcalfa pruinosa*, *Nezara viridula*, *Neodryinus typhlocybae*, *Obolodiplosis robiniae*, *Parectopa robiniella*, *Phyllonorycter robiniella*, *Platygaster robiniae*, and *Prociphilus fraxinifolii*. The results suggested that the recently detected species: *C. perspectalis*, *M. pruinosa, N. typhlocybae*, and *H. halys* have been still in the expansion phase of their invasion process in Bulgaria.

Key words: Alien insect species, pests, distribution.

Acknowledgements: The study was conducted within the projects: 'East and South European Network for Invasive Alien Species – A tool to support the management of alien species in Bulgaria' (ESENIAS–TOOLS), funded by the Financial Mechanism of the European Economic Area (2009–2014) under the Programme BG03 'Biodiversity and Ecosystem Services' and B-1016 'Early detection of alien insect species in Bulgaria' funded by the Scientific Sector of the University of Forestry.

Alien parasites on an alien host species: the monogeneans *Ligictaluridus pricei* and *Gyrodactylus nebulosus* from *Ameiurus melas* in the Srebarna Biosphere Reserve, Bulgaria

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Fish species of the genus *Ameiurus* (Siluriformes: Ictaluridae) have been known to occur in Europe as early as the 19th century. The black bullhead *Ameiurus melas*, with a native range in the Nearctic Region, has been rapidly spreading across Europe during the last hundred years. Recently, it has been reported from Bulgarian water bodies along the lower stretch of the Danube River. In its invasive range in Europe, it is known to carry its specific monogenean parasitic fauna originating from North America.

In 2017–2019, we examined for helminth parasites 32 individuals of *A. melas* originating from Srebarna Lake, an oxbow lake in the floodplain of the Danube River. We recorded two species of monogeneans, which were identified on the basis of morphological characters and DNA sequences (ITS1–5.8S RNA–ITS2 and 18S RNA). *Ligictaluridus pricei* (= *Cleidodiscus pricei*) (family Ancyrocephalidae) was recorded from gills (prevalence 100%). This alien species has previously been reported from several countries in Central and East Europe and in Italy. *Gyrodactylus nebulosus* (family Gyrodactylidae) was found on skin and fins (prevalence 72%). This is the first report of *G. nebulosus* from Europe as well as the first host record from *A. melas*. In its native range in North America, *G. nebulosus* is known from the brown bullhead *Ameiurus nebulosus*, which is a sister species of *A. melas* and has also been introduced to Europe. Further studies are needed to assess the potential of these two monogenean parasites to infect native fish species in order to understand their impact on the local biodiversity.

Key words: *Ligictaluridus pricei*, *Gyrodactylus nebulosus*, Monogenea, *Ameiurus melas*, Srebarna Biosphere Reserve, Danube River.

Invasive alien species inhabitants of the Black Sea Coast of Georgia

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The invasion process in the Black Sea began about 200 years ago and has continued up to now. Alien species have been successfully established in new areas. Here we make a review of studies on some invasive alien species from the Black Sea Coast of Georgia.

The following invasive alien species have been reported from the Black Sea Coast of Georgia: *Rapana venosa*, *Anadara kagoshimensis*, *Mnemiopsis leidyi*, *Beroe ovata*, *Balanus improvisus*, and *Mercierella enigmatica*.

According to the literature data, *R. venosa* was first recorded in the Black Sea in Georgia at Gudauta, during sampling of oysters; six individuals of this mollusc were found in July 1949. In November the same year, over 70 individuals of *R. venosa* were caught by trawl during research expedition with the ship 'Vorobiev' in the region of New Athens. Before 1949, the stock of oysters comprised 18 x 10^6 ind./ 50 m^3, while after the appearance of *R. venosa* the quantity of oysters started to decrease sharply as a result of its predation. The shell size–weight peculiarities and distribution of *R. venosa* has been studied. Interdependence of size and weight of Rapana depended on ecological conditions, including food availability. The collected data showed the picture of *R. venosa* distribution at different depths. Maximal quantity (20–25 ind.) was recorded at depths of 6–15 m. Correlation between different size groups was different.

In 1978–1979, the bivalve mollusc *A. kagoshimensis* was found in the benthos samples in the Chorokhi River mouth, at the isobaths 5–20. At first, individuals with sizes of 1–2.5 cm were recorded, while afterwards, 6–8 cm sized forms. These bivalves were especially abundant at Anaklia, where mussel collectors were installed. Currently, this self-penetrated filtrator mussel has been widely distributed in our region.

In 1929, the polychaeta *Mercierella enigmatica* was found in the brackish lake Paleostomi near Poti. Since 1976, this species has been recorded in the Black Sea. It was found at Poti, Grigoleti, Ochamchire, and Gudauta.

Key words: Invasive alien marine species, *Rapana venosa, Anadara kagoshimensis*, *Mercierella enigmatica*, Black Sea, Georgia.

Biological traits of invasive silver Prussian carp (*Carassius gibelio* Bloch, 1782) in Lake Çıldır, North-Eastern Anatolia, Turkey

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The invasive alien silver Prussian carp *Carassius gibelio* is highly adaptive species that is known to compete for food with native species in every aquatic environment. This species was introduced into Lake Çıldır, North-Eastern Anatolia, Turkey, at the beginning of the 2000s. The fish developed a dynamic stock in a very short period of time after it was established in the lake, and in 2005–2006 reached commercial size. In this study, we examined some biological traits of *C. gibelio* population in Lake Çıldır ecosystem.

The field studies were conducted within one week surveys, in five different periods each: June 2011, September 2011, June 2012, November 2012, and April 2013. A total of 379 of the samples were used for biometric measurements. Basic biometric measurements, scale fixation/ making preparation for age estimation, gender determination, and macroscopic diagnosis of gonad development stages were carried out. Some of the most important indicators for the catch size of *C. gibelio* in Lake Çıldır are the biometric characteristics of the population.

The total length, body weight and age of the population were found to be within the ranges of 8.7–33.5 cm, 9.0–674.2 g, and 1–8 years/age, respectively. The population showed bimodal distribution. This distribution is a typical indication that there was no intensive fishing pressure on the population. Those modes were composed of young individuals, which have not yet reached sexual maturity (8–15 cm length group), and adult individuals at a length of 16–33 cm. Both modes had statistically normal distribution. The oldest age determined during the study was compatible with the period (year) in which the population entered a dynamic process and yielded its first catch. The first sexual maturity was determined at the end of the 2nd year and the beginning of the 3rd year of age. The male/female ratio (1:7) of the population was found in favour of the females to a great extent. These results suggest that the population may have ginogenetic characteristics and may suppress the native carp population in the lake.

Key words: Çıldır Lake, *Carassius gibelio,* population parameters.

TOPIC 2: VECTORS AND PATHWAYS FOR INVASIVE ALIEN SPECIES INTRODUCTIONS

Analysis, prioritisation, action plans

Analysis of pathways of introduction and spread of invasive alien species of European Union concern in Bulgaria

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Understanding the pathways by which organisms are moved internationally, as well as implementation of enhanced pathway management measures, are key approaches for reducing or eliminating the risks of introduction of invasive alien species (IAS). The need to identify and manage IAS pathways is explicitly addressed in CBD Guiding Principles. The analysis and prioritisation of pathways and development of action plans on priority pathways of species of European Union (EU) concern are required by the IAS Regulation (EU) 1143/2014. Currently, 49 IAS are considered of EU concern, and 14 of them are already present in Bulgaria. In the implementation of the IAS Regulation, we made an assessment and prioritisation of potential pathways of IAS of EU concern for the territory of Bulgaria. The prioritisation was carried out in two stages: (1) An analysis of pathways using the standard categorisation of pathways presented in UNEP/CBD/SBSTTA/18/9/Add.1 and UNEP/CBD/SBSTTA/20/INF/5; and (2) Prioritisation of identified pathways according to the criteria proposed in UNEP/CBD/COP/12/INF/10.

Our results showed that some of the main priority pathways for management measures in Bulgaria were: escape from confinement, unaided natural dispersal and transport – stowaway. Some of the species already present in Bulgaria have escaped from confinement after their intentional import for different purposes, e.g. ornamentals (*Asclepias syriaca, Impatiens glandulifera*), fur farms (*Myocastor coypus*), and hunting (*Ondatra zibethicus*). Other species entered Bulgaria through the Danube River (*Asclepias syriaca*, *Eriocheir sinensis, Orconectes limosus,* and *Perccottus glenii*). Most probably *Elodea nuttallii* has been introduced by birds, while *Heracleum mantegazzianum* and *Pseudorasbora parva* as contaminants. *Trachemys scripta* has been released deliberately into the wild by owners who no longer wished to care for their pets. After the introduction and establishment in nature, most of the species have spread by natural dispersal in Bulgaria.

Some of the species can enter Bulgaria by several pathways and the probability of their introduction depends on the pathway used. We assessed the introduction in the wild by escape from confinement of species found in zoos and parks as *Nasua nasua* and *Procyon lotor* as likely, while the introduction of *Procambarus* sp., *Sciurus carolinensis*, *Callosciurus erythraeus*, *Herpestes javanicus* and *Vespa velutina nigrithorax* as moderately likely. The highest number of pathways for unintentional introduction can be used by *V. v. nigrithorax*.

Key words: Invasive alien species of EU concern, pathways of introduction and spread, prioritisation.

Acknowledgements: This study was funded by the Financial Mechanism of the European Economic Area 2009–2014, Programme BG03 Biodiversity and Ecosystem Services, under the ESENIAS-TOOLS project, D-33-51/30.06.2015, and in the framework of the National Science Programme 'Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters', approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science of Bulgaria (Agreement № DO-230/06-12-2018).

Topic 3: The Danube River as invasive alien species corridor

Priority species for the Danube Region, impact on threatened species, specificity of biological invasions in the Lower, Middle and Upper Danube River sections

Temporal and body size-dependent variation in the diet composition of the round goby *Neogobius melanostomus* (Pallas, 1814) in the Lower Danube River tributaries, Bulgaria

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The Ponto-Caspian round goby (*Neogobius melanostomus*) has recently invaded new sections of tributaries of the Lower Danube River. Analysis of the diet of invasive species contributes to understanding of their success and potential effects on the ecosystems. The aim of this work was to characterise the diet of *N. melanostomus* in the newly invaded ecosystems in the Lower Danube River tributaries, Bulgaria. Three Danube tributaries (the rivers Iskar, Vit, and Yantra) were sampled monthly from May 2017 to April 2018, and the stomach content of 350 round gobies, ranging from 19.5 to 100 mm standard length (SL), was investigated. According to the diet, four size classes of *N. melanostomus* were distinguished: < 30 mm (L1), 31–50 mm (L2), 51–65 mm (L3), and > 65 mm (L4), as well as three periods: October–March (S1), April and May (S2) and June–September (S3). The index of food importance (IFI) and selectivity index were calculated and feeding strategies were analysed. The length and temporal variability in the diet were analysed using the Bray–Curtis (BC) similarity index. The feeding preferences were assessed using the index of food importance (IFI), while the feeding strategies were analysed using the pray specific abundance and frequency of occurrence of the pray.

There were no significant differences between sites in respect of the diet of *N. melanostomus*, which included insects, crustaceans, Hydrachnidae, molluscs and Bryozoa. The IFI of Chironomidae was the highest (up to 76%) in size classes L1 and L2, while this index was ≥ 9% in L3 and L4 individuals. *Hydropsyche* spp. larvae had the highest IFI (20–40 %) in L3 and L4 individuals. Specialisation feeding towards pray taxa as *Asellus aquaticus*, Odonata nymphs, and *Siphlonurus* spp. was common during the S1 and S3 periods. Generalisation was prominent, especially during the S2 period. There was no particular prey with high dominance in the diet. Specialisation towards prey taxa as *Asellus aquaticus*, Odonata nymphs, and *Siphlonurus* spp. was common during the S1 and S3 periods. *Corbicula fluminea* was important only for L4 individuals in the Iskar River and for L2 individuals in the Vit River (IFI 20–30%), both during the S1 and S3 periods. *Neogobius melanostomus* exhibited a preference only towards some larvae of Chironomidae, Psychomyiidae g. sp., and L4 individuals – towards *C. fluminea*. Temporal and size dependant variation in the diet and utilisation of non-insect prey by the larger gobies contributes to a low interspecific competition and high population stability.

Key words: Round goby, diet, feeding strategy, invasive front, temporal variation, Danube River tributaries.

Topic 4: Invasive alien species impact

Impact on biodiversity and ecosystem services, impact on human health, safety and the economy; pests and pathogens; adverse impact on protected areas, endangered species and habitats

The impact of *Pseudorasbora parva* (Risso, 1810) on the fish fauna of Lake Mogan (Ankara, Turkey)

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The topmouth gudgeon *Pseudorasbora parva* is a species found naturally in Central Asia (Amur River Basin, Japan, China, and Taiwan), while it is an invasive species that was accidentally introduced in Europe during the transportation of Chinese cultured fish. This species was first recorded in Europe in 1962 in the Danube River, and then, has spread quickly across the European fresh waters. The topmouth gudgeon was first recorded in Turkey in the Meriç River in 1982, and since then has spread in many freshwater systems in Turkey. Our aim was to assess the impact of *P. parva* on the fish fauna of Lake Mogan.

Lake Mogan is an alluvial embarkment freshwater lake, which is fed by the water of approximately 16 streams, located within the borders of Ankara. It is one of the RAMSAR sites in Turkey. The lake has a great diversity of flora and fauna. Before introduciton of *P. parva* in Lake Mogan, the fish fauna in the lake consisted of common carp (*Cyprinus carpio*), tench (*Tinca tinca*), northern pike (*Esox lucius*), wels catfish (*Silurus glanis*), Caucasian bleak (*Alburnus escherichii*), goldfish (*Carassius auratus*), and common bleak (*Alburnus alburnus*).

In the period between July 2013 – June 2014, the following fish species were recorded in the lake: common carp, tench, northern pike, wels catfish, Caucasian bleak, goldfish, common bleak, big-scale sand smelt (*Atherina boyerii*), and the topmouth gudgeon. At present, the fish fauna has been dominated by the common carp, tench, and topmouth gudgeon, and less frequently by the big-scale sand smelt. In such a short period (about 5 years), the changes in fish species composition in the lake have been very rapid. We assume that one of the reasons may be the impact of the topmouth gudgeon on native fish species in the lake. The topmouth gudgeon is dispersing easily, and is characterised by rapid adaptation and sexual maturity, as well as high fecundity. The species feeds on native fish species eggs, thus, probably causing the decreasing or vanishing of native fish species. Therefore, a management procedure for eradicating the topmouth gudgeon in the lake has been recommended and planned to be developed in the future.

Key words: *Pseudorasbora parva,* invasive species*,* Lake Mogan, fish diversity.

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Determination of the amount of allergic pollen in the atmosphere in Çanakkale, Turkey

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Pollen grains and fungal spores are the major allergens in the atmospheric aerosols. Their amount, especially of pollen, varies during seasons. In dry weather, pollen grains are the main components of the air. Once released from the anthers, grains can be dispersed by air masses far from their origin. During the evaluation of pollen-related symptoms of allergic patients, it is important to know the type of pollen in the environment. Periodic (seasonal) allergies are most common in spring and summer months. The aims of this aerobiological study were to determine the pollen types and the amount and concentration of the pollen from invasive alien species in Çanakkale Region during the spring and summer periods when the highest concentrations of allergenic pollens occur.

This study was conducted in the period April 2019 – August 2019. Pollen monitoring station was constructed at the gate of Çanakkale Central Public Park, which is located in the centre of the city. The airborne pollen sampling was performed by Durham-trap (Gravimetric-method). The pollen grains of the local flora and those brought by the air currents from a long-distance were identified, and the share of the invasive plants was calculated.

Our preliminary data suggested that the pollens of Pinaceae (73%), *Platanus* sp. (12%), Moracea (6%), Oleaceae (2%), and Poaceae (2%) were the most common in spring. The pollen of *Ailanthus altissima* (0.01%), an invasive species in Turkey, was determined in the samples. The results may be useful to predict the beginning of the seasonal pollen-allergies and to assess the impact of the invasive species as triggers of allergenic problems.

Key words: Pollen, invasive plants, allergy.

Occurrence of the invasive Eastern Mosquitofish (*Gambusia holbrooki* Girard, 1859) in four Mediterranean river estuaries of Turkey, nursery habitats for several native and threatened species

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River estuaries are among the most productive aquatic ecosystems and play an essential ecological role as nursery and feeding areas for many species. These ecosystems are particularly used by juvenile fish, because they possess peculiar favourable ecological characteristics, such as: large availability of food, refuges from potential predators and favourable environmental conditions, which ensure growth and survival of young specimens. Despite their worldwide recognised ecological importance, river estuaries are amongst the most modified and threatened aquatic environments. One of the most severe threats to aquatic ecosystems is the introduction of invasive alien species that can impact negatively native species and alter the long term viability of these important ecotones. The Eastern Mosquitofish (*Gambusia holbrooki*) has been widely introduced for mosquito larvae control but it is now assessed as one of the world's 100 worst invasive alien species according to the Global Invasive Species Programme, because of its high potential invasiveness, rapid population growth potential, and ability to tolerate a wide range of ecological conditions.

The aim of this study was to monitor the occurrence of *G. holbrooki* in four Mediterranean river estuaries of Turkey: Manavgat, Göksu, Seyhan, and Ceyhan, nursery habitats for several native and threatened species, in order to assess its potential threat to the juvenile fish. The monitoring of fish communities was carried out from 2014 to 2017. The results revealed the presence of *G. holbrooki* in all of the four estuaries, with juvenile and adult specimens. In addition to *G. holbrooki* and other alien species, juveniles of 22 different native species were found to occur. Some of these native species, such as the critically endangered *Anguilla anguilla* and the endemic goby *Pomatoschistus anatoliae*, are of particular conservation interest and worth of specific attention. The presence of *G. holbrooki* in these areas that can serve as recruitment areas for the populations of these sensitive native fish species can act as an additional threat to their survival and upset the ecological equilibrium of the river estuary ecotones.

Key words: Alien species, river estuaries, *Pomatoschistus anatoliae, Anguilla anguilla*.

Acknowledgements: This research was financially supported by the TÜBİTAK (Scientific and Technological Research Council of Turkey) under the Project numbered KBAG, 114 Z 259.

Overview of the arthropod pests of citrus tree fruits in Montenegro

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Citrus (*Citrus* spp.) trees are among the most important fruit crops in Montenegro. The c*itrus producing area is located* along a *coastal* plain with a length of 300 km. According to the number of trees, the satsuma mandarins (*Citrus unshiu*) are the most predominantly grown species.

Here we present a comprehensive *overview* of the arthropod pests associated with the *citrus* crops in Montenegro. The study is based on our previous experiences and field *surveys* carried out along the coastal area since 2002. The surveys included citrus orchards, nurseries and individual trees in backyards and gardens, which were inspected at least once per month from April to November each year.

The aphids, particularly the spirea aphid (*Aphis spiraecola*), citrus leaf miner (*Phyllocnistis citrella*), and citrus red mite (*Panonychus citri*), were recorded every year in the majority of the studied localities and considered as the most widespread and abundant. The citrus whitefly (*Dialeurodes citri*) was also found every year but in lower abundance in the eastern coastal area (area of Ulcinj). The Mediterranean fruit fly (*Ceratitis capitata*), considered as one of the key citrus pests, was spread along the whole coast, with a higher population level in the western coastal area (area of the Boka Kotor Bay). After the first detection in 2013, the orange spiny whitefly (*Aleurocanthus spiniferus*) showed fast spreading and has become widespread, abundant, and a serious threat to the citrus production. Until 2019, this species has established in the majority of the seacoast with the exception of Ulcinj area. The presence of the woolly whitefly (*Aleurothrixus floccosus*), citrus flatid planthopper (*Metcalfa pruinosa*) and pink citrus rust mite (*Aculops pelekassi*) was detected every year in certain localities. Sporadic presence was recorded for the following pests: dictyospermum scale (*Chrysomphalus dictyospermi*), citrus mealybug (Planococcus citri), cottony cushion scale (*Icerya purchasi*), olive scale (*Saissetia oleae*), brown soft scale (*Coccus hesperidum*), grey citrus scale (*Coccus pseudomagnoliarum*), citrus bud mite (*Aceria sheldoni*), broad mite (*Polyphagotarsonemus latus*), and the two-spotted spider mite (*Tetranychus urticae*).

Key words: Citrus trees, pests, Montenegro coastal area.

Topic 5: Invasive alien species prevention and management

Early detection and rapid eradication, surveillance systems; risk assessment and horizon scanning; control measures; restoration of damaged ecosystems; education, citizen science, strategies, policy and legislation

Useful tools for prioritising invasive species for national lists

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A proactive strategy aimed at mitigating the impacts produced by invasive alien species (IAS) requires to identify and stop potentially harmful species. This approach requires developing regional or national lists of potential IAS that could enter the target area and to prioritise those already established for management. The prioritising protocols are usually developed considering different stages of the invasion process, from the possibility of transport into the areas, to subsequent risks of introduction, establishment, spread, and the likelihood of impacts on biodiversity and human society. Here we review some useful tools for prioritising invasive species for national lists in Italy.

Species priority ranking is based on species attributes and some reference criteria, such as progressive levels of potential impact on biodiversity. Attributes according to criteria are generally evaluated through an expert-based process, a procedure that allows for a rapid screening of many species, but is influenced by the level of knowledge and full understanding of the scoring system by participants. Objective and more transparent methods are therefore needed to ensure robust and evidence-based scoring systems.

The first step in evaluating the harmfulness of a species is estimating its ability to adapt and spread in target areas. Species distribution models (SDMs) have been increasingly used to predict geographic areas at risk of invasion, because they allow the evaluation of climatic matching between donor and recipient areas, a strong determinant of establishment probability. SDMs were used in Italy during a scoring assessment aimed at producing a tentative list of invasive species of national concern in accordance to the European Regulation 1143/2014.

In the last years, two scoring systems have been developed with the aim to evaluate in a more objective way the impacts of alien species on biodiversity (Environmental Impact Classification of Alien Taxa – EICAT) and socio-economic impacts (Socio-Economic Impact Classification of Alien Taxa – SEICAT). A wider application of SDMs models to predict risk of invasions and EICAT and SEICAT procedure to evaluate the impacts produced by alien taxa, could greatly improve our ability to prioritise alien species according to their possibility to enter target areas and the level of their potential negative impacts.

Key words: Prevention, prioritisation, scoring systems, species distribution models, species impacts.

Acknowledgements: I am grateful to all the people involved in the development of prioritisation lists and application of the scoring systems.

Invasive alien arthropods from Romania: First DNA barcodes

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The DNA barcoding revolutionises biodiversity research and taxonomical studies by its speed, accuracy and reliability in species identification. Recently, new tools have been developed in the areas of food traceability, food authenticity and food security. In the last decade, the DNA barcoding has been widely used by plant protectionists. Morphological identification is a challenge for people without a strong background in taxonomy. Molecular methods as a tool to identify unknown specimens, especially when plant health personnel must quickly identify different development stages of a species, has become more and more convenient, cost-effective and reliable. For quarantine or alien pests, molecular techniques for identification are imperative. The EPPO standard PM 7/129 (1) describes the use of DNA barcoding protocols to identify regulated pests and invasive plant species of importance to Europe and the Mediterranean Region and details about all steps required for molecular and analytical processing in order to arrive to a correct species identification are given.

In Romania several studies related to DNA barcoding have been performed but almost all of them focus on biodiversity, mostly on butterflies. The present work presents the first DNA barcodes of invasive alien arthropods from Romania. DNA barcodes of species as *Metcalfa pruinosa, Halyomorpha halys, Nezara viridula, Harmonia axyridis, Cydalima perspectalis, Palpita unionalis, Ostrinia nubilalis, Phyllonorycter platani,* and *Ceratitis capitata*, are now available for future studies in the Barcode of Life Databases.

Key words: DNA barcoding, invasive alien species, arthropods, BOLDSYSTEMS, Romania.

