INVASION OF ALIEN SPECIES IN HOLARCTIC

BOROK-VI

SIXTH INTERNATIONAL SYMPOSIUM

BOOK OF ABSTRACTS

BOROK — UGLICH, 11-15 OCTOBER 2021

Russian Academy of Sciences

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Division of Biological Sciences (DBS RAS)
Scientific Council of Hydrobiology and Ichthyology RAS
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INVASION OF ALIEN SPECIES IN HOLARCTIC. BOROK-VI

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The book represents proceedings of Sixth International Symposium “Invasion of Alien Species in Holarctic. Borok -VI” (11 Oct. – 15 Oct. 2021, Borok – Uglich, Russia). The wide spectrum of problems related to appearance and spread of invasive plants and animals is discussed. The book may be interested for specialists in many fields, such as limnologists, hydrobiologists, ecologists, botanists, zoologists, geographers, managers of dealing with nature preservation and fisheries.

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ЧУЖЕРОДНЫЕ ВИДЫ В ГОЛАРКТИКЕ.
БОРОК-VI

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В сборнике представлены тезисы докладов Шестого международного Симпозиума по изучению чужеродных видов “Invasion of Alien Species in Holarctic. Borok-VI”, 11–15 октября 2021 г., Борок – Углич, Россия. Обсуждается обширный спектр проблем, связанных с появлением и распространением инвазийных растений и животных. Книга рассчитана на широкий круг специалистов: лимнологов, гидробиологов, экологов, ихтиологов, ботаников, зоологов