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Integrating expert opinion and traditional ecological knowledge for freshwater invasive alien species prevention and management: *Corbicula* in Eastern Europe as a model

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The rate of non-native species introduction seems unstoppable at a global scale. Once a non-native species has been introduced, early detection and rapid eradication seems to be the only cost-effective alternative to long-term control. Here, we provide the first qualitative interpretation to determine whether expert opinion and traditional ecological knowledge (TEK) can be effectively integrated in non-native species management. For our purpose we used the Asian clam *Corbicula* sp. invasion in Eastern Europe – Romanian sector of the Lower Danube – as a model. The reference distribution data for the species was obtained through an extensive bibliographic review. Following, we weighted the importance of introduction pathways and dispersal vectors, focusing on the opinions and experience of an expert panel. Finally, information retrieved with semi-structured face-to-face interviews was contrasted against the present distribution of the species. The expert panel highlighted the opening of the Rhine–Main–Danube Canal in 1992 as the most probable pathway of *Corbicula* introduction in the Lower Danube from Western Europe. However, our bibliographic review and face-to-face interviews did not support this assumption. These sources of information suggest *Corbicula* was first introduced in ballast waters to Danube´s delta between the late 1970s and the early 1980s. Our empirical results confirm that subsistence fishers' TEK offers relevant and reliable information not only for the updated *Corbicula* distribution in the Lower Danube, and for the establishment of the invasion chronology, but also for detecting potential vectors for the dispersal processes. Altogether, this work yields an integrated multi-dimensional (scientific, social and bibliometric) representation of *Corbicula* invasion in the Lower Danube. For instance, bringing together scientific and social ecological knowledge will enable this large data resource to be better harnessed to address the introduction and spread of invasive species, and thus elaborate more effective methods of early warning, eradication and control.

Key words: Invasive species management, early detection, artisanal fishers, participatory management, social science.

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Stakeholder perceptions on marine alien species impacts towards the preparation of citizen science campaigns

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Citizen engagement with alien species research can offer valuable input to management efforts and various stages of policy implementation. In the marine environment, it has already greatly contributed to early detection efforts, monitoring and surveillance and removal programmes. It can considerably enhance the geographic coverage of data collection but can also inform on other aspects of management, such as the quantification of impacts and the proposal or acceptability of mitigation measures. In this study, we approached professional and recreational fishers in Greece and, by employing specifically targeted questionnaires, we aimed to explore their level of awareness concerning marine alien species (primarily fishes) and their perceptions about the ways in which these species impact their fishing activity. Questions relating to species-specific impacts addressed ecosystem services (in this case food provisioning and cultural), economic, social and health impacts.

Both groups of stakeholders identified all the species presented to them but fishers from southern Greece had markedly higher rates of encounter with them and reported higher perceived negative impact scores. The average negative impact on professional fishing had a magnitude of -4.15 (with -5=maximum negative), as opposed to -2.75 on recreational fishing. Out of the 13 species examined, *Lagocephalus sceleratus* and *Siganus* spp. yielded the highest number of species-specific responses and the highest degree of quantification in impact reporting. There was a remarkable agreement between professional and recreational fishers' responses with respect to the two most damaging species. Thus, for *L. sceleratus*, both stakeholder groups in southern Greece reported frequency of encounter >50% and catch declines in the order of 40%, as well as financial losses. For *Siganus* spp., encounter rates of >20 – >50% and catch declines of >20% were reported throughout the Hellenic Seas, accompanied by increased handling times and numerous injuries for professional fishers and métier changes for both groups. Our results indicated that more concise and regularly completed questonnaires, addressing single incidents of alien species encounters have a strong potential to contribute to quantitative impact information in relation to ecosystem services and human well-being. Thus, a protocol was compiled and will be disseminated through the ELNAIS online platform and ELNAIS collaborators' webpages.

Key words: Alien species, citizen science, professional fishers, recreational fishers, *Lagocephalus sceleratus*, *Siganus*.

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Can fleabanes (*Erigeron* spp., Asteraceae) become detrimental alien plants worldwide?

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Some fleabanes (*Erigeron* spp.) are known as invasive aliens and/or weeds worldwide in orchards, vineyards, roadsides, and arable fields, particularly where the tillage is limited. In the Northern hemisphere, they have an extensive duration (from late July to throughout fall) for their seedlings to emerge and form overwintering rosettes. The number of small, wind-dispersed seeds, which may exceed 200,000 per plant, makes these fleabanes very capable to occupy lands. Seeds of fleabanes can spread up to 750 km away from the mother plant, which demonstrates their success in terms of seed dispersal mechanisms. The highest germination rate is observed at 10 to 25°C, whereas the minimum and maximum temperatures for seed germination of the hairy fleabane (*E. bonariensis)* have been found to be 4.2 and 35°C. This germination flexibility demonstrates another advantage of the fleabanes, especially when combined with their ability to produce large number of seeds, dispersed to long distances. Moreover, populations of fleabanes in more than 28 countries have evolved resistance to herbicides, such as paraquat, atrazine, chlorsulfuron, and glyphosate. The recurrent application of an herbicidal ingredient in crop and non-crop areas, has resulted in resistance to the herbicides in populations of three widespread species of the fleabanes: hairy fleabane (*E. bonariensis*), horseweed (*E. canadensis*), and tall fleabane (*E. sumatrensis*). In 13 out of 20 cases in hairy fleabane, 42 out of 65 cases in horseweed, and 11 out of 20 case in tall fleabane, glyphosate had the most resistant cases among all active ingredients. These three fleabanes have been confirmed with their cross and multiple herbicide resistance in some mode of actions (MOA), such as: PSI Electron Diverters, Synthetic Auxins, ALS, Photosystem II, PPO, and EPSP synthase inhibitors. Recently, the glyphosate resistance in the tall fleabane was confirmed in Turkey as well. The abilities of being resistant to such MOAs, especially glyphosate as a non-selective herbicide, having a germination and growth flexibility to different climate conditions, and the high competition with field crops make the fleabane species more difficult to combat than ever.

Key words: Alien plants, *Conyza*, *Erigeron*, fleabanes, herbicide resistance.

First DNA–barcoding based records of new alien freshwater species in Georgia

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Georgia is considered as one of the distinguished regions of the world in respect of biodiversity, as it is part of two biodiversity hotspots: the Caucasus and Iran–Anatolian hotspots, identified by the Conservation International. However, understanding of biodiversity of Georgia (especially invertebrate animals and freshwater realm as a whole) is far from complete. Furthermore, an increasing number of species are being introduced into new environments in Georgia, either by accident or deliberately. DNA–barcoding based species identification may represent an alternative method while also provide useful information on species phylogenetic position and help distinguish cryptic lineages. Also in order to protect native biodiversity, early detection and management of established alien species populations is important. The aim of the present work was to check species identity in gobies and crabs using DNA–barcoding.

The fish and crabs were collecting from the freshwaters of west and east Georgia. Rapid and first identification of collected fish was done using traditional taxonomic methods, followed by DNA isolation and CO1 amplification with universal primers.

Four species of gobies belonging to three genera and two species of crabs belonging to two genera were identified. Among them two new invasive alien species, *Rhinogobius* cf *brunneus* and *Rhithropanopeus harrisii* were firstly detected in Georgia. Our results showed that molecular methods can be used for rapid species identification and effective detection of new introductions. These results encourage increasing the taxon number and sampling area in order to develop a comprehensive database of freshwater fauna of Georgia.

Key words: Alien, fish, crab, DNA–barcoding, Georgia

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Fishers' opinions and attitudes concerning the alien fish species inhabiting the transboundary Lake Prespa

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Greece is a hotspot of European freshwater fish diversity, with 164 listed species. Among them, 40 are alien and 60 endemic or near endemic to Greece (found in Greek or in transboundary freshwater systems, respectively). Lake Prespa is a transboundary lake, between Greece (GR), North Macedonia (NM) and Albania (AL). It is nowadays inhabited by nine endemic, two native and 12 alien fish species. Professional fishers' catches comprise *Cyprinus carpio*, *Carassius gibelio*, *Lepomis gibbosus*, *Alburnus belvica*, *Chondrostoma prespense*, and *Rutilus prespenis*.

The present survey was conducted in 2016 at seven lakeside villages in all the transboundary states of Lake Prespa, using a questionnaire addressed to both professional and amateur fishermen, which included – among others – questions related to the alien species and whether their exploitation can contribute to the local development. The results showed that the most preferred catch of the professional fishers in North Macedonia was the alien *L. gibbosus* (52%), while the most preferred catch in Greece was *C. carpio* (48%). 54% of the Greek professional fishers believed that the reason of the general fish reduction in Lake Prespa is the presence of alien species. Professional and amateur fishers of all three countries also believed that the presence of alien species, which are usually caught in quite large quantities, can potentially constitute the most important factor for the area's development (AL 72%, NM 64%, GR 42%), via their commercial exploitation (NM 70%, AL 67%, GR 52%), e.g. by using them for the production of fishmeal. On the other hand, the presence of alien species was generally deemed as harmful to the native and even more to the endemic fish populations.

In conclusion, a series of important issues were raised by the professional fishers of all three countries. Moreover, the Greek professional fishers referred to the reduction of the fish stocks in Lake Prespa due to overfishing, as well as to the spreading of alien species which causes degradation of the lake's native fish diversity. All fishers also expressed their ideas on the potential use of alien species, aiming at the economic growth of the area.

Key words: Lake Prespa, alien fish, Prespa fishermen, questionnaires, local development.

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What is the next step for the Rose-ringed Parakeet in Turkey?

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The Rose-ringed Parakeet (*Psittacula krameri*) was recorded in Turkey for the first time in 1975 and since then has established breeding populations in at least six cities as a consequence of intentional or accidental introductions. This alien species has been widely traded as a cage bird in Turkey, which has obviously provided a greater opportunity for its accidental escapes. Parakeet sightings have been recorded in and around urban areas and records are available from 27 provinces. The most abundant breeding populations have been recorded in Istanbul, followed by İzmir, Ankara, Yalova, Antalya, and Şanlıurfa. The distribution and population sizes of the Rose-ringed Parakeets have increased continuously especially since the mid 2000s. Currently, based on citizen science data, the population in Turkey is estimated to be over 1,450 individuals. The species has shown defensive / offensive interactions with the Hooded Crow (*Corvus cornix*), the Jackdaw (*Coloeus monedula*), the Caucasian Squirrel (*Sciurus anomalus*), and the Yellow-legged Gull (*Larus michahellis*). However, this species does not have any economic, health or social impact in Turkey.

Different management measures have been considered in order to prevent further introduction and spread of the Rose-ringed Parakeets in Turkey. These should include a ban on the sale of the species as cage bird. The Ministry of Agriculture and Forestry of the Republic of Turkey is going to start an EU funded three-year project on the management of some invasive alien species, including the Rose-ringed Parakeet in three cities, to be carried out in the next years. To reduce or eliminate the impact of the Rose-ringed Parakeet it is necessary to address the risk of introduction, establishment, spread, and the impact on biodiversity of the species by developing an appropriate national strategy. This requires the active collaboration between scientists, NGOs and the decision makers. Public awareness and public support, including the involvement of citizens to send new records and observations on the Rose-ringed Parakeet, are very important for the effective management of this species across the country.

Keywords: Alien species, population, introduction, management.

Acknowledgements: The author thanks all citizens, birdwatchers and photographers who contributed to the present study with their observations and photos via the Parakeet Census of Turkey, KuşBank and Trakuş web pages.

First application of the European Non-native Species in Aquaculture Risk Analysis Scheme (ENSARS) in Turkey for the farmed non-native fish, striped catfish *Pangasianodon hypophthalmus*

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In this study, one of the most popular aquaculture species in the world, the striped catfish *Pangasianodon hypophthalmus*, was assessed by the European Non-native Species in Aquaculture Risk Analysis Scheme (ENSARS) in two locations in southern Anatolia, Turkey. The ENSARS *Organism* module yielded an overall mean risk score for *P. hypophthalmus* indicating that the species poses a medium risk under current climate conditions. Other modules (the *Facility*, *Pathways*, *Socio-economic* and *Infectious agents*) all generated scores that indicate a moderately-low risk under current climate conditions. However, the risks of the species introducing novel diseases (i.e. 'Introduction') section of the *Infectious agents* module and the 'Destination use' section of the *Facility* module attracted scores indicating a medium risk. Except for the *Socio-economic* module, confidence levels were medium or high for all modules, with low confidence values also attributed to the 'Farming' section of the *Pathway* module and the 'Market impacts' section of the *Socio-economic* module. Further use of this scheme is recommended, especially for *a prior* assessment of potential future aquaculture species in countries such as Turkey, where the sector is substantially growing.

Key words: Alien species, decision support, risk assessment, risk confidence levels, biological invasions.

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TOPIC 6: MANAGEMENT AND SHARING OF IAS DATA

IAS networks and information systems, databases, data planning and management

Global Register of Introduced and Invasive Species – Macedonia, Version 1.1: An overview of the woody plants

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This is a detailed overview focused on the introduced (alien) and (potentially) invasive alien woody species known to occur in the Republic of North Macedonia as part of the Global Register of Introduced and Invasive Species – Macedonia, Version 1.1. The checklist/dataset was compiled by collating data and information through a comprehensive literature overview. The pioneering input in this global online register (GRIIS) supports the country towards achieving Target 7 of the Convention on Biological Diversity: 'To create and establish appropriate policies for the evidence, control and protection from invasive alien species' and Related Strategic Goals/Aichi Biodiversity Target 9: 'Invasive alien species' (IAS).

The checklist/dataset on woody plants within the GRIIS database for North Macedonia consists of eight terrestrial alien species introduced in the first half of the 20th century for two main purposes: i) erosion mitigation measures; and ii) ornamental use. Half of the plants are native to Asia and the other half to North America. Regarding the growth form, six species are trees and two are shrubs. Taxonomically, most represented botanical family with three species is Fabaceae, and two species are classified in the family Sapindaceae. Each of the species belongs to different genera.

Certain IAS are found in urban and peri-urban areas, some of them colonise disturbed areas along roads or invade abandoned arable lands, even spread in riparian zones. There are species that occur occasionally, with rare, sporadic or localised abundance. Some species are without evidence of impact, but certain invasive woody plants modify successional patterns and reduce/inhibit the growth of other species. Only one of those species is mentioned in the National Biodiversity Strategy and Action Plan (2004), while three species are included in the List of invasive alien plants of the European and Mediterranean Plant Protection Organization (EPPO), and one species is on the EPPO Alert List.

Beside some uncertainties for potentially invasive and invasive alien woody plants so far, one species underlines the matrix of invasiveness in all lookups: *Ailanthus altissima*. This species has been introduced intentionally and legally, and it has been well-established, invasive, widespread, highly competitive species, with both environmental and socio-economic impact.

Key words: GRIIS, invasive alien woody species, introduced woody plants, North Macedonia.

Topic 7: Other topics

General aspects related to the quality of the aquatic and terrestrial environments and associated biological communities, which may influence the introduction and spread of IAS, as well as the application of prevention and management measures

Invertebrate model organisms in ecotoxicology research

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Ecotoxicity studies are biological experiments with various standardised target or non-target test species under presence of chemical substances or environmental samples for assessing the risk of new or existing chemicals and for monitoring the environmental quality (e.g. of effluents, sediment and soil samples) in the context of national legislation and regulation of chemicals and different stressors. Environmental stressors (climate change, erosion, habitat loss, pesticides, extensive and irrational fertiliser use, chemical pollutants, plasticisers, microplastics, engineered nanomaterials, materials with endocrine disrupting activity, and deterioration of water quality) impact freshwater and marine ecosystems. They threaten biota and animal/human health; however, since more than one substance is present and in cocktail like mixtures their interactive effects on natural populations are not clearly elucidated. The EU Regulations 528/2012 'concerning the making available on the market and use of biocidal products', and 440/2008 'laying down test methods pursuant to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)', OECD, U.S. EPA and several other international institutions have put effort to develop standardised test methods to support analytical methodologies.

Invasive species are preferred in the ecotoxicity tests owing to their low sensitivity to xenobiotics and reliability. Invertebrates are important contributors crucial to the food webs, when exposed to diverse toxic substances or other antropogenic impact they may become locally or regionally extinct species. Besides the major concern of ethics, the use of alternative aquatic model organisms have been proposed to replace other experimental animals.

The present study makes a review of existing bioassays and ecotoxicological tests, using different invertebrate organisms, such as: the invasive bivalve *Dreissena polymorpha*, the mussels *Unio* sp., *Tapes* sp., *Mytilus galloprovincialis*, the gastropods *Viviparus contectus*, *Lymnaea stagnalis, Radix labiata, Planorbarius corneus*, the crayfish *Astacus leptodactylus*, and the sea urchins *Paracentrotus* sp. and *Arbacia* sp., as model organims for the larval development and spermiotoxicity assays. The invertebrate model organisms were exposure to pesticides, endocrine disruptors, plasticisers, biocides, acrylamide (well known neurotoxin), and microplastics, and treated with state-of-the-art testing, histopathology, biochemistry, physiological biomarkers as endpoints. Practical aspects are presented with scientific background and regulatory relevance.

Key words: Invertebrates, ecotoxicology, model organisms, bioassay, indicator species.

Effects of rosehip fruit extract in two wheat varieties after herbicide application

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The herbicides are commonly used for weed control in wheat fields but they can be toxic. On the other hand, medicinal plant extracts can be used as a biostimulant to overcome stress conditions of cultivated plants. This study aimed to determine the effects of tribenuron methyl (active substance of herbicide, H) on the antioxidant system in two wheat varieties (drought-tolerant cv. Tosunbey and drought-sensitive cv. Sultan 95). In addition, the effects of the rosehip (*Rosa canina*) fruit extract (R) and after herbicide application (HR) were investigated. We focused on root and shoot elongation, superoxide dismutase (SOD) isoenzyme amounts, peroxidase activity (POX), lipid peroxidation (LP), and cell membrane permeability (CMP).

Root and shoot elongation increased with R application in Tosunbey and decreased in Sultan 95. In addition, H and HR applications resulted in a decrease in both varieties. Total chlorophyll content decreased in Tosunbey with all treatments but did not change in Sultan 95. The R treatments did not alter SOD isoenzyme amount and POX activities in Sultan 95 but increased LP. On the contrary, it was determined that LP and CMP did not change although the amount of SOD isoenzyme decreased in Tosunbey. Increased LP was found to be consistent with decreased SOD isoenzyme amount and unchanged POX activities in both varieties. The lipid peroxidation and CMP did not decrease due to the decreased SOD isoenzyme amount and POX activity in Sultan 95 by HR application. However, the HR treatment decreased LP and CMP, characterised by increased POX activity in Tosunbey. As a result, it was determined that the rosehip fruit extract treatment provides protection by inducing POX activity in the drought-resistant variety after herbicide application.

Key words: Antioxidant activity, wheat, tribenuron methyl, rosehip extract, Sultan 95, Tosunbey.

Evaluation of chromosome abnormalities in human blood lymphocytes caused by extracts of *Rhamnus catharticus*

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Rhamnus catharticus (Rhamnaceae), also known as European or common buckthorn, is an invasive alien species in North America. It is native to Europe and western Asia. This species was introduced into the US from Eurasia in the turn of the 18th century as a medicinal plant, an ornamental, and food for wildlife. Currently it is a well-established plant there. The taxa of the genus *Rhamnus* are known to be rich in flavonol triglycosides, anthraquinones, anthracenes, anthrones, and naphthalenes, which determine their antioxidant activities.

The study population comprised 10 healthy human individuals aged 20–30 years with no prior health problems and without use of cigarettes, alcohol or drugs, as well as without exposure to genotoxic agents. All participants provided informed consent in accordance with the ethical standards of Çanakkale Onsekiz Mart University. The human peripheral blood lymphocytes were drawn from a peripheral venous and then the cultures were incubated at 37°C for 72 hours. The study design consisted of treatment with methanol and aqueous extracts of *Rhamnus catharticus* in four different concentrations on the lymphocyte cells isolated from human blood and determed in vitro sister chromatid exchange (SCE), chromosome aberration (CA). There were differences in methanol and aqueous extracts. Regarding doses, 1 mg/ml dose was considered reliable for usage, while doses higher than 1 mg/ml were evaluated as toxic.

Key words: Chromosome abnormalities, *Rhamnus catharticus*.

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Evaluation of chromosome abnormalities in human blood lymphocytes induced by various ratios of *Chrysanthemum cinerariifolium* and *Matricaria recutita* extracts

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Chrysanthemum cinerariifolium and *Matricaria recutita* are both members of the family Asteraceae. The chamomile *M. recutita* is a traditional medicinal herb with antimicrobial, anti-inflammatory and antioxidant effects. In contrast, *C. cinerariifolium* stimulates the nervous systems and causes hyperexcitability. These two plants are similar morphologically and non-professionals may confuse them and use them in a mix. The current study aimed to compare the chromosomal abnormalities caused by the medicinal plant *M. recutita* with different ratios. Although the species is regarded as safe and its extract, oil, and leaves are widely used in conventional medicine, there is no current scientific publication related to its toxic effects. This is the first study that examined the chromosome abnormalities in human peripheral blood cells induced by *C. cinerariifolium* and *M. recutita* alone or in a mixed extract.

The study population comprised 10 healthy human individuals aged 20-30 years with no prior health problems and without use of cigarettes, alcohol or drugs, as well as no exposure to genotoxic agents. All participants provided informed consent in accordance with the ethical standards of Çanakkale Onsekiz Mart University. Human peripheral blood lymphocytes were drawn from a peripheral venous and then the cultures were incubated at 37°C for 72 hours. The study design consisted of treatments with four different concentrations. For this purpose, cells were treated with mixtures of *C. cinerariifolium* and *M. recutita* with different concentrations. The final pyrethrin concentrations were 1/10, 1/5, 1/2, and 1/1 for the four groups. All mixtures were evaluated after 48 hours to determine *in vitro* sister chromatid exchange (SCE) and chromosome aberration (CA). The dose-effect relationship was obtained for *C. cinerariifolium/ M. recutita* extract both in SCE and CA tests.

Key words: Chromosome abnormalities, *Crysantemum cinerariifolium*, *Matricaria recutita*, pyrethrin.

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Influence of *Helichrysum arenarium* on haemocytes and encapsulation-melanisation immune responses of model organism *Galleria mellonella*

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Helichrysum arenarium (Asteraceae) is a therapeutic plant. It is known to contain etheric oil, flavones and flavon glycosides, sterins, bitter substances and tannins having various coumarins. This plant is thought to have features such as diuretic effect, dropping stones and sand from the kidney, regulating digestive disorders, strengthening the immune system, antibiotic and antioxidant effect. Additionally, this plant is traditionally used in liver and biliary tract diseases and also shows anti-inflammatory, antioxidant, detoxifying properties. *Galleria mellonella* (Lepidoptera) is a model organism used for studying the effects of human pathogens and chemical-natural products and offers unique opportunities for immune system research. Some scientists claim that roots of mammalian innate immune system are found in the insect immunity. Insect immunity is divided into two branches: humoral and haemocyte mediated. The humoral immune responses are anti-microbial peptides, coagulatin and melanisation. The haemocyte mediated immune responses are phagocytosis and encapsulation. The haemocyte count is important for both the humoral and haemocyte mediated immune responses.

In our study, the ethanolic extract of dried *H. arenarium* was dissolved in 10% dimethyl sulfoxide with four different experimental concentrations (0.1%, 0.25%, 0.5%, and 1%). The last instars of *G. mellonella* were selected (0.18 ± 0.02 g) and 5 µl experimental concentration was injected in each of them. After injection, *H. arenarium* was allowed to make effect for 24 hours. For evaluation of the haemocyte count after the 24-hour period, 4 µl haemolymph was collected from the larvae and added to microcentrifuge tubes, which contained 36 µl anticoagulant. Then, 10 µl anticoagulant-haemolymph mixture was loaded to neuber haemocytometer and the haemocytes were counted with a phase-contrast microscope. Sephadex A-25 beads were used to determinate the encapsulation-melanisation response of *G. mellonella* larvae. The beads were injected with 10 µl phosphate buffered saline (PBS) into the larvae treated with doses of *H. arenarium*. The encapsulation-melanisation responses were quantified after short (4 hour) and long (24 hour) periods. Our results indicated that 0.25 and 0.5 doses of *H. arenarium* had positive effects on *G. mellonella* haemocyte count and encapsulation-melanisation responses. This widely used therapeutic herb can support the immune system. Further studies are needed to understand the full effects of *H. arenarium* on the immune system.

Key words: *Helichrysum arenarium, Galleria mellonella,* model organism, immune system, encapsulation-melanisation responses, haemocyte counts.

A preliminary research on imposex in Rapa whelk (*Rapana venosa* Val., 1846) population in the Eastern Black Sea, Turkey

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Imposex is the formation of male sex organs, including the penis and vas deferens, by female gastropods, which causes reproductive failures in over 150 species worldwide. Imposex is mainly caused by the tributyltin (TBT), which is contained in the antifouling paints used in dockyards. Though the use of TBT based paints were fully banned in 2008, their residuals in the sediment are still affecting the gastropods.

After working on population of *Rapana venosa* in the Black Sea for more than 25 years we have noticed that the sex ratios changed from 1:1 to 1:3 in favour of males. The changes in the sex ratios enforced us to focus on the possible reasons affecting the population of *R. venosa* where the males were most abundant. According to the study on samples collected near one of the important dock yard locality in the Eastern Black Sea, we have reached some evidences of imposex.

This study was conducted between July 2014 and December 2017 to determine the status of imposex in the Rapa whelk population in the Eastern Black Sea, Turkey. The TBT analysis was performed on Rapa whelk tissue and sediment. The imposex stages were determined with macroscopic observation in 798 individuals. Of them, 11% were identified as imposex females, 14 % as females, while 75% as males. The ratio F+I : M was 1:3. The shell length versus penis length for males and imposex females was estimated, and vas deferens sequence index for 6 development stages was derived.

It was concluded that the impact of TBT residuals was still ongoing. The level of imposex was not high as in other studies but strong evidences for its appearance were obtained, especially in the early ages. It was found that the female individuals in the area still had their reproductive abilities and the population had its normal tendency. More comprehensive research is needed at a larger scale.

Key words: Rapa whelk, *Rapana venosa*, tributyltin, imposex, Eastern Black Sea.

Assessing the risk of distribution and spread of invasive and alien species – a future of the conservation of hilly-mountainous referent watercourses

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Nowadays, the potential spread of invasive alien species (IAS) in freshwater ecosystems presents a worldwide problem in ecological and economic aspects. Mainly, the loss of environment quality is most evident at ecosystem disturbances that result from direct reduction of habitat quality and natural resources, further to biodiversity loss. In that order, from great importance is to evaluate the risk of the potential introduction and spread of freshwater IAS. Most affected and at the same time the least studied are the cases of hilly-mountainous river ecosystems. In practice, there are many documented cases of freshwater IAS spreading in lowland river watercourses, their enormous negative impact on the environment and ecosystem services. Aware of the fact that at hilly-mountainous watercourses there is high presence of endemic and relict species, we decided to focus our study on assessing the risk of IAS occurrence at these ecosystems and the potential of their further spread in the river systems.

We studied a total of 41 sites from Bulgaria and North Macedonia from the Aegean Sea Basin (Vardar and Struma River catchments) during autumn 2017 (33 samples), spring 2018 (36 samples), and winter 2019 (2 samples). Nine referent sites were confirmed: three from Bulgaria and six from North Macedonia. The rest 32 sites were assessed more or less under the anthropogenic influence. During the period of investigation we did not detect the presence of any IAS at the sampled sites in both countries. At few sites we confirmed the presence of the native freshwater amphipod *Gammarus roeseli*, which has low spreading potential and its presence in the new infected watercourses, can only be explained by the anthropogenic activities. This preliminary assessment of the risk of distribution and spread of invasive and alien species in the studied watercourses will contribute to prevent the future contamination of these freshwater hotspots.

Key words: Native watercourses, benthic communities, risk of distribution of IAS, ecosystem services, *Gammarus roeselii.*

Biodiversity, endemism and presence of alien and invasive species in the benthic fauna of Lake Prespa (2016-2017)

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Lake Prespa together with Lake Ohrid are part of the group of old lakes that are recognised worldwide as centres of biodiversity, harbouring highly specialised flora and fauna. Lake Prespa and its watershed are a habitat of more than 2000 species, whose future survival is endangered by the low level of protection, on the one hand, and the growing anthropogenic pressure, on the other. With this in mind, and especially after the dramatic decline in lake's water level over the past decade, the interest in lake's protection and species conservation has taken on a new dimension.

An insight into the status of biodiversity of the benthic fauna, the level of endemism and the possible presence of alien and invasive species was the main objective of the monitoring carried out in the period 2016–2017. The samples were collected from six sites along the lake's littoral (both Macedonian and Albanian sides), including two samples from three depth points (0.5, 2 and 5 m) along each transect.

The results showed the presence of 38 species from seven major groups of benthic fauna: Turbellaria, Oligochaeta, Hirudinea, Gastropoda, Bivalvia, Crustacea, and Insecta. The Gastropoda group was characterised by the highest diversity, 10 species with the highest endemism at the class level. Thus, 60% of the species belonged to the endemic species of snails in Lake Prespa. The lowest biodiversity was found in the Turbellaria class, of which only a single representative was registered. The general level of endemism was significant, reaching 36%. Although the Insecta class contributed significantly to the total biodiversity of the benthic fauna (9 registered species), the level of endemism within this group was insignificant, i.e. no endemic species were recorded. Only one alien snail species (*Physella acuta*) was recorded in the benthic fauna of Lake Prespa. This species was recorded at only one site at two depths in the locality of Pustec on the Albanian side of the lake, in conditions of visibly increased trophic status of the water.

Key words: Lake Prespa, endemism, diversity, alien and invasive species.

Distribution of *Heracleum* species in different habitat types in Düzce, Turkey

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Many species have a high negative impact on ecosystem services (habitat loss, dominant species in agricultural areas, economic losses, human and animal health, etc.). There is very limited information on the impact and habitat types of many indigenous or alien species in Turkey. In order to cover this gap, we have examined the status of the genus *Heracleum*, which is the largest genus of the family Apiaceae in different habitat types in Düzce Province.

The family Apiaceae has great significance due to its high endemism rate of 37.3% in Turkey. There are 23 taxa of *Heracleum*, nine of which are endemic. However, information about their habitats and the impact of these taxa is very limited in Turkey. Therefore, seven different habitats according to the EUNIS habitats classification were studied. The floristic investigations were conducted within selected sample areas in the Düzce region. The spread of two different taxa – *Heracleum sphondylium* ssp. t*ernatum* and *H. platytaenium*, was recorded. In addition, in some sample areas, *Chaerophyllum byzantinum*, which is very similar to *Heracleum*, was recorded as well.

The two *Heracleum* species were present in four of the habitat types, but they were lacking in the meadow habitat. In coastal and agricultural habitats, only *H. platytaenium* was recorded. It was observed for the first time in hazelnut orchards during this study. Allergic problems by *H. platytaenium* were identified in the coastal, forest, urban and agricultural habitats, in agriculture and forestry farms, and in tourist areas.

Heracleum sphondylium ssp. t*ernatum* species was found to have ethnobotanical use. It is consumed as food by the local people in Düzce, especially in highland areas and in many villages. It was stated by locals that the differentiation between *H. sphondylium* ssp. *ternatum* and allergy-causing *H. platytaenium* is easily made by the hairiness of the plants.

Key words: *Heracleum*, habitat, expansion, impact, hazelnut, ethnobotany.

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Dreissena species in Turkey

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Turkey has a crucial role in the paleoarctic region in terms of biological resources because it is a peninsula rich in species diversity. Although Turkey is not a country with an extensive network of inland waters, because of paleocographic developments and hydrocographic connections, speciation has been fostered in aquatic organisms in various water bodies. These same water bodies that are rich in species diversity are also habitats suitable for alien and invasive species.

In the inland waters of Turkey, some characteristic invasive species are the bivalves of the genus *Dreissena*. In addition to the suitability of many inland waters to this genus, other factors as fishery activities and the lack of sufficient control have allowed individuals of this genus to easily invade new areas, where large populations have developed. Although there is agreement that *Dreissena* are spreading, there are serious differences in the determination of which species of *Dreissena* are involved. Here we make a review of the species of genus *Dreissena* in Turkey.

Due to the complexity of morphologically identifying *Dreissena* spp., studies within Turkish lakes, ponds, reservoirs and river basins have frequently identified these mussels simply as the widespread Eurasian species *Dreissena polymorpha*. A comprehensive review of the literature, however, reveals that a wide diversity of other *Dreissena* species has also been proposed or reported based on shell morphology, including: *Dreissena iconica*, *D. rostriformis*, *D. bouldourensis*, *D. bukowskii*, *D. diluvii*, *D. bourguignati* species as a fossil, *D. polymorpha gallandi*, *D. p. anatolica*, *D. p. siouffi*, *D. p. arnouldiformis*, and *D. caputlacus*. More recently, molecular analysis of *Dreissena* has identified *D. p. gallandi, D. anatolica*, and *D. caputlacus* in Turkey. Additional molecular studies are needed to determine clearly what *Dreissena* species are present in Turkey.

Key words: Invasive mussels, *Dreissena,* diversity, Turkey.

Abundance and distribution of round goby (*Neogobius melanostomus)* population in the Southern Black Sea Coast

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The round goby *Neogobius melanostomus* is one of the most widespread invasive fish on earth, with substantial introduced populations within the Laurentian Great Lakes watershed, the Netherlands waters, the Black and Baltic Sea and several major European and Anatolian rivers. Rapid expansion and deleterious ecosystem effects have motivated extensive research on this species. In this study, temporal variation in the abundance and distribution of *N. melanostomus* in Turkey's Black Sea littoral was monitored in the 2010s.

This study was planned seasonally between 2010 and 2014 in Samsun and Western Black Sea (Sakarya Shelf and Thrace) littoral, representing the Southern Black Sea Coast. The surveys were carried out with experimental bottom trawl nets. The experimental operations were performed at three different depths (≤0–30 m, 30–60 m, ≥60 m) and half-hour trawling was performed. The catch amounts of *N. melanostomus* in the trawl yileld taken on board were recorded as numerical and weight. After standardising the catch data, the biomass index (kg/km^2) was calculated and compared statistically according to season and depth.

Our results showed that during the five-year monitoring period the population of *N. melanostomus* had higher biomass index (mean 23.8 kg/km^2), especially in the coastal shelf regions where large rivers discharge, compared to the 30–60 m and 60 m deeper areas of the littoral region. It was also found that the amount of biomass of *N. melanostomus* tended to increase gradually compared to previous studies on demersal and bentopelagic macrofauna in the region. In the 1990s, this index was 0.09%, in the 2000s, the rate increased to 0.14%, while in the 2010s, when this study was conducted, the index reached 0.34%. According to the results obtained during our study, in spite of the decrease in the local fish fauna in the Southern Black Sea littoral, especially during the 2000s, a significant increase in the round goby population was observed. This increase in the biomass of the round goby population is an important indicator for the macrofauna change in the Southern Black Sea ecosystem. Similar cases were observed in the Danube Delta and the Baltic Sea.

Key words: Southern Black Sea, littoral zone, *Neogobius melanostomus*, biomass index.

POSTERS

Topic 1: Invasive alien species traits and trends

Invasive alien species introduction and spread, biological and ecological traits; characteristics of recipient environment; invasive alien species and climate change

Ecological traits of invasive alien species *Lepomis gibbosus* in the water bodies of Kiev Region, Ukraine

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The pumpkinseed *Lepomis gibbosus* is an invasive alien species in the ichthyofauna of Ukraine. The first findings of this species in the water bodies of the city of Kiev dated back to the 1970s. During the next 40 years, data on the occurrence of the pumpkinseed in this region were absent. In 2011, the species was found again in the Kiev Reservoir. In the following years, this species propagated intensively in the water bodies of the Kiev Region. Its invasion is considered hazardous to native fish owing to its high ecological plasticity and competition for food resources.

In 2019, a new location of the pumpkinseed in the Kiev suburb was revealed: a former sand pit lake (N 50.271593; E 30.304007) without any hydraulic connection with the river system. Most probably, the species was brought there by birds. Based on the complex of morphological characteristics, the specimens of the pumpkinseed from this water body belonged to the pelagic form, compared to specimens from the flood water bodies within the suburb of the city of Kiev, which belong to the littoral form.

All specimens caught were sexually mature and characterised by high fatness. The filling of intestine corresponded to 2–3 points. The main feeding objects were larvae of Chironomidae, followed by plant residues, algae (filamentous green and diatoms) and larvae of Lepidoptera as the secondary objects. The feeding spectra of the pumpkinseed in the studied sand pit lake appeared to be wider than in the flood water bodies within the Kiev city suburb, in which the food consisted totally of Chironomidae larvae. The data obtained can contribute to studies of interrelations between the invasive alien and native fish species and preservation of the biological diversity in the lakes.

Key words: Invasive alien species, pumpkinseed *Lepomis gibbosus*, eco-morphological forms, feeding.

Assessment of some invasive species photosynthetic adaptation to new habitat environment using closed chamber system

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Dynamics of biological systems, from cells to communities and ecosystems, have been shaped by resistance to environment pressures that force organisms to maximise their adaptation and reproductive success. Herbaceous plants generally are considered photosynthate sinks due to their dependence on energy provided by sugars transported from leaves (produced by photosynthesis) to carry out the highly demanding processes of growth, development, and maturation. Thus, growth and development of plant body remains significantly affected by the process of photosynthesis. For that reason photosynthesis response to environmental conditions of invaded habitat were evaluated as indices of invasive species adaptation. Photosynthesis measurements of *Fallopia japonica*, *Heracleum sosnowskyi*, and *Rumex confertus* were performed using closed chamber system every month along the grassland or forest ecotones in Kaunas District, Central Lithuania during plant vegetation period in 2016.

The invaded habitats differed by environmental conditions. *Rumex confertus* established in open ecotones of damp grassland, where the observed mean soil moisture (43.41%) and temperature (15.95°C) were the highest. The lowest soil moisture (23.51 and 26.25%) and temperature (12.24 and 12.33°C) were detected in scrubs habitats invaded by *H. sosnowskyi* and *F. japonica*, respectively. The observed photosynthetically active radiation (PAR) ranged from 36.00 to 1083.67 μmol m^{-2} s^{-1} throughout the vegetation period regarding to meteorological conditions and habitat type. Therefore, significantly mean PAR rates were estimated for invaded ecotones and established species there. *Fallopia japonica* and *H. sosnowskyi* settled in shadow scrubs habitats exhibited the potential to gain the lowest mean PAR rates of 58.33 and 124.70 μmol m^{-2} s^{-1}, respectively. *Rumex confertus* was located in open grassland habitats where the mean PAR was assessed at 529.35 μmol m^{-2} s^{-1}. Consistently to available radiation (r=0.9), significantly (p=0.000) the highest mean photosynthesis rate of 11.60 μmol m^{-2} s^{-1} was observed for *R. confertus*. The lowest mean photosynthesis rate of 3.02 and 4.52 μmol m^{-2} s^{-1} exhibited *F. japonica* and *H. sosnowskyi* in shadow habitats. The results on soil and PAR conditions acclimation, photosynthetic capacity and its positive relationship to environment tolerance confirmed that the assessed invasive species recently established will also exhibit enhanced photosynthetic performance during their vegetative growth in new invaded habitats.

Key words: Ecotone, environment, PAR, invasive species.

Occurrence of the box tree moth *Cydalima perspectalis* (Walker, 1859) in Mountain Galicica

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The box tree moth, *Cydalima perspectalis* (Crambidae), is a nocturnal moth species, originating from East Asia. After its introduction in Europe (2006 in Germany), due to its invasiveness this species quickly spread throughout the continent, reaching the Netherlands and Switzerland in 2007, and France, United Kingdom and Austria in 2008. The moth has been registered also in Slovenia and Hungary (2011), Croatia (2012), Greece (2013), and Bosnia and Herzegovina, Bulgaria, Montenegro, and Serbia, in 2014. The first record of the box tree moth in the Republic of North Macedonia was in 2014 on box seedlings in parks, gardens and other urban green spaces in the city of Skopje. In natural populations of *Buxus sempervirens*, this species was firstly recorded in the Vodno Mountain in 2015, and since then its population has increased.

We present a review on the occurrence, morphology, biology, impact, control actions and distribution of the box tree moth in Mountain Galicica. The study was conducted in an association of *Phillyreo latifoliae – Carpinetum orientalis*, i.e. in one of its subassociations – Subassociation *buxetosum*, which is spread most likely due to the subatlantic influence of Lake Ohrid. The data on occurrence of the box tree moth were obtained by field observations and data collected from the general public. Based on the obtained results, recommendations about measures for gradual regulation of the box tree moth populations in Mountain Galicica were made.

Key words: Invasive alien species, *Buxus sempervirens*, box tree moth, morphology, control measures.

Metcalfa pruinosa Say, 1830 (Homoptera: Flatidae), an established alien species in continuous expansion in Romania

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The citrus flatid planthopper *Metcalfa pruinosa* (Homoptera: Flatidae) is native to eastern North America. This species entered the European continent in 1979, being first recorded in the northern part of Italy, and after that spread in most of the European countries. The pest was reported for the first time in Romania in 2009, in the eastern part of the country. In the next years, it was detected both in the west and in the south of the country. The citrus flatid planthopper can be considered a slow expanding species, adapting easily from one area to another. Currently, this pest has been encountered in parks and green areas, fruit and wine plantations, herbaceous plants and herbaceous species, almost everywhere in Romania. Here we present the findings of the citrus flatid planthopper during recent surveys in Romanian urban parks and gardens, with emphasis on the pest host plant spectrum.

Key words: *Metclafa pruinosa*, expansion, invasive pest.

Vanessa cardui (Lepidoptera: Nymphalidae) – migratory behaviour induced by recent climate changes or just a seasonal migration shift

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The painted lady butterfly, *Vanessa cardui* (Lepidoptera: Nymphalidae), is a well-known species for its seasonal long-distance migrations and for its dramatic population fluctuations between years. Recent studies proved that this species holds the record for the longest roundtrip migratory flight ever recorded in butterflies, as it was found out that these butterflies return from the Afrotropical region to recolonise the Mediterranean regions in early spring, travelling an annual distance of 12,000 km across the Sahara Desert. Although the painted lady butterfly has a worldwide distribution and was rarely considered a pest of agricultural crops, in some of the recent years it started to cause losses to farmers, as its larvae are highly polyphagous. As the species is present everywhere from the Black Sea coast to the highest peaks of the Carpathians and it was mentioned recently as a pest in two regions of Romania and in the Republic of Moldova, the citizen science reports about its presence and damages started to put authorities in alert. In 2010, an invasion from North affected the whole Europe. In July 2018, the roads in Transylvania and Moldova were full of butterflies' clouds and thousands were killed by cars in the traffic. With three generations per year and extensive distribution, biology of the painted lady butterfly may shift and pose a threat to biodiversity and human economic activities. The climate changes, which we are witnessing in the last decades, favour the development of insects, especially Lepidoptera. Here we describe the recent alert signals related to behavioural changes of the painted lady butterfly.

Key words: Painted lady butterfly, *Vanessa cardui*, climate changes, migration, citizen science.

Distribution of *Elodea nuttallii*, an invasive alien species of EU concern, in Bulgaria

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Elodea nuttallii (Hydrocharitaceae) is an aquatic plant, native to North America. In Bulgaria, the species was recorded as a naturalised alien relatively recently – in 2002. Since then, the number of the recorded localities has increased. The species is considered to have high ecological impact in the invaded areas, and therefore, it was included in the List of invasive alien species of EU concern under Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. Article 24(1) from the same Regulation obliges the EU Member States to report by 1st June 2019, and every six years thereafter, the distribution of the invasive alien species of Union or regional concern. Therefore, the reporting of all known localities of *Elodea nuttallii* in Bulgaria is urgently needed. The poster presents a distribution map of the species in the Bulgarian flora and provides some comments on the state of the populations and the impact of the species.

Key words: Bulgarian flora, mapping, Regulation (EU) 1143/2014, species distribution.

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Taxonomy and spread of the alien fleabane species, *Erigeron* spp. (Asteraceae) in Turkey

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Currently, three alien species of *Erigeron* L. (fleabanes; pireotları in Turkish) occur widely in Turkey: *E. bonariensis* L. (hairy fleabane, flaxleaf fleabane, tüylü pireotu), *E. canadensis* L. (horseweed, Canada fleabane, Kanada pireotu), and *E. sumatrensis* Retz. (Sumatran fleabane, tall fleabane, uzun pireotu). They are native to the Americas and considered invasive alien species and/or weeds in many parts of the world, including Turkey. They grow in orchards, row crops, abandoned fields, and non-crop areas, including urban areas, in more than 70 countries. Until recently, the former two species were more known with their synonyms *Conyza bonariensis* (L.) Cronquist and *C. canadensis* (L.) Cronquist, respectively. Situation with *E. sumatrensis* is more complicated. Under *Conyza*, the latter was known as *C. sumatrensis* (Retz.) E. Walker or *C. albida* Spreng, which was a rarely mentioned name. Actually, these two species were mostly considered synonyms although The Plant List (www.theplantlist.org) had them two separate species. Currently The Plant List provided the name *E. sumatrensis,* which has two synonyms, *C. albida* Willd. ex Spreng. and *E. albidus* (Willd. ex Spreng.) A. Gray and the name *C. sumatrensis* (S. F. Blake) Pruski & G. Sacho, which has three synonyms, namely: *C. floribunda* var. *subleiotheca* (Cuatrec.) J. B. Marshall, *C. groegeri* V. M. Badillo, and *C. sumatrensis* var. *sumatrensis*. Furthermore, *C. sumatrensis* (Retz.) E. Walker, *C. sumatrensis* var. *floribunda* (Kunth) J. B. Marshall, and *C. sumatrensis* var. *leiotheca* (S. F. Blake) Pruski & G. Sancho are among to synonyms of *E. floribundus* (Kunth) Sch. Bip, which has synonyms formerly lower taxons of hairy flabane and horseweed. This may cause confusion with many former agricultural studies related to *C. sumatrensis* if the identification of specimens was not done in detail (under species level) and if voucher specimens were not stored in a herbarium. Hairy fleabane and horseweed are distributed almost throughout Turkey. However, there are few records of Sumatran fleabane, which have spread in the Aegean and the Marmara Regions. These fleabanes have high ability to produce a large number of seeds, which are easily dispersed by the wind, and rapidly colonize any suitable habitats in Turkey. Their ability to spread seeds at very long distances suggests that integrated management strategies should be conducted at larger areas than the individual fields and that a more efficient combination of control techniques should be applied in the individual fields.

Key words: *Conyza*, *Erigeron*, fleabane, taxonomy, Turkey.

Soil seed reserves of invasive weed species in two protected areas of the Autonomous Province of Vojvodina, Serbia

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The seed bank is the resting place of weed seeds and is an important component of the life cycle of weeds. Seed banks are the sole source of future weed populations of the weed species that reproduce only by seeds. This study was conducted in order to determine the seed reserves of invasive weed species in two protected areas. The soil sampling was carried out in north of Serbia, in Landscape of Outstanding Features Nature Park 'Palić' and Nature Reserve 'Ludaško Jezero'. Forty-two soil samples were taken at the depth of 0–10 cm in autumn 2018. Identifying the seeds and determining their quantity was carried out with microscopes and appropriate identification guides.

The soil samples taken at the Nature Park 'Palić' contained seeds of 19 weed species, of which six were identified as seeds of the invasive weed species: *Amaranthus retroflexus*, *Portulaca oleracea*, *Celtis occidentalis*, *Robinia pseudoacacia*, *Asclepias syriaca,* and *Phacelia tanacetifolia*. *Amaranthus retroflexus* was the weed species with the highest number of selected seeds from the samples (5503.07 seeds per m^2), followed by *Celtis occidentalis* (1834.36 seeds per m^2), *Phacelia tanacetifolia* (1993.87 seeds per m^2), *Portulaca oleracea* (1595.09 seeds per m^2), *Asclepias syriaca*, and *Robinia pseudoacacia* (79.75 seeds per m^2).

The soil samples taken at the Nature Reserve 'Ludasko Jezero' contained seeds from 28 weed species, of which 10 were identified as invasive weed species: *Amaranthus retroflexus*, *Portulaca oleracea*, *Setaria italica*, *Datura stramonium*, *Echinochloa crus-galli*, *Ambrosia artemisiifolia*, *Asclepias syriaca*, *Matricaria discoidea*, *Ailanthus altissima*, and *Lolium multiflorum*. *Amaranthus retroflexus* was the weed species with the highest number of selected seeds from the samples (13,478.53 seeds per m^2), followed by *Portulaca oleracea* (5,503.07 seeds per m^2), *Setaria italica* (1,355.83 seeds per m^2), *Datura stramonium* (957.06 seeds per m^2), *Ambrosia artemisiifolia* (638.04 seeds per m^2), *Lolium multiflorum* (558.28 seeds per m^2), *Matricaria discoidea* (478.53 seeds per m^2), *Ailanthus altissima* (239.26 seeds per m^2), *Echinochloa crus-galli*, and *Asclepias syriaca* (159.51 seeds per m^2).

The results showed that the two protected areas contain a high number of invasive weed species and their seeds. Further research will be necessary in order to control the dymanics and spreading of the invasive weeds.

Key words: Invasive weeds, seed bank, protected areas.

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Interactions between two invasive mussels *Dreissena polymorpha* and *Corbicula fluminea* in Negovan sand-pit lake, Bulgaria

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The freshwater zebra mussel *Dreissena polymorpha* and Asian clam *Corbicula fluminea* are among the most harmful aquatic invaders, which have great potential to cause impact on biodiversity and economy. Until 2012, *D. polymorpha*, which is native to Bulgaria, has been introduced to 55 inland water bodies. *Corbicula fluminea* was first recorded from the Danube River in Bulgaria in 2001, and since then has rapidly spread along the entire Bulgarian stretch, extending its range upstream of the Danube tributaries and some standing inland waters. Negovan sand-pit lake is located in the Iskar River catchment, the Danube River Basin, Sofia Region. It has been used for sand extraction, as well as for angling and recreational purposes. Established and abundant population of *D. polymorpha* was recorded in May 2008, while single specimens of *C. fluminea* were detected first in the lake in December 2010.

The aim of our study was to monitor the distribution and population quantitative characteristics of the two mussels *D. polymorpha* and *C. fluminea* in Negovan sand-pit lake. The quantitative sampling was conducted in two seasons – summer and autumn, during the period 2015–2018. The samples were collected by using of SCUBA diving equipment and other standard hydrobiological methods.

The results showed that *D. polymorpha* was found at all studied sites of different depths and type of substrates. *Corbicula fluminea* was found mainly in the littoral zone on sand and gravel substrate. The highest abundance of *D. polymorpha* was recorded at a depth of 5 m, in the north-east part of the lake, while the lowest abundance was estimated at a depth of 1.6 m in the littoral zone. On the contrary, *C. fluminea* was very abundant in the littoral zone, while only single specimens were found at depths higher than 2 m. During our study, in the littoral zone, *D. polymorpha* had an abundance of 1000 ind./m^2, while *C. fluminea* reached 3500 ind./m^2. Compared to previous studies (before the introduction of *C. fluminea*), the abundance of *D. polymorpha* has considerably decreased in this zone. However, at higher depths *D. polymorpha* was still the dominant species, which may indicate its higher plasticity related to the type of substrates and depths compared to *C. fluminea*.

Key words: Invasive mussels, *Dreissena polymorpha*, *Corbicula fluminea*, artificial lake, abundance, biomass, dominance.

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Invasive Alien Species in National Park Galicica, North Macedonia

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The National Park Galicica (NPG) is situated on Mountain Galicica, which is a part of the mountain range of Sara-Pind. Due to its exceptional natural beauty and extremely rich flora and fauna, both with high endemism, in 1958 the Macedonian section of the mountain was designated as a National Park. The Park covers an area of approximately 227 km^2 between the lakes Ohrid and Prespa, and it stretches in a meridian direction. The goal of this work was to provide the first report on the distribution of invasive alien species within the NPG based on various information sources in order to assist future decision-making concerning management strategies for these species. The occurrence of such species in the Park was determined from diverse sources, such as: internal reports, survey questionnaires and literature review. The lists of registered archeophytes and neophytes in the national flora have not been compiled precisely yet. Nevertheless, rough estimations show that there are more than 110 species and this number is continuously increasing. Out of these, 46 are considered invasive plant species. The following species were registered on Mountain Galicica: *Robinia pseudoacacia*, *Populus canadensis*, *Ailanthus altissima*, and *Pseudotsuga menziesii*.

Key words: Invasive species, alien species, protected area, conservation.

Modelling the invasiveness of *Tilia platyphyllos* in urban ecosystems in conditions of climate change

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Climate change can influence the boundaries of the native and alien plant species distribution. Fluctuations in air temperature, relative humidity and other factors can become a stimulus to initiation and/or intensification of the invasive nature of some alien plant species, especially in areas with a high degree of anthropogenic transformation. The identification of alien species and analysis of their population development is important for assessing the current state and forecasting possible changes in regional vegetation. Therefore, conducting studies on structure, viability and dynamics of local populations of alien plants, as well as of their tendency to become invasive is a topical issue of the present. This paper presents an analysis and prediction of invasive ability of the introduced linden species (*Tilia platyphyllos*) under climate change in the Northern Steppe Dnieper.

Thickets of young plants of seed origin were found on the territory of the city of Dnipro, in distant old parks 'Friendship of Peoples' (left bank of the city) and 'Zelenyi Gai' (right bank), where the large-leaved linden was introduced more than 60 years ago. Both parks were deprived of the proper maintenance by the municipal services for several years before the present study, which provided favourable conditions for the development of seedlings of different species. The young plants of *T. platyphyllos* in the local populations were located at a distance of 15 to 50 m from the mature potential parent plants. The analyses of the polynomial and linear models indicated that the size of local populations of *T. platyphyllos* has increased steadily over the past 13 years, regardless of the graphic representation of the models. The analytical dependence of the number of plants in the local population of *T. platyphyllos* in 'Zelenyi Gai' during development time was described by a polynomial model with a determination coefficient of 79.8%. The changes in number of the large-leaved linden young trees in the park 'Friendship of Peoples' were described by a linear model with a determination coefficient of 81.4%. The intensification of invasion process of this introduced linden species was positively correlated with the increase in temperature indices in comparison with the long-term climatic norm in the region. Consequently, in accordance with the predicted estimate, the tendency of expansion of local populations and further invasion of *T. platyphyllos* will be maintained until 2020.

Key words: Large-leaved linden, invasiveness, local population, modelling, climate change.

Ecological peculiarities of the helminth fauna of invasive *Carassius gibelio* (Bloch, 1782) from Madatapa and Khanchali lakes (Javakheti Wetlands, South Georgia)

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Wetlands belong to the most productive ecosystems. Javakheti Plateau is remarkable by the number of lakes and wetlands in the Caucasian Region, which serve as nesting and resting sites of local and migratory birds. The fauna of helminths of widely distributed invasive fish species gibel carp (*Carassius gibelio*) was investigated in two small, neighbouring lakes of Javakheti Plateau. In Madatapa Lake, the gibel carp was represented as a monospecies, while in Khanchali Lake, it was a dominant species. In both lakes, the material was sampled in September, but with time interval of four years: during 2014 in Madatapa and 2018 in Khanchali. A total of 34 young gibel carps were studied from Madatapa Lake and 24 young specimens from Khanchali Lake.

In Madatapa Lake, 91% (n=31) of the studied specimens appeared to be infested with larvae of two helminths, taxonomically different but with similar life cycles (trixenous type): *Ligula intestinalis* (85.2% n=29) and *Diplostomum spathaceum* (35.2% n=12). The infestation with both parasites was about 20.5% (n=7). In Khanchali Lake, 87.5% (n=21) of the studied gibel carps were infected by helminths, belonging to five taxa (*Ligula intestinalis, Diplostomum spathaceum, Tylodelphys clavata, Dactylogyrus* sp.*,* and Nematoda sp.) and four taxonomic groups (Cestoda, Trematoda, Monogenea, and Nematoda). Again, among the identified helminths dominated species with trixenous life cycle: cestoda – *L. intestinalis* (75% n=18) and trematodes – *D. spathaceum, T. clavata* (45.8% n=11). Nematoda (12.5% n=3) and Monogenea (4.1% n=1) were represented in low numbers. Cases of simultaneous invasion were also identified (79.1% n=19).

The peculiarities of the ecosystems of Javakheti Plateau are the main driving factors for the formation of the parasitic fauna of gibel carp in the studied lakes. The area is very important for aquatic birds. A great number of migratory and local fish–feeding birds inhabit the lake surroundings. The lakes are rich in zooplankton, especially copepods. The population of freshwater molluscs (*Limnaea stagnalis)* is abundant. In Madatapa Lake, 97.3% of investigated molluscs were infested with trematode larvae. Combination of these ecological components encourages the circulation of heteroxenous helminths and determines the structure of parasitic fauna of gibel carps in Madatapa and Khanchali Lakes.

Key words: Javakheti Wetlands, gibel carp, helminths, ecology.

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Are there records of the horse chestnut leaf miner *Cameraria ohridella* (Deschka & Dimic, 1986) on other host plants in Mountain Galicica?

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The horse chestnut leaf miner *Cameraria ohridella* (Lepidoptera: Gracillariidae) is among the 100 worse invasive species in Europe as listed in the DAISIE database, and a priority species for the ESENIAS region. This species virtually wholly develops on leaves of the white flowered horse chestnut, *Aesculus hippocastanum*, and causes extensive damages resulting in early defoliation of trees in the summer. In addition, *C. ohridella* has also been found attacking and developing on maple trees (*Acer pseudoplatanus* and *A. platanoides*), on which the damage levels may be as high as on the horse-chestnut. Although the moth has been firstly recorded near Lake Ohrid in North Macedonia, there is a few data about its occurrence in Mountain Galicica and there is no data about its other host plants.

A survey on the present infestation level of *C. ohridella* on *A. hippocastanum* and its potential impact on other host plants (*Acer* sp.) was conducted in Mountain Galicica. As a result of the study no infestation of *C. ohridella* was recorded on maple trees in Galicica Mountain. The infestation level of the moth on the horse chestnut trees is presented and discussed.

Key words: Invasive species, horse chestnut leaf miner, *Aesculus hippocastanum*, maples, infestation.

Distribution of *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) in Ukraine

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The introductions and spread of invasive insect species worldwide are largely due to climate change. In the past decade, the Asian ladybird, *Harmonia axyridis*, has spread throughout the world. In Ukraine, the first records of this species were reported in 2009. Here we make a review of the distribution of *H. axyridis* in Ukraine since its first introduction.

Within ten years (2009–2019) this species of ladybird has actively occupied all regions of Ukraine. In 2009, there were only 11 locations where *H. axyridis* was recorded, whereas by 2019 there were about 125 locations covering the entire country. Most of these locations were found in urban areas, mainly on common dogwood, *Cornus sanguinea*, used for gardening in the cities.

In terms of morphological features, five phenotypes (forms) of *H. axyridis* were found, four of which have naturalised: *conspicua*, *spectabilis*, *axyridis*, and *succinea*. The only specimen of the form *aulica* was found in the Odessa Region. The 'light' form *succinea* was the most commonly found form (for instance, 73.1% in Kiev). The proportion of various forms in the populations depends on the season and the gradient of urbanisation. As for Kiev, the 'black' forms were more common in the autumn in the surroundings of the metropolis and by the end of the year their abundance showed an increase. Throughout the years, the Asian ladybird has rapidly invaded vast territories, and according to published data, the species range has extended at a speed from 100 to 500 kilometers per year. According to expert opinion, *H. axyridis* will soon become one of the most common species on the continent.

Key words: *Harmonia axyridis*, invasive species, Ukraine.

Reports of some ornamental plants as aliens for the Bulgarian flora

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Introduced ornamental species are a major source of naturalised alien plants. Although the registration of such species is important for many reasons, e.g. monitoring of their distribution, impact and risk assessment, many ornamental plants which escaped from cultivation have not been reported for the Bulgarian flora yet. This concerns both long-used plants as well as recently introduced plants. We present data about the distribution, habitat condition and naturalisation of three ornamental taxa observed in different regions of Bulgaria. Considerations about their status are provided.

Hemerocallis fulva (Asphodelaceae), native to temperate Asia, is very widely cultivated in Bulgaria. It has been reported as an alien species for many European countries and is considered invasive in USA and Canada. In Bulgaria, localities of this common ornamental plant have been found in different floristic regions: North-eastern Bulgaria, Znepole Region, Sofia Region, Vitosha Region, Western and Central Rhodope Mountains.

Oxalis articulata (Oxalidaceae), native to temperate South America, has been naturalised in many parts of the world. In Bulgaria, it is used traditionally as a pot or balcony plant and only recently is planted in open areas as well. This species has been observed as escaped in natural vegetation in Southern Valley of the Struma River and in urban habitats in Sofia and Varna cities (Sofia and Black Sea Coast floristic regions).

Phalaris arundinacea var. *picta* (Poaceae) with white variegated leaves is a popular garden cultivar of a native species. It has been recorded as an alien in natural or semi-natural vegetation in wet places in the following floristic regions: Balkan Range (Western, Central), Rhodope Mountains (Western, Central).

The localities of *Hemerocallis fulva* and *Phalaris arundinacea* var. *picta* as a rule are a result of thrown-out plants or their propagules and consequent vegetative expansion and local establishment if the habitat is suitable. Both taxa can be considered established aliens. The data about *Oxalis articulata* are still very scarce and it has to be considered as 'casual'.

Key words: Alien plants, flora of Bulgaria, ornamental escapes, *Hemerocallis fulva*, *Oxalis articulata*, *Phalaris arundinacea* var. *picta*.

Acknowledgements: We are grateful to Boris Assyov, Rosen Vassilev, Kamen Bakardziev and Stefan Avramov who accompanied the first author during some of the field trips.

Distribution update for the invasive Pond Slider (*Trachemys scripta*) in Bulgaria with possible successful breeding in the wild

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This study presents an update on the distribution of the invasive Pond Slider (*Trachemys scripta*) with first evidence for successful breeding in the wild in Bulgaria. Since its first introduction in the 1990s the species has been slowly expanding its range across the country, with most observations concentrated in or around urban areas. The dataset for the Pond Slider sightings was complied by the authors' own observations for the period 2015–2019, with additional localities provided by colleagues and the citizen science project SmartBirds. Surveys were performed throughout the country on various natural, semi-natural, and artificial water bodies and the surrounding terrain, representing potentially suitable habitats for freshwater turtles. The dataset of Pond Slider presence/absence with exact geographic coordinates for each record was summarised and plotted on a national level using a 10×10 km UTM grid. A total of 46 new sightings were registered during the observation period, and the species distribution was expanded with additional five UTM squares compared to 1990–2015 data. The vast majority of the registered individuals belong to the subspecies *T. s. elegans*, but in recent years there have also been sightings of the nominate subspecies *T. s. scripta*; *T. s. trootsi* is yet to be reported for the country. On two separate occasions during the summer of 2017, a total of three different newly hatched *T. s. elegans* were observed along the canal around the hot springs near the Rupite Protected Area, where this species had been present since 1996. These were the first records of hatchlings in the wild and were documented in the Guide to Invasive Alien Species of European Union Concern. In May 2018, another newly hatched specimen of *T. s. elegans* was collected from a small pond near the canal in the same area and a female demonstrating nesting behaviour was observed next to the road along the canal. We can conclude that the species is expanding its range in Bulgaria and is also beginning to breed successfully in the wild.

Key words: Alien species, expansion, hatchlings, mapping, range.

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Regional peculiarities of the ecology of *Elodea* in Eastern Europe on the example of water ecosystems of Ukraine

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There are four species of the genus *Elodea* that are spread across aquatic ecosystems of Europe: *Elodea canadensis*, *Elodea nuttallii*, *Elodea callitrichoides*, and *Egeria densa* (= *Elodea densa*). Currently, these species are widespread in many European countries. *Elodea canadensis* has spread widely in Western and Eastern Europe almost simultaneously. In Ukraine, this species was first recorded in 1884. Secondary range expansion of the other *Elodea* species to the East did not happen so rapidly. *Elodea nuttallii* and *E. densa* appeared in Ukraine almost 100 years later than the first records in Western Europe (2001 and 2005, respectively). Records of *E. callitrichoides* in Eastern Europe are unknown.

All species in the habitats of Eastern Europe, in particular, in Ukraine, have shown certain regional population and phytocoenotic features. Due to the peculiarities of the ecological-coenotic strategy, these species are capable of naturalisation in natural ecosystems. *Egeria densa* and *E. nuttallii* are characterised by a wider ecological valence in relation to the content of nutrients in water. They expand actively borders of their secondary range in the region. *Elodea canadensis*, on the contrary, is characterised by vulnerability to anthropogenic eutrophication. We have recorded a significant decrease in its coenotic activity. In Ukraine, *E. canadensis* is at the stage of regressive changes in the secondary distribution area, it has disappeared from the flora of aquatic plants in certain reservoirs.

In Ukraine, the coenopopulations of *Elodea* have shown a wide morphometric variability, which demonstrates the plasticity of the species and the passage of the processes of their active adaptation. The populations are formed with morphometric parameters, which are larger than in the primary range, but smaller than in Western Europe.

Key words: Alien species, aquatic ecosystems, *Elodea*, Eastern Europe, Ukraine.

Modelling co-occurrence patterns of the invasive Pond Slider (*Trachemys scripta*) and the native European Pond Turtle (*Emys orbicularis*) in Europe

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The Pond Slider, *Trachemys scripta*, is an invasive species with a negative effect on autochthonous turtles. *Trachemys scripta* and the native *Emys orbicularis* have similar ecology, and therefore, interspecific competition is expected.

Species distribution modelling (SDM) has been used to determine potential distribution of invasive species in new environments. We used SDMs for the detection of co-occurrence patterns, understanding that ecological processes behind them could be scale dependent, and thus, such analyses may be subsequently refined by measuring and comparing co-occurrences at different scales. In this respect, creating coarse-scale SDM models regarding the distribution and habitat suitability (in terms of the bioclimatic niche) of both species in Europe can be considered as a first step in this direction.

Our occurrence data consisted of 3436 and 3662 georeferenced points for *T. scripta* and *E. orbicularis*, respectively (GBIF and our original data). To reduce sampling bias spatial autocorrelation methods were employed. The 'SDM' R package was used for creating the models. The performance was evaluated using the true skill statistics (TSS). The bioclimatic data (10 arcmin resolution) was downloaded from the CliMond archive; variables with VIF greater than 10 were excluded from model fitting. The most accurate technique was 'random forests' (TSS=0.60 and 0.66 for *T. scripta* and *E. orbicularis*, respectively).

The habitat suitability maps for Europe showed a strong correlation (Pearson's r=0.68) between the species, indicating high chances of co-occurrence and potential for interspecific competition. However, across Europe such chances of co-occurrence were very different and could range, for instance, from 0.83 in Latvia (north of *E. orbicularis* range) to 0.22 in Ukraine (south of *E. orbicularis* range).

Key words: Range expansion, invasive species, *Trachemys scripta*, *Emys orbicularis*, species distribution modelling, bioclimatic niche.

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Recent records of the brackish copepod *Eurytemora velox* (Lill.) in Ukranian rivers

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The genus *Eurytemora* of calanoid copepods has been considered as a neo-limnetic form. The species have a brackish water origin and mainly inhabit or recently migrate into fresh waters. *Eurytemora velox* is one of the typical crustaceans of oligohaline coastal waters of the Black Sea and the Sea of Azov, as well as the lower reaches of the main Ukrainian rivers. This species is especially widely distributed in streamlets, channels, marshes, ponds, and lakes of the Danube Delta, which waters show a high variability in salinity.

In the Middle Dnieper River and its tributaries, *E. velox* was found in the second half of the 20th century. In the region of Eastern Carpathian Foothills of Ukraine, *E. velox* was recorded for the first time in 2001 in a pond between the towns Drogobych and Boryslav. According to a number of deposited samples from 1976–1978, the species was absent in that watershed in the previous study period.

The most recent records of *E. velox,* in 2018, include Olexandriiske Reservoir on the Pivdenny Buh River, and continuous records in the cooling pond of the Khmelnitsky Nuclear Power Plant and its watershed. Furthermore, we found this species in the Dniester River at the Podol Uppland (near Kamianetc–Podilsky), in the Salgir River near Simferopol (middle of Crimean Peninsula), in many localities of the Horyn River of the Polissia Lowland (2001–2016), and in the Middle Dnieper River and upper parts of its tributaries.

This recent success of the copepod *E. velox* in invading fresh water up to the upper parts of the Ukrainian rivers can be interpreted as a result of mainly passive way (e.g. transit of undigested eggs in fish's guts); however, active way (locomotor moving) may also be considered.

Key words: *Eurytemora velox*, neo-limnetic form, successful distribution, upper parts of rivers, Ukraine.

Acknowledgements: The zooplankton samples from the Khmelnitsky Nuclear Power Plant cooling pond, courtesy of Prof. O. Protasov (Institute of Hydrobiology, NASU).

Mass aggregations of four invasive alien species of Hemiptera on *Hibiscus syriacus* in Sofia, Bulgaria

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The species *Hibiscus syriacus*, native to Southern China, has been currently introduced widely all over the world. This deciduous shrub is a common ornamental plant in Bulgarian city parks and gardens. Rarely, this species is planted as a hedge and is the most common in small groups of plants. Up to the first decade of the present century, only aphids have been reported as serious pests on *Hibiscus* in nurseries and greenhouses in Bulgaria.

In 2016, during a study of invasive alien true bugs in the city of Sofia, a mass development of *Oxycarenus lavaterae* on *H. syriacus* in Sofia downtown (N 42.692065; E 23.335043; 550 m a.s.l.; Knyazheska Garden) was detected. In addition to the heavy infestation with *O. lavaterae*, many specimens of *Nezara viridula* and *Pyrrhocoris apterus*, as well as a single nymph of *Halyomorpha halys* were observed. During the following two years (2017–2018), all mentioned species were recorded in a huge number at the same plants, together with another invasive alien species of Hemiptera – *Metcalfa pruinosa*.

Our results showed that on a comparatively small area (of about 10 m^2) huge amounts of four invasive alien hemipteran species co-exist together and manage to reproduce and develop successfully, feeding on the same plant, in particular on its fruits and seeds. Although three of the four species are polyphagous, they are very rarely observed to develop as a mass on a single specimen of the host plant or even on closely situated fruit capsules. Based on our findings, we suggest that *Hibiscus syriacus* may have a very good potential to facilitate the rapid spread of different invasive alien species of Hemiptera in urban environments.

Key words: Invasive alien species, true bugs and leaf hoppers, rose mallow, Sofia parks, Bulgaria.

Alien vertebrates in Romania – a review

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We conducted a literature review regarding the presence of alien vertebrates in Romania. We used conference abstracts, official reports, scientific articles, books, chapters and theses published between 1947 and 2018. In addition, we used the data provided by five of the best-known and largest online databases regarding alien species: the Invasive Species Compendium (CABI), The European Alien Species Information Network (EASIN), the Global Invasive Species Database (IUCN GSID), Delivering Alien Invasive Species Inventories for Europe (DAISIE), A Global Information System on Fishes (FishBase), and two national repositories for birds – ORNITODATA and Birding Romania. The literature review and survey of national online repositories resulted in a species list of 46 alien vertebrates, while the survey of the five online databases resulted in a list of 116 species. However, after a quality check of the latter, the number of species records was reduced to 44. The quality check resulted in excluding 49 species which are actually native to Romania, ten species present only in some form of captivity (zoos, aquaria) or domesticated, three fossil records, while the rest of species records were excluded due to their doubtful origin (e.g., improbable presence in Romania, possible erroneous identification/confusion, original source not found, species with uncertain origin/cryptogenic). Five new alien species for Romania, two recorded in the international databases and three in the national repositories, were provided through citizen science, and were not yet confirmed by the scientific literature.

Key words: Alien species, Romania, Actinopterygii, Aves, Mammalia, Reptilia.

Changes in distribution of *Elodea canadensis* in Lake Ohrid in the period 2000–2016

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Elodea canadensis is an alien species to the Republic of North Macedonia; it is known as 'water plague' because of its rapid and easy spreading in different habitats. In Lake Ohrid, *E. canadensis* was introduced in 1957 through the Channel Studencishta. Later, the species entered the waters of the Drim River and the springs Tushemisht – St. Naum. With this study we present the changes in distribution of *E. canadensis* in Lake Ohrid in the period from 2000 to 2016. The study was performed at total of 38 localities, covering almost the whole Macedonian coastline along Lake Ohrid (from Radozda to St. Naum).

The obtained results indicated that over the last 16 years there have been changes in distribution of *E. canadensis* in Lake Ohrid in terms of number of localities and depth distribution. In 2000, this species was present in 16 localities at depths from 2 to 6 m, while in 2016, it extended its range and was found in 22 localities at depths from 0 to 12 m. In the studied localities, *E. canadensis* grew at various substrates (stony-sandy, sandy, sandy-muddy, and muddy), and it was present in localities of coastline with different conditions: from very clean (nutrient poor) to polluted (nutrient rich) waters. If the uncontrolled spread of this plant species continues in the future it may have high negative impact on the native macrophyte vegetation along the coastline of Lake Ohrid.

Key words: Alien species, changes, *Elodea canadensis*, Lake Ohrid.

Inventory of alien fish species in Lake Ohrid catchment in 2016

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The ancient Lake Ohrid represents one of the most significant hotspots of endemic biodiversity on the Balkan Peninsula. It is known that the aquatic and isolated ecosystems with globally significant biodiversity are most vulnerable to different impacts, such as invasive alien species (IAS). The tributaries and water bodies in the lake's catchment may play an important role in the introduction of alien and invasive species into Lake Ohrid. Our previous study in 2013 showed the occurrence of two alien fish species (*Carassius gibelio* and *Pseudorasbora parva*) of comparatively low abundance in Lake Ohrid tributaries and its outflow the Crni Drim River. The aim of the present study was to monitor and assess the status of the alien fish species in Lake Ohrid catchment, with a special focus on the Sateska River and the Crni Drim River.

The study was conducted in May 2016. A total of 15 sites were sampled, as follows: the Sateska River (6 sites), Crni Drim River (3 sites), Lake Ohrid (1), Lake Prespa (2), Debarsko Lake (2), and Globocica Reservoir (1). The samples were collected using a cast net and dip net. Water physical and chemical parameters were measured at each sampled site.

A total of 288 fish specimens were recorded. They belonged to 15 species and four families: Petromyzontidae, Cyprinidae, Cobitidae and Salmonidae. Fourteen fish were native, of them, 13 species – endemic to Lake Ohrid and Crni Drim River catchments. The only alien species recorded was *Pseudorasbora parva,* which is considered an IAS of European Union concern. Most frequently found were *Alburnus scoranza*, *Pachychilon pictum*, and *Squalius squalus* (mainly in the Crni Drim River system), followed by *Barbus rebeli* (in both rivers) and *Phoxinus limaireul* (mainly in the Sateska River). Single specimens of *P. parva* were found in Prespa Lake at Oteshevo and in Debarsko Lake at Melnichki Most. *Phoxinus limaireul* had the highest relative abundance, followed by *A. scoranza* and *Rutilus ohridanus*. Although our results showed a low number and abundance of the alien fish species, urgent measures, including regular monitoring and awareness raising about IAS, are needed in order to protect the endemic ichthyofauna in Lake Ohrid and its catchment.

Key words: Sateska River, Crni Drim River, fish, invasive alien species, distribution, composition.

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Bioclimatic modelling of the distribution of the brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855), with special reference to Ukraine

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The brown marmorated stink bug *Halyomorpha halys* (Stål, 1855), an invasive species of Pentatomidae (Heteroptera) native to Eastern Asia, in recent years has been unintentionally introduced into the United States and Europe. The species has already appeared in Sochi (Russian Federation) and Georgia and is assumed to have been brought to Sochi from Europe (Italy) with planting material of ornamental plants for landscaping the 22nd Olympic Winter Games. Most recently, in 2016, the bug egg mass has been recorded in Odesa (Ukraine). This detection of the bug calls upon the need to forecast the potential suitable bioclimatic range of the pest in Ukraine. For this purpose a species distribution modelling (SDM) approach has been used. The occurrence data consisted of 573 non-duplicate European records. Sampling bias and spatial autocorrelation were reduced to improve model performance. The 'sdm' R package was employed for building the models, including 'random forests', 'boosted regression trees', 'bioclim', 'maxent' and 'support vector machine'. The performance was evaluated using the true skill statistics (TSS). The bioclimatic data was downloaded from the *CliMond* data set; variables with a variance inflation factor (VIF) greater than 10 were excluded from model fitting. The most accurate technique was 'random forests' (TSS=0.80) and the least accurate was 'bioclim' (TSS=0.34). In terms of variable importance, the annual mean temperature and temperature seasonality were the highest contributing variables in formulation of the models, accounting up to nearly 60% of the variation. High-accuracy predictive distribution maps from the 'random forests', 'maxent' and 'support vector machine' models were combined to form ensemble forecasting of *H. halys* distribution. According to the SDM, under current climate conditions the pest has chances to significantly expand its range in Ukraine. Particularly threatened are areas located in the Transcarpathian Lowlands (Zarkarpattia Oblast) and most of Crimea; other areas of potential invasion cover sections of the Odesa, Mykolaïv, Kherson, and Zaporizhia regions.

Key words: *Halyomorpha halys*, species distribution modelling, Ukraine.

Modelling the distribution and habitat associations of the monkey goby, *Neogobius fluviatilis* (Pallas, 1814) (Actinopterygii, Gobiiformes) in Europe

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Our study evaluates the distribution and habitat associations of the monkey goby, *Neogobius fluviatilis*, which has invaded continental Europe. We developed a species distribution model (SDM) using 409 occurrence data for the species and GIS environmental data layers characterising river catchments, including climate (http://chelsa-climate.org), soil features (https://soilgrids.org), net primary production (https://sedac.ciesin.columbia.edu), and the Human Footprint (HF) downloaded from the same SEDAC website and used as a measure of anthropogenic impact. Sampling bias and spatial autocorrelation were reduced to improve model performance, and environmental variables with a variance inflation factor greater than 10 were excluded from model fitting. The 'sdm' R package was employed for model building, including 'random forests', 'bioclim', 'maxlike', 'glm', and 'domain'. Performance was evaluated using the true skill statistics (TSS). The most effective technique was the 'random forests' (TSS=0.87). In terms of variable importance, the Annual Mean Temperature (Bio01), Mean Temperature of Wettest Quarter (Bio08) and HF were the highest contributing variables in model formulation, accounting collectively 71% of the variation. Interestingly, the soil variable 'sand percentage' contributed only 2%. The response curves showed upward trends for the variables Bio01, Bio08 and HF, indicating their positive relationships with the predicted habitat suitability. These findings give a reason to believe that rising temperatures due to climate change could have triggered the recent expansion of the monkey goby. This climate-driven expansion is likely to have been elevated by man-made alterations of river systems, in particular through the development of inland shipping infrastructure and building of artificial banks with rip-rap habitats which are often preferred by the gobiids and facilitate their establishment, and are sources for further expansion. We measured fragmentation of high-suitability habitat, because such habitat is defined as essential for species persistence. Primary areas of high-quality and less-fragmented core habitat broadly occupy a vast area stretching from Southeastern Poland across Ukraine towards the Caspian Sea, much of which includes the native range of the species. Other sizeable core areas where the species has established populations are centered in the Pannonian Basin, Northwestern Germany and the Netherlands. Similar core areas are predicted to occur in North Italy and Southeastern England.

Key words: *Neogobius fluviatilis*, invasive species, species distribution modelling.

First record of *Humulus japonicus* (Cannabaceae) in the Bulgarian flora

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Humulus japonicus (Cannabaceae) was recorded as an alien species for the first time in the Bulgarian flora, on the banks of the Yantra River, Northeast Bulgaria Floristic Region. At the reported locality, the species formed an abundant population of hundreds of individuals, inhabiting riversides, especially the bare alluvial bars formed by temporary floods. As a vigorous climber, *H. japonicus* outcompeted the other plants, including the native *Humulus lupulus*.

Humulus japonicus is native to East Asia but it has been cultivated as an ornamental plant in many countries of the world. In Europe, the species has been reported as an alien from a number of countries. On the Balkans, it has been recorded in Romania, Serbia and Slovenia. The poster presents data about the recorded population of this alien species in Bulgaria, the main distinguishing characters with the native *H. lupulus*, and some considerations and observations about the impact of the species.

Key words: Alien plants, invasive species, Japanese hop, new floristic records, ornamental plants.

Acknowledgements: *Humulus japonicus* was recorded during field work within the project 'Flora of the Republic of Bulgaria, vol. 12: Biological diversity in Asteraceae subfam. Carduoideae and Cichorioideae', funded by the Bulgarian National Science Fund under Contract DN01/7 of 16.12.2016. Part of the study was carried out in the framework of the National Science Programme 'Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters', approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science of Bulgaria (Agreement № DO-230/06-12-2018).

The alien species of *Heracleum* (Apiaceae) in the Bulgarian flora revisited

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The genus *Heracleum* (Apiaceae) is represented by four native species in the Bulgarian flora. In 2017, an alien species, *H. sosnowskyi*, was reported for the first time for Bulgaria in Acta Zoologica Bulgarica, Supplement 9: 47–51, 2017. However, further studies have revealed that the species is misidentified and the reported plants in fact belong to *H. mantegazzianum*. Therefore, *H. mantegazzianum* has been recorded in Sofia City, Sofia Floristic Region.

In summer 2018, *H. sosnowskyi* was found in the Rhodope Mountains. The population comprised a few thousand specimens spread in grasslands, arable land and along three confluent rivers. The specimens outgrew any of the native herbaceous plants and reached a height of over three meters. The poster presents the main distinguishing characters between *H. mantegazzianum* and *H. sosnowskyi* and provides some data about the population, local spread and impact of *H. sosnowskyi* in the Bulgarian flora. Both species are native to the Caucasus, *H. sosnowskyi* extending southwards to Transcaucasia. In Bulgaria, *H. mantegazzianum* has been recorded so far in the Sofia Floristic Region, while *H. sosnowskyi* – in the Rhodope Mountains (Western).

Key words: Alien plants, Giant hogweed, *Heracleum mantegazzianum*, *Heracleum sosnowskyi*, invasive species, Sosnowky's hogweed.

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Invasive alien flora of the Zagreb County (Croatia) – spatial distribution and potential spread

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The County of Zagreb consists of urban and rural areas, which are extremely affected by alien species, and their mapping began in 2012. A preliminary study of invasive alien plants was performed in nine selected towns of the Zagreb County. In total, 541 plots of 250 × 250 m^2 were investigated, and 39 invasive taxa were recorded. The most represented families were *Asteraceae* (35.90%) and *Poaceae* (10.26%). Most of the detected invasive plants were therophytes (48.72%), and originated from Americas (71.79%). The most frequent plants recorded in all towns of the Zagreb County were *Erigeron annuus, Conyza canadensis* and *Ambrosia artemisiifolia.* The majority of invasive taxa were good indicators of warmer habitats and soils with low acid content. The most common life strategies were CR (41.03%) and C (38.46%), and zoochory was the most frequent way of spreading (20.51%). A fragmentation of the habitat was noted at 89.65% of the explored plots. The spatial distribution showed an increase in the number of invasive plants at most surfaces, especially in urban areas and rural outskirts. Several anthropogenic, abiotic and biotic factors that can affect the spread of invasive plants were detected, and the study has pointed to the need for permanent monitoring of distribution of alien and invasive plants in order to control their further spread within and outside the Zagreb County.

Key words: Invasive plants, non-native plants, spatial distribution patterns, urban flora.

Oithona davisae (Ferrari F. D. & Orsi, 1984), a new invader for South Eastern Black Sea Coast: Invasion history and present situation

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Oithona davisae is a zooplankton species, which is indigenous to the coastal areas of the Japan and China Seas. This new non-native cyclopoid copepod species was first discovered at the Black Sea Anatolian Continental Shelf Area during a regular monitoring programme in 2009. It is one of the top 10 invaders in the ESENIAS area, widely distributed in the Black Sea. *Oithona davisae* feeds on pico- and nano-planktonik groups and because of energy transfer efficiency this species is a valuable food item for fish larvae. According to our recent observations, *O. davisae* has replaced the other cyclopoid copepod *Oithona nana* in the Black Sea. Because of its feeding behaviour *O. davisae* has become one of the key species for the energy transfer to the upper level of the food web. Considering these features, *O. davisae* is given special importance in the plankton studies in the Black Sea recently. The aim of the present study was to determine the population structure and the biomass of *O. davisae* in the coastal and off-shore area of the South Eastern Black Sea Anatolian Continental Shelf Area.

Samples were taken quarterly from February 2015 to November 2015. Our results showed that the abundances of *O. davisae* were higher in the coastal areas when compared with the off-shore waters of the Southeastern Black Sea. The abundance of *O. davisae* population changed with season and the highest population abundance was observed in November at the amount of 7,344 ind. m^{-3}. In contrast, the lowest population abundance was estimated in May 2015, when its value was 68 ind. m^{-3} in the coastal stations, while there were no *O. davisae* individuals detected at the off-shore station in the sampling areas. Therefore, it can be concluded that autumn is the most productive period for *O. davisae*.

Key words: Black Sea, Copepoda, invasive alien species.

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TOPIC 2: VECTORS AND PATHWAYS FOR INVASIVE ALIEN SPECIES INTRODUCTIONS

Analysis, prioritisation, action plans

Potential pathways of invasive plant species distribution in the water bodies of Ukraine

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Global climate changes significantly affect plant and animal species, inter-species relations and ecosystem processes. For instance, changes in the species distribution become more frequent, quick and, what is the most important, irregular. On the territory of Ukraine, excessive vegetation of *Pistia stratioides* and *Trapa natans* has occurred, and some species, such as *Ceratophyllum tanaiticum*, *Typha laxmanii*, and *Arundo donax* have expanded their range. Here, we make a review of potential pathways of spread of invasive plant species in water bodies of Ukraine.

We suppose that the spread of many invasive aquatic vascular plants and algae in the waterbodies of Ukraine, beside other pathways, can occur owing to transport of their vegetative fragments and seeds by the waterfowl and wetland birds. Firstly, this concerns birds, which feed on plants, and thus, distribute them (endozoochoria), such as: Greylag Goose (*Anser anser*), Mute Swan (*Cygnus olor*), Mallard (*Anas platyrhynchos*), Teal (*Anas crecca*), Gadwall (*Anas strepera*), Wigeon (*Anas penelope*), Pintail (*Anas acuta*), Garganey (*Anas querquedula*), Shoveler (*Anas clypeata*), Red-crested Pochard (*Netta rufina*), Pochard (*Aythya ferina*), Ferruginous Duck (*Aythya nyroca*), Tufted Duck (*Aythya fuligula*), Moorhen (*Gallinula chloropus*), and Coot (*Fulica atra*). Secondly, fragments of the aquatic plants can be transported for the nest building by the Great Crested Grebe (*Podiceps cristatus*), Grey Heron (*Ardea cinerea*), Black-headed Gull (*Larus ridibundus*), and some other birds. Furthermore, many birds can accidentally transport algae, seeds and vegetative fragments of vascular plants, attached to their legs and feathering (epizoochoria). This is indirectly proved by vegetation of some freshwater species (particularly *Typha*, *Bolboschoenus*, and *Juncus*) at sites where the artesian wells are made within salinised vast areas, as well as in some water bodies outside the floodplains, far from the main distribution areas. Therefore, we recommend hydrobotanical and hydroecological monitoring, especially related to invasive species, to be carried out in close cooperation with ornithologists. This will enable more substantial prognosis of the spread of invasive plants and their negative impact in water bodies of Ukraine.

Key words: River systems of Ukraine, invasive species, water vascular plants and algae, invasions, distribution pathways, ornitohoria.

Pond aquaculture as a pathway of introduction and spread of *Perccottus glenii* in Latvia: current status and proposed prevention measures

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Uncontrolled fish transfer by fishermen, aquarists and aquaculture can be a plausible important vector and external anthropogenic trigger for the Chinese sleeper *Perccottus glenii* invasion in Europe. In the present study, we analysed the role of the pond fish stock farms as a pathway of introduction and spread of the invasive *P. glenii* in Latvia. For this purpose, we: 1) investigated the distribution of *P. glenii* in the water systems of 26 pond farms in Latvia by catching and conducting interviews with 114 fish farmers and fishermen; 2) conducted a search for sales of *P. glenii* for stocking ponds on the trade portal www.ss.com and other websites; 3) evaluated the possibility of the accidental distribution of *P. glenii* when selling other fish; 4) evaluated the possibility of transboundary actions of the above-mentioned factors.

As a result of the study carried out, we found out two ways of anthropogenic industrial settlement of *P. glenii* in the pond aquaculture: 1) special sale of *P. glenii*, as a new species for stocking into ponds (two cases); 2) possible spread when selling fry of other species of fish. In addition, we found out the non-industrial, but widespread re-settlement of *P. glenii* by owners of traditional aquaculture small ponds and fishermen (16 cases). We also found out the transboundary effect of the above mentioned factors: 1) in Latvia, the fry from the Lithuanian pond farms were sold without biological control with delivery throughout Latvia; 2) at least in one case, the fishermen from Latvia illegally imported *P. glenii* from Belarus (~100 individuals) and released into six local ponds.

The measures we have developed to control the pathways of introduction and spread of *P. glenii* related to aquaculture in Latvia include: 1) drawing-up a National Action Plan for *P. glenii* with implementation of control on aquaculture vectors; 2) cross-border coordination of the actions with similar plans in neighbouring countries; 3) annual e-DNA identification of *P. glenii* and certification of ponds of fish farms to obtain the right to sell fry in Latvia (including foreign ones); 4) automatic species sorting of the fries, proposed for sale, using the transparent tubes for eradiation of *P. glenii*. In addition, the barcoding methods are necessary to be developed.

Key words: Range expansion, invasion vectors, aquaculture, invasive alien species control.

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Intentional introduction of non-native fish species in the Republic of North Macedonia: benefits and consequences

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In many cases, intentional introduction of non-native fish species have been reported in the Republic of North Macedonia. There are many different reasons, and in this study we focus on three of them: food production, disease control, and bio-manipulation in order to improve the water quality.

The rainbow trout (*Oncorhynchus mykiss*) is an important species for aquaculture. It occupies the second place in the list of the most frequently introduced species in the world, having been spread for farming and stocking. The aggressive behaviour of this introduced species may alter the distribution pattern of native fish. The rainbow trout has been introduced to Lake Ohrid. According to some reports this species may be a competitor to native salmonids, as they have overlapping habitats and dietary requirements, which may lead to the reduction of native salmonid populations in the lake.

In the early 20th century two native North American species, *Gambusia holbrooki* and *Gambusia affinis*, were introduced to Europe as a mosquito control agent. The species *Gambusia holbrooki* was introduced also to Lake Ohrid watershed in order to suppress malaria. In Europe, *Gambusia* species are responsible for the impairment of foraging success, decreased survival rate, and reduction in reproduction rate of several native fish of comparable size and amphibian tadpoles, whish cannot effectively compete with this highly adaptive coloniser. Similar impact may be expected in Ohrid Lake watershed.

The grass carp (*Ctenopharyngodon idella*) was introduced to Strezevo Reservoir and according to published data so far, this species has been an efficient bio-manipulation fish for reducing the macrophytic biomass in the Strezevo hydro-ecosystem. Bio-manipulation with fish species has been very effective in the process of slowing down the quick growth of the primary and a part of the secondary production, as well as of preserving the quality of aquatic ecosystems.

For the success of future conservation and management programmes, it is necessary to understand better the pathways of introduction and spread as well as the impact of invasive alien species of fish in the Republic of North Macedonia.

Key words: *Oncorhynchus mykiss, Gambusia* species, *Ctenopharyngodon idella*, Lake Ohrid, Strezevo Reservoir.

Topic 3: The Danube River as invasive alien species corridor

Priority species for the Danube Region, impact on threatened species, specificity of biological invasions in the Lower, Middle and Upper Danube River sections

Invasibility of different habitat types in riparian areas of Serbia

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Habitat type is considered to be one of the best predictors of the level of invasion at the regional level. Riparian habitats are seen as one of the three habitat types which represent the most significant sources of invasive plants. Furthermore, given that mapping of the level of invasion of neophytes in Europe has predicted the highest invasion levels for the lower basin of the Danube River, the aim of our research was to determine which habitat types in riparian areas of rivers and canals in the Danube catchment area in Serbia are the most invaded and which invasive alien species (IAS) are dominant in these habitats.

The riparian areas along the course of 39 rivers and six canals of the Danube-Tisa-Danube hydrosystem (250 field sites in total) were analysed during four consecutive years. The plant cover and abundance were recorded along the studied 100 m long transects and scored following the standard *van der Maarel* scale. Habitat types of the analysed field sites were determined in accordance with the European habitat classification system (EUNIS), up to the third hierarchical level.

A total of 27 different habitat types were identified. The most highly invaded habitats were found to be: Riparian and gallery woodland (G1.1 habitat type), with 200 records of IAS; Anthropogenic herb stands (E5.1) with 178 records; Riverine scrub (F9.1) with 125; and Southern riparian galleries and thickets (F9.3), with 117 IAS records. On the other hand, the smallest number of IAS was recorded in: Beech woodlands (G1.6), Highly artificial coniferous plantations (G3.F), Pavements and recreation areas (J4.6), and Small-scale ornamental and domestic garden areas (I2.2). When observing the number of different IAS taxa in the analysed habitat types, the highest diversity was evident in Southern riparian galleries and thickets (26 IAS registered), followed by Anthropogenic herb stands, with 23, and Riparian and gallery woodland, with 21 species. The IAS which were recorded in the highest number of analysed habitat types were *Erigeron canadensis* (21), *Robinia pseudoacacia* (19), *Echinochloa crus-galli* (18), *Xanthium strumarium* subsp. *italicum* (18), and *Amorpha fruticosa* (17).

Key words: Invasive plants, level of invasion, riparian habitat, rivers, canals, Danube Basin.

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New records of the tropical aquatic worm *Branchiodrilus* (Clitellata, Naididae) in the Danube River

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The naidid genus *Branchiodrilus* is very common in Asia, and according to some authors, the first discovery of this aquatic oligochaeta in Europe was in the Botanical Garden in London together with the tubificid species *Branchiura sowerbyi*. This specimen was described in 1890 as *Branchiodrilus semperi*. Since then, it has been recorded in the Netherlands, Belgium, France, and Slovakia as the species *B. hortensis*. A recent molecular phylogeny suggested that species complexes may occur within the genus *Branchiodrilus*, potentially represented by 10 different species. However, morphological examination has grouped all specimens from the Palearctic Region and suggested that all of them belong to the same species, probably *B. hortensis*, one of the three nominal species of the genus. Furthermore, the latest molecular analysis has conformed that the Oriental region might be the centre of origin, from which *Branchiodrilus* species have dispersed and radiated. In our latest investigation of the Danube River (September 2018 and April 2019), along a river section of 588 rkm in Serbia, we recorded *Branchiodrilus* specimens at four localities: Ram (8 ind.), Veliko Gradište (14 ind.), Donji Milanovac (2 ind.), and Kladovo (56 ind.). The scattered findings and native distribution of this worm suggests that its introduction in the Danube River has probably been human mediated. These new records are valuable contribution to the knowledge of the species distribution. In this phase, we are not able to predict the possible effects of *Branchiodrilus* on the aquatic ecosystems, and therefore, further monitoring on its distribution and population dynamics is necessary.

Key words: New records, invasive species, Serbia, the Danube River.

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Invading the Danube River: range extension of Ponto-Caspian polycheate *Manayunkia caspica* Annenkova, 1929

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Freshwater polychaetes are most diverse in the Palaearctic Region and beside Lake Baikal, the second notable area of diversity is the Ponto-Caspian region, comprising low saline waters (0.5–5%) of the Black and Caspian Seas. There are several characteristic polychaetean species that are spreading from this area and among them are *Hypania invalida*, widespread in European freshwaters, and *Manayunkia caspica*, which distribution range has been probably prevented for a long time due to the Iron Gate dam. The latter Ponto-Caspian relict was found in the Danube River for the first time in 1943 and has been well known along almost the entire Romanian stretch of the river. It reached the Serbian Danube part in November 2005. After that the species has been repeatedly found at 934 rkm (the town of Kladovo), in the reservoir Iron Gate II. During the Joint Danube Survey 3 (JDS 3) in September 2013, *M. caspica* was recorded at five localities in total: Romania/Bulgaria: Pristol/Novo Selo; Hungary: upstream Budapest and Szob; Slovakia/Hungary: Iza/Szony and Klizska Nema as the most upstream locality. These findings moved the limit of the species distribution upstream of the Iron Gate and confirmed that this Ponto-Caspian relict, extend its known distribution from the Ponto-Caspian region to the Central and Western Europe. It is obvious that *M. caspica* has become a regular element of the macroinvertebrate fauna along the entire stretch of the Danube River, establishing its populations. Additional research is needed in order to understand better how the presence of this species will affect the existing communities.

Key words: Polychaeta, alien species, range extension, the Danube River.

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Analyses of intestinal content of round goby *Neogobius melanostomus* (Pallas, 1814) in the Serbian part of the Danube River Basin

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In the Serbian part of the Danube River, of the 25 fish species recorded, five species from the Gobiidae family have a participation with 10-20%. Since the early seventies, the spreading of the gobiids along the Danube River has been reported, mainly owing to the construction of dams and channels linking larger rivers. The round goby *Neogobius melanostomus* is a fairly small bottom-dwelling fish, living in brackish and freshwater environments. It is typically found near sandy, stony bottoms. This fish mostly stays in one place with noticeably restricted movement. A patchy distribution and long distances between native regions of occurrence and newly settled areas is characteristic for the current world distribution of the species. Most probably, transport has occurred in ballast waters. The aim of our study was to analyse the intestinal content of round goby in the Serbian part of the Danube River Basin.

The fish samples were collected during October 2018 at three localities in the Danube River (Zemun and Stari Slankamen) and Velika Morava River (Ljubičevo). A total of 35 individuals of round goby were collected and examined. Fish were caught with electrofishing ((HONDA 1,2ĸW, 6 A) and transported to the laboratory, where the analysis of their intestines for food items was conducted. The intestines were examined under an Olympus binocular microscope and an Olympus stereomicroscope. Identification was carried out to the species level, using the appropriate identification keys.

At the locality Ljubičevo, eight from 18 sampled specimens were without intestine content. At the localities Zemun and Stari Slankamen, one specimen of ten and seven, respectively, was without food items. The analysis showed that the intestinal content of the round gobies consisted of representatives of the family Gammaridae (*Dikerogammarus* sp.), insect larvae (Trichoptera), Gastropoda, Bivalvia (family Unionidae) and Oligochaeta. The diet of fish samples from Ljubičevo consisted mostly of gammarids and oligochaets, while this of fish from Zemun and Stari Slankamen from caddisfly larvae and molluscs. Round gobies are voracious feeders, eating mussels and other molluscs, with up to 60% of their diet made up of mussels in some places. They also eat aquatic insect larvae and the young and eggs of other fish.

Key words: Food items, round goby, Danube River, Velika Morava River.

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JDS4 preliminary results on the distribution of invasive alien species in the Bulgarian sector of the Danube River

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The introduction and spread of invasive alien species (IAS) in the Danube River Basin (DRB) have increased recently. As a result, the biodiversity and ecosystems are affected, and adverse socio-economic impact and impact on human health have been reported. During the Joint Danube Survey 3 (JDS3) (2013), the level of biocontamination of the studied section was estimated as moderate to high, with higher levels for the Upper and Middle Danube River. The International Commission for the Protection of the Danube River (ICPDR) acknowledges that IAS have become a major concern for the DRB and they are included as a major issue to be addressed by the Danube River Basin Management Plan update (2015). The ICDPR has prepared a 'black list' as well as a guidance document on IAS relevant to the DRB, including tools for risk assessment and evaluation of impact. Considering the importance of IAS in terms of the implementation of EU Water Framework Directive 2000/60/EC, an individual IAS programme has been designed and implemented during JDS4 (2019) at country levels. Here we report preliminary results on the implementation of the JDS4 IAS programme in Bulgaria.

The sampling was conducted in July – August 2019, during three expeditions in the Danube River, in adjacent standing water bodies (canals, lakes, marshes), lower reaches of some Danube tributaries, as well as in lower and middle reaches of the Yantra River and its main tributaries. The samples were collected by different methods: beach seine and dip net for fish, dredging from a boat and from the shore for molluscs, and LiNi traps for crayfish.

The preliminary results showed the occurrence of 11 invasive alien species in the studied Bulgarian sector of the Danube River and adjacent water bodies. Most frequently found was *Corbicula fluminea* (in the Danube River and its tributaries) and *Carassius gibelio* (in all studied types of water bodies). The fish *Pseudorasbora parva* and the mussels *Dreissena bugensis* and *Sinanodonta woodiana* were found at single sites in the Danube River. Some of the alien species (*Orconectes limosus*) were recorded mainly in the tributaries, while others (*Ameiurus melas*, *Lepomis gibbosus*, *Perccottus glenii*, *Pectinatella magnifica*) were found mostly in the standing waters and canal systems. We recorded seven invasive alien species of EU and regional concern (DRB) at 14 sites with the smartphone application **'**Invasive Alien Species Europe' developed by the European Commission's Joint Research Centre (JRC) and updated with the Danube IAS 'black list'. The further processing and analysing of collected samples will allow us to assess the pressure of the recorded IAS on native species and ecosystems and make comparisons with other Danube River sectors as well as with data from previous study periods.

Key words: JDS4, invasive alien species, monitoring, EU Water Framework Directive, smartphone application.

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Invasive spiny-cheek crayfish *Orconectes limosus* (Rafinesque, 1817) invades new areas in the Danube River Basin in Serbia

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The spiny-cheek crayfish, *Orconectes limosus*, native to the eastern part of the North American continent was introduced in Europe at the end of 19th century and up to now has become the most widespread non-indigenous crayfish species in Europe. Introduction in the Danube River was first observed near Budapest in 1985. Nowadays, the spiny-cheek crayfish is presented along the entire course of the river and across Europe in total of 21 countries. The first record from Serbia was in the Danube River near Apatin in 2002, and then near Smederevo in 2004 when 13 individuals were detected. In 2008, new records have been reported from the Danube River near Veliko Gradište, Donji Milanovac, and in Đerdap Gorge. Since then, this species has expanded its range along the entire section of the Danube River in Serbia. The colonisation has continued further upstream and downstream at seven new sites along the river main course: Bogojevo, Bačka Palanka, Slankamen, upstream of the Sava confluence, Pančevo, Banatska Palanka, and Kladovo. Moreover, the spiny-cheek crayfish has spread into all main tributaries of the Danube River, the rivers Sava, Tisa and Velika Morava, as well as in the Danube–Tisa–Danube Canal. The species was recorded also in the Tamiš River in 2019, confirmed earlier detected finding from 2011. All these new records and the fast dispersal rate, together with the negative effects on native crayfish species, in particular *Astacus leptodactylus* found at the most sites in association with *O. limosus*, suggest that urgent measures are needed in order to prevent the further dispersion of this invasive species.

Key words: Spiny-cheek crayfish, invasive species, Serbia, range expansion.

Topic 4: Invasive alien species impact

Impact on biodiversity and ecosystem services, impact on human health, safety and the economy; pests and pathogens; adverse impact on protected areas, endangered species and habitats

Invasive insect species detected on grapevine in Romania in 2016–2018

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Romania is a great cultivating country of grapevine. The area of vineyards in 2016 was about 180 thousand hectares, ranking this country on the 5th position in Europe and on 11th position in the world. Different non-native insect species with invasive character, such as leafhoppers, lepidopterans and fruit flies, entered Romanian territory in the recent years, representing new threats to the agro-ecosystems of grapevine. Early discovery and monitoring are essential practices in preventing the spreading of the invasive species. These are also the basis of adopting the most appropriate management measures prior to pest population increases.

Here we present the findings of the survey conducted in 2016–2018 in vineyards from the viticultural regions in western and eastern parts of Romania. There are reported data on six non-native insect species: three species of Auchenorrhyncha leafhoppers from the Cicadellidae family, *Phlogotettix cyclops*, the Japanese leafhopper *Arboridia kakogawana* and the grape leafhopper *Erasmoneura vulnerata*; two species of Lepidoptera, the vine bud moth *Theresimima ampellophaga* from the Zygaenidae family and the American grapevine leaf miner *Phyllocnistis vitegenella* from the Gracillariidae family; and one species of vinegar fly, the spotted-wing crosophila *Drosophila suzukii* from the Drosophilidae family. The insect sampling was done using: yellow double-faced sticky traps for the leafhoppers, specific feromone traps for the vine bud moth, visual inspections for the miner moth, and plastic bottles of 0.5 l baited with apple vinegar and red wine mixture for the drosophilids. The data with regard to the presence and impact of the detected invasive species are presented.

Key words: Invasive insects, grapevine, Romania.

The alien Auchenorrhyncha (Insecta: Hemiptera) species to Turkey: their known and potential impact on agriculture lands

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Alien Auchenorrhyncha species are insects that have negative econonomic impact on cultivated plants owing to their feeding. *Metcalfa pruinosa* and *Orosanga japonica* attracted attention in recent years, especially due to the damages on agricultural plants in the Eastern Black Sea region. They are invasive in the Western Palearctic Region and are listed on the EPPO's list as polyphagic pests. Four Auchenorrhyncha species are considered alien in Turkey: *Metcalfa pruinosa* from the family Flatidae, *Orosanga japonica* from Ricaniidae, *Stictocephala bisonia* from Membracidae, and *Kyboasca bipunctata* from Cicadellidae. Data on their distribution across the country and their impact on agricultural areas were summarised and updated. The field surveys about distribution and impact of *M. pruinosa* and *O. japonica* were conducted in the agricultural areas of the Western Black Sea region.

Orosanga japonica has been distributed along the Black Sea coast of Turkey since 2007 and has caused great damages in tea gardens, especially in the Eastern Black Sea provinces. Experiments have been conducted by many researchers in the Eastern Black Sea region to combat biopesticides against this species. In addition, a large-scale project carried out by the Turkish Ministry of Agriculture and Forestry in the Black Sea region, including the first author, is ongoing to control this species. *Metcalfa pruinosa*, which has been distributed since 2004 in the country, has been reported to cause damage to quince orchards in the Eastern Marmara region and kiwi orchards in the Eastern Black Sea region. During our field studies, it was found that *O. janopica* rapidly proliferated in hazelnut orchards in the Western Black Sea region, while *M. pruinosa* was concentrated on walnut, fruit trees and ornamental plants. *Stictocephala bisonia* is distributed in Thrace and Northern Anatolia, while *K. bipuctata* is found in Central and Eastern Anatolia. There is no information about their economic impact in Turkey

Key words: Auchenorrhyncha, alien, invasive pests, Turkey.

Phenolia picta (Coleoptera: Nitidulidae): A new pest on strawberries and its damages in the Çanakkale Province of Turkey

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Several alien pests have been introduced in Europe, as well as in Turkey in the last decades. One of them is *Phenolia picta* (Coleoptera: Nitidulidae), which was recorded in Europe for first time in Spain, and then in France and Turkey. In 2016, *P. picta* was detected in ripening and rotten fruits in Lapseki District of the Çanakkale Province, Turkey; however, the population status of the pest was not studied.

A study of presence, distribution and level of damages of *P. picta* was carried out in strawberry fields of Çanakkale in 2018. A hundred of unripe and a hundred of ripe strawberry fruits were checked for presence of the pest and damages in the field.

There were no damages found in unripe fruits, while the damages on ripe fruits varied from 1 to 22%. Damaged ripe fruits were detected approximately in a half of the territory of the fields surveyed. Biology of *P. picta* was studied under laboratory conditions. We observed that both adults and larvae feed on ripe fruits and cause considerable damages. The females lay their eggs one by one or in groups on the upper surface of ripe or decayed strawberry fruits. Rarely, the eggs were laid inside of decayed holes. The larvae completed their development as pupate in the soil. This is the first record of *P. picta* on strawberry fruits.

Key words: Çanakkale, strawberry, *Phenolia picta*, invasive pest.

Patterns in catch per unit effort of non-native gibel carp and native fish species in three natural lakes in Sakarya, Turkey

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Alien species are commonly considered as threats to native biological communities. In addition to their ecological impacts, invasive alien species frequently cause economic losses, both locally and globally. The gibel carp, *Carassius gibelio,* is one of the most common alien freshwater fish species in Turkey, as well as in Europe. In the last decades, this species has invaded many natural and artificial lakes in Turkey. In this study, we aimed to evaluate the abundance of the invasive gibel carp and commercially valuable native fish species in three natural lakes located in Sakarya province. Fish samples were caught by gill nets with certain mesh sizes. At all sites, fishing gears with exactly the same properties were used for sampling within equal time periods. Catch per unit efforts (CPUEs) were estimated for all sites, separately. The gibel carp was the most abundant species (75% of total catch) in Lake Küçükboğaz. On the contrary, the other two natural lakes, Lake Sapanca and Akgöl were dominated by native commercial species with rates of 89% and 85%, respectively. Our results suggested that the invasive gibel carp is a potential threat to population size of native fish species and it can adversely affect the commercial fisheries in the region.

Key words: *Carassius gibelio*, invasive fish, CPUE, Lake Sapanca, Lake Akgöl, Lake Küçükboğaz.

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Impact of invasive animals on the species diversity and abundance of invaded communities

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Much studies has been paid to negative effects of alien species on resident communities but studies that quantify community-level effects of a number of invasive animals are poorly in Vietnam. We address this issue by assessing the impact of three invasive animal species (*Hypostomus punctatus*, *Oreochromis mossambicus*, and *Pomacea canaliculata*) from Hai Duong Province in Northern Vietnam on a wide range of animal communities. Animals in invaded and uninvaded plots with similar site conditions were sampled. All species of vertebrates were recorded for calculating the Shannon diversity index H′, Evenness J and Sørensen index R of similarity between invaded and uninvaded areas. Species exhibiting the greatest impact reduced species numbers per plot and the total number of species recorded in the communities sampled by almost 60%. A strong reduction of species number at the plot scale resulted in a marked reduction in the total species number at the landscape scale, and in less similarity between invaded and uninvaded areas. The decrease in species richness in invaded compared to uninvaded plots is largely driven by the identity of the invading species. Management decisions based on impact need to distinguish between invasive species, as their effects on diversity and composition differ largely.

Key words: Impact, invasive animals, species diversity, abundance, Hai Duong Province, Vietnam.

Aquarium mollusks of the family Thiaridae as a biological hindrance for the operation of the cooling pond of Zaporizhzhya Nuclear Power Plant

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In the last 20 years, introduction of more than 10 species of freshwater and mesohalobiotic aquarium mollusks (e.g. *Helisoma duryi*, *Physella* spp., Ampullariidae spp., *Melanoides tuberculata*, *Ferrissia fragilis*, and *Tarebia granifera*) into natural and artificial water bodies has been reported in Ukraine. The spread of new species has often occurred when water from aquariums was poured into open water bodies. Most commonly, some thermophilic mollusks were able to naturalise in the artificial ponds, where heated water is discharged, such as: cooling ponds and channels of Combined heat and power plants (CHPP), and Nuclear power plants (NPP).

Since 2013, the appearance of two molluscs from the family Thiaridae has been noted in the cooling pond of Zaporizhzhya NPP: *Melanoides tuberculata* and *Tarebia granifera*. The two species have naturalised, and by 2017, have increased in number and spread over the whole reservoir; currently their number is still increasing. The spiral shells of the molluscs have posed a threat to the operation of the thermal mechanical equipment.

The number of molluscs *M. tuberculata* and *T. granifera* on the concrete walls of the outlet channel varied from 420.5 to 619.8 ind./m^2. The largest amount of the molluscs was found at the water surface at a depth of 15 cm. A survey of the pumping stations revealed that the daily accumulation of molluscs in the receiving chambers was 230–300 g. The maximum concentration of molluscs was observed in the coastal zone on the rocks, in the crevices between the concrete slabs of the channels, in the shade of the higher aquatic vegetation thickets, in the roots of *Phragmites australis*, and near the thickets of Cladophora. In the groups of gastropods gathered from the concrete slabs and the outlet channel of Zaporizhzhya NPP, the proportion between individuals of *M. tuberculata* and *T. granifera* was 1:12. The analysis of the size series of the two mollusc species showed the following ratio of size groups I – less than 10 mm, II – from 10 to 15 mm, III – more than 15 mm: *M. tuberculata* 1:2:4, *T. granifera* 1:2:7, respectively. To control the population of alien molluscs it is necessary to develop an effective biomeliorative system, using aquatic organisms, which are the potential predators of these molluscs.

Key words: Molluscs, *Melanoides tuberculata*, *Tarebia granifera*, biological invasions, biological hindrance, NPP.

Wetland forests in lower Mureş River Basin (Arad County, Romania) strongly affected by the American maple (*Acer negundo*)

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Alluvial and wetland forests area in the lower Mureş River Basin, between Lipova and Săvârşin (Arad County), is strongly affected by dispersal of the American maple (*Acer negundo*). In the past this species was used in stabilising the Mureş River banks. Thus, in recent decades, the American maple has dispersed greatly, in some areas even forming homogeneous stands along the river banks. Deforestation, abandonment of orchards and agricultural lands in close proximity to the river banks have also contributed to this situation. Furthermore, following the field studies, we noted another aspect related particularly to contribution of the beaver (*Castor fiber*). The latter is a protected species recently introduced in the Mureş River, after the emergence of homogeneous areas covered by the American maple. The beaver feeds on trees and tendrils, mostly formed from various species of willow (*Salix* spp.), white poplar (*Populus alba*), and black alder (*Alnus glutinosa*). These are native species that used to grow along the Mureş River banks, now rare within the study sector. There were no records of the American maple trees to be taken down by the beaver. Thus, the selective feeding on native species by the beaver favours additionally the American maple in creating homogeneous forest units along the lower Mureş River basin.

Key words: *Acer negundo*, American maple, Mureş River, *Castor fiber*, Romania.

Alien species in city park ecosystems of Kiev, Ukraine

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Biological invasions of alien species of all currently existing kingdoms of living organisms beyond their native ranges have become global. The Parties to the Convention on Biological Diversity assess this phenomenon as the second most significant threat to biodiversity, after the biotope destruction. Invasive species are seen as biological pollution and can threaten the ecological safety of a country. They are a common threat and reduce the quality of life on Earth through depletion and simplification of biodiversity and disruption of functional relationships in the biosphere. Invasive species worsen the quality and quantity characteristics of the ecosystem services of biodiversity.

Park forest ecosystems have a complex structure. Their condition is an indicator of the ecological balance of the urban environment. Their assessment requires systematic and multivariate analysis. In park ecosystems, functional relationships are poor and unstable. These ecosystems function due to human subsidies. Alien plant species in the parks are a stabilisation element. They lead to an increase in the species diversity of parks in the conditions of industrial, recreational and thermal pollution of cities, especially megapolises. The spread of alien plant species in parks leads to the attraction of new species of insects and birds, the creation of new consortia connections and food chains, which, in general, leads to the stabilisation of subsidised ecosystems. Thus, the role of alien species in ecosystems of parks requires further comprehensive research. The goal of this study was to identify the role of the introduction of alien plant species into the ecosystems of parks in a large city.

Bioindication of the state of park forest ecosystems in Kiev by the gradient of complex anthropogenic impact (industrial pollution and motor vehicle emissions, recreational load) is an urgent task. The following study methods were applied: bioindication at different levels of the organisation of the living organisms; system, comparative, gradient analysis and methods of environmental profiles; field surveys (silvicultural-taxation, ecological-floristic, geobotanical), laboratory studies; and mathematical statistics. Monitoring of the presence of synanthropes and alien species on the territory of five parks in Kiev (Ukraine) by vegetation tiers, the ecological characteristics of the grass tiers of parks, and a multi-criteria assessment of the parks state ecosystems will be presented.

Key words: Alien plants, anthropogenic influence, park ecosystem, biodiversity.

Growth and growth analysis of the tree of heaven, *Ailanthus altissima* (Mill.) Swingle, in the city of Karlovac, Croatia

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Historically, alien plant species have been an important part of prestigious city parks. Today, they are on the list of invasive species and pose a threat to natural habitats. By mapping the distribution of these aliens it is possible to confirm that horticulture is one of the major pathways for their introduction and further spread. Uncontrolled spread was observed along the roads and the suburban areas. During our study, increment analysis of the trees in the city was made. Along with the analysis of the tree of heaven (*Ailantus altissima*), the increment of oak was also analysed. The conclusion is that the tree of heaven has higher increment, which intensifies its domination in the habitat.

Key words: Invasive alien species, *Ailanthus altissima*, growth analysis, urban area, Karlovac.

Understanding the impact of exotic parrots on human health: A reply to Oymak et al. (2017)

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Parrots are birds that live in the tropical regions of the world. International trade of parrots is carried out according to the CITES Convention. A total of 138 parrot species were imported and 40 parrot species re-exported between 1982 and 2018 in Turkey. The alien Rose ringed parakeet (*Psittacula krameri*) (RRP) and Alexandrine parakeet (*Psittacula eupatria*) (AP) have started to spread and established breeding populations in the wild in Turkey. Introduction and establishment of alien species in the country is unwanted situation because alien species may have adverse effects on ecosystems, economy, human health, and social factors. Therefore, alien species should be monitored. The Parakeet Census of Turkey study has been conducted since 2016.

According to Oymak et al. (2017) presentation at the 7th ESENIAS Conference, the two alien parakeet species (RRP and AP) carry risks regarding human health in Turkey. However, based on our knowledge, this statement is not correct. So far, there is no evidence and related literature to support it. We assume that the incorrect assessment was made because of wrong interpretation of two published sources in the literature review. In the first published article (Tantaş et al. 1987), the taxonomic name of the parrot was not mentioned. In the second article (Tantaş et al. 1990), a species of bacteria found on the grey parrot (*Psittacus erithacus*) was investigated.

Although RRP and AP do not have any impact on human health until now in Turkey, various microorganisms and vectors may be transported with the alien parakeet species in the next years. RRP and AP live in the wild as a result of intentional or accidental introductions. Moreover, pet trade with these species has continued in Turkey. This is a problem in terms of biosecurity. Biosecurity measures should be increased in Turkey. Scientific assessments not sufficiently supported by evidence should be considered with caution in the management of these species.

Key words: Alien, trade, incorrect assessment, human, biosecurity.

Biological invasions in cooling-ponds of nuclear power plants

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Alien species invasion is a multi-aspect environmental phenomenon. Invasive alien species can form new ecological niches, affect food chain stability, change productivity and indigenous species habitats. In technoecosystems they can cause hindrance in the operation of technical systems. Specific thermal conditions of cooling-ponds (CP) are favourable for invasion and successful naturalisation of thermophilous alien species. For example, in the Konin lakes (Poland, CP of two thermal power plants), *Sinanodonta woodiana* was registered, the cooling-ponds of Zaporizhzhya and South-Ukraine Nuclear Power Plant (NPP) are inhabited by *Melanoides tuberculata* and *Tarebia granifera*, while the cooling-pond of Chornobyl NPP – by numerous populations of Ponto-Caspian crustaceans. With the present work, we make a review of the biological invasions in cooling-ponds of certain NPPs in Ukraine.

For more than 20 years in CP of Khmelnytskyi NPP (KhNPP) numerous alien species have been registered: *Pleurosira laevis*, *Cyclotella marina*, *Aulacoseira tenella* (Bacillariphyta), *Cylindrospermopsis raciborskii* (Cyanoprokaryota), *Chaetomorpha henningsii* (Chlorophyta), *Eunapius carteri* (Porifera), *Craspedacusta sowerbii* (Coelenterata), *Tyrrhenocythere amnicola donetziensis* (Ostracoda), *Theodoxus euxinus*, *Ferrissia* sp. (Gastropoda), *Dreissena polymorpha*, *D. bugensis* (Bivalvia), and *Najas marina*, *Typha laxmannii* (vascular plants). The following taxa: *Bratislavia* sp. (Naididae), *Planorbella* sp. (Gastropoda), and *Stenocypris* sp. (Ostracoda) were also observed. Some of these hydrobionts have established populations, while others have been recorded only for a short period.

The CP KhNPP has been most significantly affected by *D. polymorpha* invasion. Owing to the mussel filtering activity water has become clearer, primary production, density of benthic invertebrates and periphyton increased. In CP KhNPP within two vegetation seasons alone, the biomass of *D. polymorpha* amounted to about one thousand tons, causing serious disturbances in waterworks. Significant growth of *M. tuberculata* and *Tarebia granifera* resulted in biohindrance in technical water supply of the Zaporizhzhya NPP. Significant damages in CPs have been also caused by some aquatic vascular plants. For efficient prevention of possible negative effects in the technoecosystems, constant hydrobiological monitoring is needed, aimed at invasive alien species detection and potential biohindrance prognosis.

Key words: Invasive species, cooling-ponds, nuclear power plants.

Topic 5: Invasive alien species prevention and management

Early detection and rapid eradication, surveillance systems; risk assessment and horizon scanning; control measures; restoration of damaged ecosystems; education, citizen science, strategies, policy and legislation

Collaborative management for conservation of forest and grassland habitats affected negatively by IAS in Bulgaria, as part of IAS Free Habitats Project, co-financed by the Life Programme of the European Commission

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The objectives of the IAS Free Habitats Project (www.invasiveplants.eu) are to improve and maintain the conservation status of rare and vulnerable habitats in three Natura 2000 sites in Bulgaria, and to raise the knowledge and experience of stakeholders and land managers about management and control of invasive alien species (IAS). The targeted habitats are: 9180* *Tilio-Acerion* forests of slopes, screes and ravines; 9560* Endemic forests with *Juniperus* spp.; 6510 Lowland hay meadows and 6210 Semi-natural dry grasslands and scrubland facies.

The following actions concerning IAS have been conducted: information database development; mapping and GIS database development for the distribution of eight invasive alien plant species and training of stakeholders. The removal of *Robinia pseudoacacia*, *Amorpha fruticosa*, and *Ailanthus altissima* has started and the success of implemented activities will be monitored. Establishment of collaborative management platform for each habitat is envisaged.

Only mechanical methods for eradication of IAS are being implemented in the forest habitats. These habitats are situated in protected areas, where the use of chemicals is forbidden. Three appropriate methods were applied in 2018: 1) cutting the stems, sprinkling the trunks with sea salt; 2) same as 1, but also covering the trunks with thick, opaque nylon, and 3) girdling – cutting away two 15–20 cm broad rings of the bark and cambium tissue in the basal part of the trunk.

The first results showed drying out of the trees treated with girdling. All of the girdled trees gave stem shoots up to the second ring. The majority of cut stems covered with nylon did not have sprouts, whereas the ones left uncovered had roots and stump sprouts. The targeted territories have been monitored for collection of data on the success of the treatment and removal of new shoots.

The removal of IAS by mechanical control methods and selective chemical treatment with glyphosate is starting soon in the grassland habitats.

The project introduces the collaborative management platform approach for development of six-year habitats' conservation plans with all stakeholders. Commitment statements will be signed by the stakeholders. The training of stakeholders was carried out on issues related to IAS and methods of their eradication. Inspired by the training, a State Forestry Unit planned to establish four experimental plots to test the methods for eradication of *R. pseudoacacia*.

Key words: Control measures, invasive alien plants removal, habitat restoration, collaborative management, capacity building, Natura 2000.

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Experimental field application of *Beauveria bassiana* Bals. Vuill. for control of the invasive sawfly *Aproceros leucopoda* Takeuchi, 1939, in Romania

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Fungal treatment with a native strain of *Beauveria bassiana* isolated from *Aproceros leucopoda* larva and formulated as blastospores suspension (2.7 x 10^{12} bl. / l) was applied by foliar spraying of elm trees (*Ulmus* spp.) in forests highly infested with *A. leucopoda*, located in eastern part of Romania. The trees were naturally infested with L_1–L_5 larvae from the G_2, G_3, G_4 generations, as well as with eonymphs in summer cocoons. The treatment was applied in June – July in three different locations, at altitudes above 400 m. Using a backpack sprayer, doses of 100 to 200 l / ha bioinsecticide were applied on 20 ares/ location. The observations of larval density were performed before and after the biological treatment by choosing three sample trees /repetition. The efficacy of treatment was set at 10–14 days after treatment. Data of infestation level and climatic conditions at the time of treatment are presented for each location. The insecticidal effect of the entomopathogenic fungus *B. bassiana* was expressed as a decrease of infestation with *A. leucopoda*, as well as a decrease of defoliation of trees where the biological treatment was applied. The population decreasing percentages were correlated positively with the dose of the bioinsecticide; the best results were obtained at a dose of 200 l / ha, when the efficacy was in the range from 60 to 90%. The recorded defoliation showed values, which correlated negatively with the treatment dose, ranging from 5 to 23%. During the field observations, larvae of *A. leucopoda* naturally infected with the entomogenic fungi *Isaria farinosa* and *Aspergillus flavus* were found as well.

Key words: *Beauveria bassiana*, *Aproceros leucopoda*, field application.

Invasive alien species of Union concern in the Czech Republic

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The EU Regulation 1143/2014 on invasive alien species (IAS) entered into force on 1st January 2015. The Regulation foresees three types of interventions: prevention, early detection and rapid eradication, and management. A list of species of concern to the whole Union is at its core. Currently, this so-called 'Union list' includes 49 species. EU member states are required to implement cost-effective measures to reduce and eradicate species from the Union list and prevent their spreading.

In the Czech Republic, Act No. 114/1992 Coll. on the Nature and Landscape Protection is modified in order to ensure a full compliance with the provisions of the EU Regulation 1143/2014. An amendment will come into force in the beginning of 2020. The Czech Ministry of Environment (MoE) is the national competent authority charged with the relations with the European Commission, the coordination of activities and the issue of permits. Inspection and control system will be secured by the Central Institute for Supervising and Testing in Agriculture, State Veterinary Administration and Customs Administration. A surveillance system is set up and coordinated by the Nature Conservation Agency (NCA). The obligation to rapidly eradicate populations of IAS from the Union list is established. The eradication measures are ordered by the NCA. Adopting a list of IAS of national concern is not the order of the day in the Czech Republic. Action plans for the main vectors of introduction of IAS are drawn up by research institutions and subsequently approved by MoE.

From the 49 species in the Union list, 4 plants and 10 animals occur in the Czech Republic. *Heracleum mantegazzianum* and *Impatiens glandulifera* are common, while *Elodea nuttallii* and *Asclepias syriaca* have local distribution. *Eichhornia crassipes* is found rarely but does not overwinter. The invertebrate species *Eriocheir sinensis, Orconectes limosus* and *Pacifastacus leniusculus* have local distribution. The invasive crayfish are detaily monitored as the main vectors of the crayfish plague. *Pseudorasbora parva, Alopochen aegyptiaca, Procyon lotor, Myocastor coypus, Ondatra zibethicus* and *Nyctereutes procyonoides* belong to the widespread species in the Czech Republic. *Trachemys scripta* is also common but the population is unstable due to its limited ability to breed.

Key words: Invasive alien species, Union list, Czech Republic, legislation, distribution.

Management measures for *Veronica persica* Poir., an invasive weed in rape crops in south-eastern Romania

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More and more farmers grow winter rape (*Brassica napus*) in Romania because this is an economically profitable crop. One of the basic technological issues is weed control, as the rape plants are susceptible to weed infestation especially during the early stages of vegetation. In the last years, changes have occurred in the floral spectrum and some species, such as *Veronica persica*, have become more and more damaging. This invasive weed causes both direct losses by decreasing the production on hectare and indirect losses by the cost of control. Our assessments on rapeseed crop during 2017 and 2018 in south-eastern Romania have pointed out that this weed may form associations with other species of the genus *Veronica* so that they become dominant and can totally compromise the winter rape crop. The success of this weed is ensured by the high number of seeds and by the fact that it survives over the winter season, being immune to frost, especially in the context of winters becoming milder. Early weed control allows the rapeseed to develop vigorously throughout the growing season, as the plant has a great natural capacity to control weeds that occur later. During our study, we developed measures to eradicate and limit the spread of the invasive species *V. persica* in winter rape crops by integrating agro-technical measures with products for plant protection, which will be presented.

Key words: Invasive species, winter rape, weeds, herbicides, agro-technical measures.

Horizon scanning for invasive alien species in Sovereign Base Areas in Cyprus

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Invasive alien species (IAS) are one of the major drivers of change that can negatively affect biodiversity, ecosystem functions and services and human health; islands are particularly vulnerable to biological invasions. Horizon scanning can lead to prioritisation of IAS to inform decision-making and action; its scale and scope can vary depending on the need. We focussed on IAS likely to arrive, establish and affect biodiversity and human health on the Mediterranean island of Cyprus. The scope of the horizon scanning was the entire island of Cyprus. We used a two-step consensus-building process in which experts reviewed and scored lists of alien species on their likelihood of arrival, establishment and potential to affect biodiversity, ecosystems and/or human health in the next ten years. We reviewed 225 alien species, considered to be currently absent on Cyprus, across taxa and environments. We agreed upon 100 species that constituted very high, high or medium biodiversity risk, often arriving through multiple pathways of introduction. The remaining 125 species were ranked as low risk. The potential impacts on human health were documented for all 225 species; 82 species were considered to have a potentially negative impact on human health ranging from nuisance to disease transmission. The scope of the horizon scanning was the entire island of Cyprus, but the thematic groups also considered the relevance of the top 100 species to the Sovereign Base Areas of Cyprus, given their differing governance. This horizon scan provides the first systematic exercise to identify invasive alien species of potential concern to biodiversity and ecosystems but also human health within the Mediterranean region. The process and outcomes should provide other islands in the region and beyond with baseline data to improve IAS prioritisation and management.

Key words: Consensus approach, Cyprus, Levant, non-native species, pathways, prioritisation.

Invasive hydrobionts *Perccottus glenii* and *Trachemys scripta elegans* in Latvia: updated distribution, management strategy, and perspectives

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The invasive species Chinese sleeper *Perccottus glenii* and Red-eared Pond Slider *Trachemys scripta elegans* are actively spreading and invading new water bodies in Latvia. In the invaded ecosystems, they have a negative impact on native species as predators, competitors and as vectors of parasites. This influence is important in the Latvian small ponds, where they threaten small northern populations of native amphibians and reptiles, in particular the rare species: *Bombina bombina*, *Triturus cristatus*, *Epidalea calamita*, and *Emys orbicularis*. Reciprocal predation usually cannot have a noticeable effect on the population of *P. glenii*. In the present study we present the updated distribution of the two invasive species in Latvia and propose management measures to limit their introductions and spread.

Currently, *P. glenii* is widely distributed in the eastern part of Latvia from Daugavpils to Tukums, with 50 known localities. At the same time, 45 findings of *T. scripta elegans* have been registered in Latvia. The strategies of limitation of *P. glenii* and *T. scripta elegans* invasion in Latvia include activities in the following six main areas:

1. Science: Study the distribution and ecology of the two species in Latvia: implemented projects; published articles and monographs; presentations at conferences; registered experts in the Nature Conservation Agency of Latvia.
2. Legislation: Integration of the research data and inclusion of measures against the invasive species into the Threatened Species Conservation Plans for *T. cristatus*, *B. bombina*, *E. calamita*, and *E. orbicularis* for Latvia.
3. Informing specialists: Publication of technical documents.
4. Training of students: Training the students in biology and environmental sciences: published materials; integration in the study courses.
5. Education: Educating citizens (fishermen, landowners, pupils): published brochures; informing visitors at the Latgales Zoo.
6. Practical actions: eradication at key habitats; creation of 'anti-invasive' pond systems (optimal ponds + ponds without water connections + ponds filled every 2-3 years) for threatened key species.

Furthermore, to limit the invasion of *P. glenii* and *T. scripta elegans* in Latvia, it is necessary to develop and implement Action plans for these tow species.

Key words: Invasive hydrobionts, *Perccottus glenii*, *Trachemys scripta elegans*, invasive alien species management, Latvia.

Acknowledgements: The research was conducted in accordance with the legislation of Latvia and Ukraine. The research was supported by the Latvian – Ukrainian VIAA project Nr. LV-UA/2018 'The ecological and biological triggers of expansion of the invasive fish, Chinese sleeper (*Perccottus glenii*), in Eastern Europe'.

Contribution of the project 'State and perspectives of citizen science for invasive alien species in Bulgaria' to implementation of COST Action CA 17122 (Alien CSI)

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Preventing introduction of invasive alien species (IAS) is generally more cost-effective than measures taken following their introduction and establishment in a new location. The good awareness about the negative impact and early detection of IAS are crucial for prevention of their introduction and spread. Citizen science (CS) play important role for involvement of wide range of stakeholders and societal engagement with the issue of IAS. In 2018 started the implementation of COST Action CA 17122 'Increasing understanding of alien species (AS) through citizen science' (Alien CSI) addressing multidisciplinary research questions in relation to developing and implementing CS on AS.

In 2019 we launched the project 'State and perspectives of citizen science for invasive alien species in Bulgaria' contributing to implementation of tasks of two working groups of the Action. The main goal of the project is to study the state of the CS on IAS in Bulgaria and integrate the results obtained in the analysis at European level, within the framework of the COST action Alien SCI. The specific objectives are: (1) Inventory and analysis of the existing initiatives, activities and strategies implemented in Bulgaria to engage citizens in the problem related to alien species; (2) Assessment of the level of IAS awareness of different groups of society and their motivation to participate in the early detection of AS, and identification of the most appropriate approaches for engaging them with citizen science; (3) IAS awareness raising of different groups of society, and (4) Increase of the capacity of stakeholders involved in the study, awareness raising and management of invasive alien species in Bulgaria. The implementation of the planned activities will contribute to the fulfillment of the following deliverables of the COST Action CA17122: database of AS-related CS; review of needs, motivations and attitudes towards AS and CS; and publication on strengths and limits of methods used for managing different kinds of CS data to provide relevant information for end-users. First results of conduced activities are presented and obstacles encountered are discussed.

Key words: Invasive alien species, citizen science, awareness raising.

Acknowledgements: The study was conducted within the project № KP-06-COST-14 'State and perspectives of citizen science for invasive alien species in Bulgaria' funded by the National Science Fund of Bulgaria.

Increasing understanding of alien species through citizen science (Alien CSI): Approaches to citizen science, data management and standards in Bulgaria

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The COST Action CA 17122 'Increasing understanding of alien species (AS) through citizen science' (Alien CSI), which started in 2018, has addressed multidisciplinary research questions in relation to developing and implementing citizen science, advancing scientific understanding of alien species dynamics while informing decision-making, specifically implementation of technical requirements of relevant legislation such as the EU Regulation 1143/2014 on IAS, support of the EU biodiversity goals and embedding science within society. To facilitate the implementation of this COST Action in Bulgaria, two projects supported by the National Science Fund of Bulgaria have just launched. One of them is entitled *'Increasing understanding of alien species (AS) through citizen science' (Alien CSI): Approaches to citizen science, data management and standards in Bulgaria* and will be implemented by the Institute of Biodiversity and Ecosystem Research with the Bulgarian Academy of Sciences. This project aims at performing the activities of Alien SCI working group 2 (WG2) and WG3 in Bulgaria. The main objectives are: (1) Horizon scan available and novel technologies for CS in Bulgaria; (2) Explore novel ways to increase the level of participation in AS related CS and to reach non-traditional audiences of citizen scientists, through translating in Bulgarian, including invasive alien species of national/ regional concern, and promoting among different stakeholder groups the smartphone application 'Invasive Alien Species Europe' developed by EC JRC; (3) Coordinate activities related to the collection and validation of data with the IAS app in Bulgaria together with the EC JRC and EASIN; (4) Review structure of data across existing AS CS initiatives in Bulgaria; (5) Facilitate IAS data mobilisation, communication and awareness raising in Bulgaria; and (6) Disseminate results and cooperate with other AS CS projects, databases, and networks at regional and European level.

Key words: Alien species, citizen science, smartphone application, data management, communication.

Acknowledgements: We acknowledge the financial support of the National Science Fund of Bulgaria under the project № KP-06-COST-13: 'Increasing understanding of alien species (AS) through citizen science' (Alien CSI): Approaches to citizen science, data management and standards in Bulgaria.

Towards an early detection and warning system for invasive alien species in Bulgaria

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Invasive alien species have been widely recognised worldwide as one of the main threats to biodiversity and related ecosystem services. One of the most efficient and cost-effective ways to prevent the introduction and spread of alien species is to develop a system for early detection, warning, and rapid response. The Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species requires the EU Member States to develop such national surveillance systems aiming at early detection and rapid eradication of newly introduced invasive alien species.

A national project for establishment of an early detection and warning system has been launched recently in Bulgaria. Here we present the objectives and main activities of this project and outline the expected results. The most important steps for the development of the national early detection and warning system include: identification of major information sources, experts and institutions dealing with alien species, analysis of main pathways of introduction and spread of alien species, risk assessment of selected alien taxa, considered to have high impact, regular update of the national alert lists of invasive alien species, capacity building at national level, and development and testing of a model of the national early detection and warning system for invasive alien species.

Key words: Control of invasive species, early detection, early warning, Regulation (EU) 1143/2014, surveillance system for invasive alien species.

Acknowledgements: The study was carried out in the framework of the National Science Programme 'Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters', approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science of Bulgaria (Agreement № DO-230/06-12-2018).

Topic 6: Management and sharing of IAS data

IAS networks and information systems, databases, data planning and management

Preliminary list of selected alien plants of Balkan and Southern Europe origin in the Information system of alien plant species in Ukraine

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One of the pathways for invasion of alien plant species is their introduction and use as ornamental plants. The plants of Balkan and/or Southern Europe origin have high ornamental properties, and therefore, they have been intensively introduced for cultivation in Ukraine during the past 100 years. However, a small part of the introduced species escaped from cultivation and settled in natural areas.

The Information System 'Threatening alien invasive species of Ukraine' (TAISU) is an information system, which focuses on alien species that threaten native biodiversity, and covers taxonomic groups from fungi to animals and plants in all ecosystems. Currently, the information system includes 889 alien plant species. The following species have been analysed: *Centaurea benedicta*, *C. cyanus*, *Scorzonera hispanica*, *Tanacetum cinerariifolium*, and *T. macrophyllum*, from Asteraceae; *Diplotaxis muralis*, *Lepidium draba*, *Matthiola incana* subsp. *incana*, and *Thlaspi alliaceum* from Brassicaceae; *Clematis vitalba*, *Helleborus dumetorum*, and *H. viridis* from Ranunculaceae; *Laburnum anagyroides* and *Onobrychis viciifolia* from Fabaceae; *Nonea pallens* (Boraginaceae); *Campanula medium* (Campanulaceae); *Eragrostis minor* (Poaceae); *Polygonum bellardii* (Polygonaceae), and *Digitalis lanata* (Scrophulariaceae).

The vast majority of the analysed alien plant species are kenophytes, except for the archaeophyte *C. cyanus*. Most of the alien plants are herbaceous, while shrubs and lianas are represented by one species each group – *Laburnum anagyroides* and *Clematis vitalba*. All the alien plant species occur in man-made biotopes (I and J type by EUNIS) – abandoned lands, roadsides, railroads and other waste areas, where there are primary and secondary progressive successions. Some of the plants invade actively natural biotopes (E, G, F, H), where they seek to form an ecological niche as in their native range.

Key words: Information system, database, alien plant species.

National reporting on the invasive alien animal species of European Union concern in Bulgaria

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The aim of this study was to collect and map data on the distribution in Bulgaria of invasive alien animal species of European Union (EU) concern for the purposes of national reporting under Article 24(1) of the Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. The first reporting included 25 animal species of EU concern and covered the period 2015–2018. Data for the species distribution in Bulgaria were collected from different sources, such as: scientific publications, available databases, internet portals and media, data from previous projects, and data from national museum collections. The data were not limited to the reported period, but referred also to previous periods. Published as well as unpublished data were included. The data format followed the requirements of the Directive 2007/2/EC (INSPIRE).

Currently, eight invasive alien animal species of EU concern have been reported from Bulgaria and seven of them were included in the first national report. *Eriocheir sinenis* was found first in the Danube River in 2005 and only two records have been documented until 2018. *Orconectes limosus*, which was recorded for the first time in 2015, still had limited distribution in three tributaries in the Danube River in Northwest Bulgaria. *Perccottus glenii* was found first in 2015 in the Danube River and since then has spread rapidly along the entire Bulgarian sector of the river, its backwaters and adjacent canals, lakes, and marshes. *Pseudorasbora parva* has been one of the most widespread species. It was found first in a fish pond along the Danube River in 1975, and now is present on the whole territory of Bulgaria. We reported it from 175 sites within the three river basins (the Danube River, Black Sea and Aegean Sea). *Trachemys scripta* was also reported from the three river basins (31 sites), mainly in wetlands close to urban areas. In Bulgaria, *Myocastor coypus* was introduced in 1953. We reported it from 121 sites mostly in the Aegean Sea and Black Sea basins, and much less in the Danube River basin. On the contrary, *Ondatra zibethicus*, which was introduced in 1956, still had limited distribution within the Danube River basin, and only single records were reported from the other river systems. The distribution maps of the reported invasive alien animal species of EU concern for Bulgaria are presented.

Key words: Bulgarian fauna, invasive alien species of EU concern, distribution, mapping, Regulation (EU) 1143/2014.

Acknowledgements: This study was carried out within the project 'National reporting on invasive alien species under Article 24(1) of the Regulation (EU) 1143/2014' (Contract № D-30-43/28.05.2019). The financial support by the Financial Mechanism of the European Economic Area, Programme BG03 'Biodiversity and Ecosystems', under the projects ESENIAS-TOOLS (Contract D-33-51/30.06.2015) and IBBIS (Contract D-33-72/20.07.2015) is acknowledged as well. We thank Alexander Kotsev for the help with data formatting according to INSPIRE Directive and Veselin Vasilev for preparation of the maps.

National reporting of Bulgaria about the invasive alien plants of EU concern

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Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species, Article 24(1), obliges the EU Member States to report by 1st June 2019, and every six years thereafter, the distribution of the invasive alien species of Union or regional concern. Currently, the List of invasive alien species of EU concern comprises six species which are present in the Bulgarian flora. Of these, five species were included in the first national report: *Asclepias syriaca*, *Elodea nuttallii*, *Heracleum mantegazzianum*, *Impatiens glandulifera*, *Pennisetum setaceum*. The poster presents the distribution of these species in the Bulgarian flora and provides some considerations related to the establishment of a national surveillance system to record the occurrence and impact of the species, wider involvement of citizens in their monitoring, collection and verification of data, etc.

Key words: Bulgarian flora, mapping, Regulation (EU) 1143/2014, species distribution.

Acknowledgements: The study was carried out within the project 'National reporting on invasive alien species under Article 24(1) of the Regulation (EU) 1143/2014' (Contract № D-30-43/28.05.2019). We thank Alexander Kotsev for the help with data formatting according to INSPIRE Directive and Veselin Vasilev for preparation of the maps.

Topic 7: Other topics

General aspects related to the quality of the aquatic and terrestrial environments and associated biological communities, which may influence the introduction and spread of IAS, as well as the application of prevention and management measures

The roles of antioxidant enzymes in some lentil varieties under the broomrape infection and drought stress

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Environmental stress factors limit the growth and yield in crop plants. It is known that the plant antioxidant defense system has a protective role in resistance to biotic and abiotic stresses. The broomrape infection is a major problem in Turkey especially for the lentil (*Lens culinaris*) production. In this study, we focused on short-term (7d) broomrape stress (biotic stress, *Orobanche crenata*, group B) and drought stress (polyethylene glycol – PEG, group P) effects of antioxidant enzyme activities in some lentil varieties (drought resistant cv. Sultan 1, drought sensitive cv. Özbek, and drought sensitive cv. Çiftçi). For this purpose, superoxide dismutase (SOD), peroxidase (POX), glutathione reductase (GR), and catalase (CAT) activities were investigated in root and leaf tissues of the lentil plants.

Our results showed that in terms of the resistance to the broomrape infection, SOD and POX activities were significant in the leaf tissues, while GR was important in the root tissues. In terms of the drought stress, GR activity was important in the leaf tissues, while SOD, GR and CAT activities were important in the root tissues. Therefore, it can be concluded that GR activity in the root tissues of these lentil varieties is an indicator for both the broomrape induced biotic stress and the PEG-induced drought stress. The results suggest that GR activity can be used as a criterion in the selection of resistant lentil species.

Keywords: Lentil, broomrape, drought stress, Glutathione reductase.

Distribution and abundance of *Theodoxus fluviatilis*, a species with low invasive potential in Lake Ohrid and its watershed

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Theodoxus fluviatilis is one of the most abundant cosmopolitan species of Lake Ohrid gastropod fauna (Prosobranchia), which equally inhabits both the lake and its adjacent waters. In order to investigate the abundance and distribution, and to evaluate the status of this species, the samples were collected from six depth points along transects at 30 investigated localities in the littoral region of Lake Ohrid. Thus, the representatives of this species were recorded in 23 profiles, with a density starting from 25 to 625 ind. m^{-2}. The highest densities were recorded on muddy bottom with macrophyte vegetation. The lowest population density was registered on muddy bottom without macrophyte vegetation (0–75 ind. m^{-2}). The European cosmopolitan species *T. fluviatilis* in Lake Ohrid and its watershed, with a frequency greater than 20%, belongs to the group of most frequent species at European level with low invasive potential according to the European Alien Species Information Network (EASIN) list.

Key words: Gastropoda, low invasive potential, Lake Ohrid, watershed.

The role of *Harmonia axyridis* in the Coccinellidae complex in forest-steppe agrolandscapes in Ukraine

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Ladybirds (Coleoptera: Coccinellidae) are important secondary consumers in the trophic food chains of cereal and other crops. Their high ecological plasticity and developed migration capabilities allow them to occupy various biocenoses. The imago and larvae feed on Aphids, Diaspididae, Psyllidae, Acarines, and some other phytophagous animals. However, practical questions about the use of ladybirds in protecting plants from pests in Ukraine are solved quite slowly.

The study of Coccinellidae species composition was carried out during 2006–2019 in Kiev and Cherkasy regions on farms located in the Central Forest-Steppe of Ukraine. The sampling was made during routine surveys of grain cereal fields and adjacent forest fallows, forest shelter belts, edges and other habitats. Methods and techniques commonly used in entomology and plant protection were applied.

A total number of 14 species of Coccinellidae family was recorded: *Adalia bipunctata*, *A. decempunctata*, *Calvia qatiordecimguttata*, *Coccinula qatuordecimpustulata*, *Coccinella divaricata*, *C. septempunctata*, *C. quinquepunctata*, *Harmonia axyridis*, *Hyppodamia variegata*, *Oenopia conglobata*, *Psyllobora (Thea) vigintiduopunctata*, *Propylea quatuordecimpunctata*, *Tytthaspis sedecimguttata*, and *Scymnus frontalis*. *Coccinella septempunctata* was the most common species in all studied biocenoses. In the general collection the share of this species was 52.6% of all detected ladybirds. On cereal crops, the percentage of *C. septempunctata* was also the highest (19.3%), followed by *H. variegata* and *P. quatuordecimpunctata* (12.6% each). The ladybirds recorded showed different trophic preferences: *P. quatuordecimpunctata* was a polyphage, *C. quinquepunctata* and *H. variegata* fed on aphids on cereal crops, while *P. (Thea) vigintiduopunctata* fed on powdery mildew.

Among the identified ladybirds, the share of the invasive alien species *H. axyridis* was 9.7%. We detected this species first in 2013 in Bila Tserkva Park (Kiev Region). *Harmonia axyridis* has shown excessive adaptability and fertility. Further studies need to focus on the potential impact of this species on other species of *Coccinellidae* family and biodiversity in the in forest-steppe agrolandscapes in Ukraine.

Key words: Coccinellidae, *Harmonia axyridis*, invasive species, agrolandscapes.

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Antimicrobial activity in a drought tolerant lentil variety under some stress conditions

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Broomrapes are the most difficult plant parasites to control in all the biotic stresses affecting plants in the Mediterranean, Europe, and Asia. The lentil (*Lens culinaris*) is sensitive to broomrape (*Orobanche crenata*), which causes significant yield losses in this species around the Mediterranean region. Our study aimed at evaluation of antibacterial properties of *L. culinaris* cv. Sultan–1 under three stress conditions during one and seven days (d), with controls: (1) control (1d); (2) broomrape infection (1d); (3) drought stress (1d); (4) drought stress + broomrape infection (1d); (5) control (7d); (6) broomrape infection (7d); (7) drought stress (7d); (8) drought stress + broomrape infection (7d)]. The antimicrobial activity of the ethanol extract of Sultan–1 variety was assayed against the test microorganisms *Escherichia coli* NRRL B-3704, *Pseudomonas aeruginosa* ATCC 27853, *Proteus vulgaris* ATCC 13315, *Acinetobacter baumannii* ATCC 19606, *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 25923, *S. haemolyticus* ATCC 43252, and Candida *albicans* ATCC 10231 by methods of diffusion in agar and dilution in broth. The ethanol extracts from the different treatments studied showed antimicrobial activities, with the diameters of the inhibition zone ranging from 7 to 14 mm and from 2.5 to 20 µg mL^{-1}, respectively. The highest antimicrobial activity against *A. baumannii* ATCC 19606 was demonstrated by the extract of cv. Sultan–1 with drought stress + broomrape infection (1d). Furthermore, the drought stress + broomrape infection (1d) treatment promoted antibacterial effect against some gram-negative bacteria.

Key words: Antimicrobial activity, lentil, Sultan–1, broomrape, drought stress.

Effects of broomrape and drought stress on antimicrobial activity of drought sensitive lentil variety

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The lentil (*Lens culinaris*) is moderately resistant to drought and high temperature but sensitive to weeds, such as broomrape (*Orobanche crenata*). The current study aimed at evaluation of antibacterial properties of *L. culinaris* cv. Çiftçi under three stress conditions during one and seven days (d), with controls: (1) control (1d); (2) broomrape infection (1d); (3) drought stress (1d); (4) drought stress + broomrape infection (1d); (5) control (7d); (6) broomrape infection (7d); (7) drought stress (7d); (8) drought stress + broomrape infection (7d). The antimicrobial activity of the ethanolic extract of cv. Çiftçi was assayed against some test bacteria and yeast culture by methods of diffusion in agar and dilution in broth. The ethanol extracts from the different treatments studied showed antimicrobial activities, with the diameters of the inhibition zone ranging from 7 to 11 mm and from 5.0 to 20 μgmL^{-1}, respectively. The highest antimicrobial activity against *Proteus vulgaris* ATCC 13315 was demonstrated by the extract of cv. Çiftçi, which had grown in drought condition (7d). However, only drought stress + broomrape infection (7d) treatment was observed to promote antagonistic effects of the extract against *Staphylococcus aureus* ATCC 25923 bacteria compared to the control (7d).

Key words: Antimicrobial activity, lentil, cv. Çiftçi, broomrape, drought stress.

Crustacean zooplankton diversity and relations with bacterioplankton, chlorophyll-a, macrophytes and abiotic factors in two wetlands of the Middle Danube River, Hungary

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Species composition and seasonal and spatial distribution of crustacean zooplankton groups Cladocera and Copepoda were studied in different points of two lake type wetlands, Mocskos–Danube (MDU) and Riha (RIH), located in the protected side of Béda-Karapancsa National Park in the Middle Danube River, Hungary. The first wetland was situated in the active part of the floodplain and dominated by the invasive aquatic plant *Trapa natans*, while the second was isolated, with dominance of the invasive alien species *Ceratophyllum demersum*. The investigations were carried out in 2014 from April to October (with a strong flood in May). Parallel samples were taken from the main channel of the Danube River at Mohács (rkm 1447). The bacterioplankton, phytoplankton biomass determined by the content of chlorophyll-a (Chl-a), and environmental factors, measured simultaneously, were tested for relationships with zooplankton by statistical analyses.

A total of 23 crustacean species were found, 17 Cladocera and six Copepoda. The species richness was the lowest in the river with four species of low density, while this in MDU and RIH were 16 and 19 species, respectively. The dominant species were different in each of the wetlands and in the river. Cladocera had a spring maximum in MDU, presented numerically mainly by two species, decreasing towards autumn, while Copepoda was with a summer maximum and the lowest values in spring. Two alien species were recorded, the chydorid cladoceran *Pleuroxus denticulatus* found only in RIH, with weak presence, and the calanoid *Eurytemora velox* found in both wetlands, with an average 23% of Copepoda, with relatively high numbers and a spring maximum.

Positive correlations of zooplankton with the organic carbon, the temperature and the total phosphorus (with Cladocera) were found. The relation of each of two groups with Chl-a was negative, indicating strong grazing pressure on the phytoplankton. The bacterioplankton, which had the highest abundance in spring and the highest biomass in summer, was better presented in MDU, than in RIH. The total bacterioplankton number had a weak negative relation with Copepoda, while the fraction of the attached bacteria had a positive relation, probably because of higher quantities of detritus from the copepods excretions. Cladocera affected only the medium-sized free-living bacteria. *Eurytemora velox* and the bacterioplankton were positively related, especially in spring during the flood. The invasive submerged *C. demersum*, better developed in RIH, probably, as good competitor for nutrients, caused better oxygen conditions and feeding for the zooplankton. At the same time it caused nitrogen and phosphorus limitation for the phytoplankton and bacterioplankton, and, due to the isolation from the river, these parameters had the lowest values in RIH compared to MDU and Mohács.

Key words: Zooplankton, *Eurytemora velox*, bacterioplankton, Chl-a, *Ceratophyllum demersum*, relations, Hungary.

The effect of *Nerium oleander* extract on *Meloidogyne* spp. on *Cucumis sativus*

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Root-knot nematodes (*Meloidogyne* spp.) are problematic species that cause economic losses in agricultural products within many different regions. Being a large number of species in the genus and able to infect an extensive variety of hosts make them very difficult to combat by chemicals. In addition to the negative effects of the root-knot nematodes on the environment, the fact that their chemical management is difficult and expensive to apply have encouraged growers and professionals to find out alternative methods for control. Such method is the using of *Nerium oleander* extracts, which have been used traditionally in the town of Tekmen of the İçel Province. The aim of this greenhouse study was to determine the effects of the extract obtained from *N. oleander* on root-knot nematodes that infested the soil-grown *Cucumis sativus*. The experiment started with soil solarisation for weeks combined with application of the extract via irrigation weekly. Concurrently, the control population had fumigation. After the crop plants were transplanted the solarised part received extract weekly during three months, while the other site was kept without any application. According to observations, 20% of yield loss was determined in the control population compared to the population treated with the extract of *N. oleander*.

Key words: Control, *Meloidogyne* spp., root-knot nematodes.

Amphicerus bimaculatus (Olivier, 1790) on vine grape in the Republic of North Macedonia

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The grape cane borer beetle *Amphicerus bimaculatus* (Coleoptera: Bostrychidae) was recorded on vine grape in the Republic of North Macedonia during the spring 2019. The attacks of the pest were registered in 12-year old vineyards, crop varieties Victoria and Insulia, located in Kocilari Village, near Veles Town. Firstly, during the pruning of the vine trees, dry branches with a hole (about 0.3-0.4 cm in diameter) in their central part were noticed. Immediately after that, the flight of unknown adults was detected. The first adults were observed on 18th April 2019 and the flight lasted until 24th April 2019.

Amphicerus bimaculatus was determinated based on the morphological characteristics. The adult was 9–12 mm in length with black body, brown legs, gray-black elytra with randomly placed brown stops. At the anterior margin of the pronotum there were two grey spots, each with two black spots. The larva was about 15 cm long, whitish with brown head.

The vine grape is an economically important crop in the Republic of North Macedonia, presented at about 24,000 ha with more than 180,000 t grape production in 2017. The main pest insect on the vine grape is the European grape moth (*Lobesia botrana*) with three generations per year, which requires intensive plant protection, dominantly leaded by the insecticides. The appearance of *A. bimaculatus* was registered in vineyards where *L. botrana* was controlled by mating disruption pheromones in the last three years. These semiochemicals for pest control replace successfully the chemical measures against the main pest and allow the natural enemies to stay and increase their reproduction, which reflects later with better control of other pests. However, non-insecticidal plant protection provides conditions for outbreaks of some secondary pests suppressed by the insecticide treatment in conventional crop protection practice. Regarding the pest control of *A. bimaculatus*, there are different practices, e.g. sanitation by removing and burning all pruned branches.

Key words: *Amphicerus bimaculatus*, vine grape, damages.

Microbiological and chemical aspects of the water quality in Lake Ohrid in 2016

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Quality of surface waters is of extremely great importance not only for aquatic organisms but also for humans who use them for various purposes. The aim of our study was to determine water quality and assess the anthropogenic impact in the littoral and pelagic zones of the Macedonian part of Lake Ohrid, from St. Naum springs to the village of Radozhda. The study included microbiological parameters of ecological and sanitary aspects, organic and nutrient loading. The sampling was conducted in 2016.

The results obtained for the investigated bacteria showed that generally, their values in some parts of the littoral were with a greater variability, and higher than in the pelagial of the lake. The littoral zone of Lake Ohrid belonged to slightly and moderately polluted by organic matter. The microbiological investigations showed organic and faecal pollution of the lake water near the settlements and river mouths. In the water of Lake Ohrid, pelagial coliform bacteria and faecal indicators were not detected. The pelagic zone was still oligotrophic and balanced as a result of the lake ability of self-purification. This zone was still not under the influence of communal, industrial and waste waters, compared to the littoral zone. Therefore, it is necessary to conduct regular monitoring of water quality and take certain measures for the protection of Lake Ohrid.

Key words: Lake Ohrid, water quality, microbiological and chemical parameters.

Potential hazard of estrogen bioaccumulation in *Procambarus virginalis* for water biota and aquatic culture consumers in the Dnipro River, Ukraine

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The marbled crayfish *Procambarus virginalis* is a freshwater crayfish species. It has been a popular pet species in Europe and North America. *Procambarus virginalis* is an invasive species for the Dnipro River in Ukraine. Currently, this species have been introduced into the natural ecosystems in the Dnipro River near the city of Dnipro. Its establishment may be faciliated by its parthenogenetic mode of reproduction, polytrophic omnivoring, and the fact that *P. virginalis* can withstand low winter temperatures in the European temperate zone.

Aquatic vertebrates, such as fish and shellfish, are particularly affected by aquatic anthropogenic contaminants; exposure can be lifelong and through multiple routes, including the skin and gills or through feeding on contaminated sediments or organisms and bioaccumulation is frequent. Many contaminants are present in the aquatic environment both alone (in different concentrations) or in complex mixtures that may have an estrogenic disrupting action (Endocrine Disrupter Compounds – EDCs), and their lipophilic and persistent nature may contribute to their bioaccumulation in aquatic organisms. The water contaminants can impair reproduction, development, immune response, and other physiological processes that ultimately can affect the survival of aquatic organisms.

The present work aimed to determine estradiol concentration in *P. virginalis* at different developing stages from the Dnipro River in the city of Dnipro. The estradiol concentration was determined by ELISA method in the spawn, embryos, and young crustacean carcasses.

Our results showed that the average estradiol level was 2107 ng/g fresh weight in the spawn samples, 2876 ng/g in the embryos samples, and 4924 ng/g in the young crustacean carcasses. The average estradiol level was 4634 ng/g in one-month age crustacean muscles, 4854 ng/g in five-month crustacean muscles, and 4877 ng/g fresh weight in one-year crustacean muscles. These results highlighted the ubiquitous bioaccumulation of estrogens in aquatic invertebrates, depending on the exposure duration. The estradiol transfer from *P. virginalis* digestive system to the muscles can rule a potential risk to aquaculture, wild animals and human health related to the consumption of aquatic organism meat. Finally, the estrogens bioaccumulation can contribute to the general environmental estrogen pool. In addition to the direct impact of the water pollutants on the population of aquatic organisms that are included in the food chain when used by humans and wildlife, they pose human health risk and adversely affect the fisheries and aquaculture economy.

Key words: *Procambarus virginalis,* endocrine disrupter contamination, estrogenic bioaccumulation.

Use of *Bacopa monnieri* (Plantaginaceae) to purify waste water

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The rapid depletion of clean water resources has made it imperative that people develop new methods to obtain clean water. *Bacopa monnieri* (Plantaginaceae), an alien species to the Turkish flora, can be used in biological filtration of water. It is an important water plant used for removing heavy metal pollution in water, for making medicines, and for decorative purposes in aquariums. The aim of this study was to develop an efficient method for *in vitro* cultivation of *B. monnieri*, using easily obtained and cheap sources. Subsequently, the plants obtained can be used in waste water treatment systems.

Plant tissue culture method was used to propagate the plant. In addition, a controlled experiment was performed in hormone-free environment. After the isolation of apical meristem and leaf explants in the experiments, they were placed in solid or liquid media containing different concentrations of growth regulators for shoot regeneration. When the resulting shoots reached 1–2 cm in length, they were cut and placed in sterile Magenta GA7® containers for rooting. In the experiment, natural materials such as seed shells of carob (*Ceratonia siliqua*) or isubgol (mucilage husk of *Plantago ovata*) were used as hardener instead of agar. The liquid medium did not contain any solidifying material. Eight weeks later, multiple shoots were obtained from the leaf and apical meristem explants. More shoots were obtained from the leaf explants than from the apical meristem explants. Comparing the solidifying agents, isubgol was found to be better for the shoot formation. Comparing the solid and liquid media, the solid media gave better results. The obtained shoots were successfully rooted and adapted to water.

Key words: *Bacopa monnieri*, phytoremediation, heavy metal, wastewater treatment.

Spatial and temporal distribution of phytoplankton in Lake Prespa, Republic of North Macedonia, in 2014–2016

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Lake Prespa, one of the world's ancient lakes shared by North Macedonia, Greece and Albania is a very unique ecological and hydrological system, which over the past years has faced serious environmental challenges, such as eutrophication and introduction of alien species. The main objective of this study was to investigate the spatial and temporal distribution of phytoplankton as a key biological quality element to be used in lake ecological quality assessment. The phytoplankton samples were taken during the period 2014–2016, in different seasons, with special emphasis on summer sampling, at three pelagic and six littoral sampling stations in the Macedonian part of Lake Prespa.

Our results showed that the phytoplankton community was represented mainly by species of the groups Bacillariophyta (dominant in winter, spring and autumn) and Cyanophyta (dominant in summer). The other groups of algae contributed with significantly lower part to the total phytoplankton abundance. The total abundance of phytoplankton was considerably higher in summer than in other seasons, which is characteristic for meso-eutrophic lakes.

During the studied period the total abundance of phytoplankton was significantly higher in 2014 compared to 2015 and 2016. There were no significant differences between phytoplankton composition and abundance at the surface layers of pelagic stations and at the littoral sampling stations in different seasons. The highest average phytoplankton abundance in the water column of Lake Prespa was observed at 5 m depth and it was slightly lower at 10 m depth and at the surface layer. At the deeper layers from 15 to 30 m, the phytoplankton abundance significantly decreased.

Key words: Lake Prespa, phytoplankton, composition, abundance, seasonal distribution, spatial distribution.

Anthropogenic pressure triggered changes in Charophyta composition in Lake Ohrid and its watershed

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Lake Ohrid has been known as a centre of biodiversity and radiation of Charophyta on the Balkan Peninsula. Charophyta vegetation represents very important lake's component, which owing to its huge biomass and wide distribution, influences the lake's ecosystem metabolism.

Lake Ohrid, despite the increased anthropogenic pressure, still retains its original oligotrophic status partly due to the increased level of protection but mostly due to the hydrogeology and morphology of the lake basin. This emphasises its capacity for self-purification. Unlike the lake, its watershed is more prone to the negative anthropogenic pressure whereby the rapid urbanisation and the agricultural activities play the key role.

According to the recent studies, Lake Ohrid is inhabited by 18 Charophyta species. However, distinct changes in Charophyta composition and distribution have been detected compared with data from the 1980s and earlier periods. The species inhabiting the area in the northern watershed of the lake have disappeared as a result of the habitat destruction/ conversion. For example, the species *Nitella mucronata* in its two forms (f. *heteromorpha* and f. *rubistior*), *Nitella hyalina* and *Nitella syncarpa*, which were registered in the past in the lake's watershed, are not present in these localities anymore. A major part of the wetlands, including the canals where these species lived, has been converted to agricultural areas or dried. Changes in Charophyta composition in the lake have occurred as well. The latest studies have pointed out that there are changes in the composition of the associations in which Charophyta species coexist with other submerged macrophytes.

Key word: Antropogenic pressure, Charophyta, biodiversity, Lake Ohrid, watershed.

Inventory of benthic macroinvertebrates in Lake Ohrid catchment in 2016

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Lake Ohrid is well known by its high level of biodiversity and endemism. The lake is part of the group of ancient lakes which harbour very specific and unique fauna and flora that have been identified as especially sensitive and vulnerable to invasions and impact of invasive and alien species, and therefore, require special protection. The main aim of our study was to monitor selected sites in Lake Ohrid and its watershed for the presence and quantitative characteristics of invasive and alien species of benthic macroinvertebrates. The study was carried out in May 2016 and the data obtained will allow comparing the results with our previous studies: in 2010 for Lake Ohrid and in 2013 for its tributaries and outflow, the Crni Drim River.

A total of 26 sites were sampled, as follows: the Sateska River (8 sites), Crni Drim River (7 sites), Radika River (2 sites), Lake Ohrid (4), Lake Prespa (2), Debarsko Lake (2), and Globocica Reservoir (1). The samples were collected using standard methods for benthic macroinvertebrates, such as a multi habitat kick and swipe method with D-shape net (500 µm), sieves and hand nets. Water physical and chemical parameters were measured at each site.

Representatives of the following benthic taxa were recorded: Turbellaria, Oligochaeta, Hirudinea, Isopoda, Amphipoda, Decapoda, Ephemeroptera, Odonata, Plecoptera, Coleoptera, Trichoptera, Heteroptera, Diptera, Gastropoda, and Bivalvia. Most frequently found were Amphipoda and Ephemeroptera, followed by Gastropoda, Odonata and Trichoptera. The highest richness of taxa was recorded in the Sateska River. Only one alien species was recorded – the gastropod *Physella acuta*. We present the qualitative and quantitative composition of benthic macroinvertebrates in Lake Ohrid catchment and evaluate the ecological status of water as a factor that could facilitate the introduction and establishment of invasive and alien species.

Key words: Lake Ohrid catchment, benthic macroinvertebrates, invasive and alien species, distribution, composition.

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Water quality of Lake Ohrid according to physical, chemical and biological parameters, in 2010

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Industrial growth, agriculture with application of agrotechnical methods, and modern lifestyle are more and more contributing to changes in quality of aquatic ecosystems. Lake Ohrid is a transboundary water body, and one of the largest and deepest lakes in Europe, of high importance for both countries Republic of North Macedonia and Republic of Albania. In the last decades, the anthropogenic impact on the lake, especially expressed in the littoral zone, near the river mouths, agriculture areas, and touristic complexes, has caused alarming deterioration in water quality at certain sites.

This study aimed to determine the water quality of Lake Ohrid based on some physical and chemical parameters (biodegradable organic matter, total phosphorus and total nitrogen concentrations) and biological indicators (chlorophyll-a, heterotrophic bacteria, total number of coliform bacteria). The sampling was conducted during 2010 at 15 littoral points, which covered the entire shore of Lake Ohrid: littoral at Cerava River, Trpejca, Velidab, Metropol, Park, Ohrid Bay, Grasnica (littoral at Velgoska River), littoral at Sateska River, Struga, and Radozda, from the Macedonian side, and Udenisht, Piskupat, Pogradec, Dogana, and Lin, from the Albanian side. The Carlson's method was applied to determine the trophic state index of the water based on the following parameters: concentration of total phosphorus and content of chlorophyll-a.

According to the mean values of the trophic state index, a classification of the respective measuring points was made. The results showed that the water in the littoral zone near the mouth of rivers (Sateska, Velgoska, and Cerava) was more loaded with nutrients, and had higher trophic state, which was more expressed in summer, compared to other studied points.

Key words: Lake Ohrid, nutrients, trophic state index, heterotrophic bacteria, coliform bacteria.

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Popov M.
Prokopuk M.
Protasov A.
Pupins M.
Puşcalău M.
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Radulović S.
Radulovici A.
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Savytskyy O. L.
Shushkivska N.
Simov N.
Simovski B.
Sinchuk A.
Skorić S.
Skute A.
Slavchev M.
Spirkovski Z.
Stănescu F.
Stefanov T.
Stefanova H.
Stoianova D.

Stoichev S.
Stoumboudi M. Th.
Şubernetkii I.
Sylaieva A.
Talevska M.
Talevski T.
Tanner R.
Tarkan A. S.
Tat M.
Teker M.
Teodoru A.
Teofilova T.
Tocan B.
Toderaş I.
Todorov M.
Tomov R.
Tomović J.
Trajanovska S.
Trajanovski S.
Trichkova T.
Tsiamis K.
Tsoneva S.
Tsvetkova E.
Tsybulskyi A.
Tubić B.
Tudor M.
Türkdoğan S.
Turvey K.
Tymoshenko N.
Tytar V.
Tyufekchieva V.
Uludağ A.
Ünver H.
Uzer U.
Uzunova E.
Vancheva N.
Varga F.
Varshanidze M.
Vasiljević B.
Veljanoska-Sarafiloska E.
Velkova-Jordanoska L.
Vidinova Y.
Vilizzi L.
Vladimirov V.
Vladović D.
Vlahović D.
Vrbničanin S.
Winfield I.
Wood L. E.
Yazlık A.
Yildirim M. Z.
Yildiz İ.
Yıldız T.
Yoğurtçuoğlu B.
Zdraveski K.
Zenetos A.
Zengin M.
Živković M.
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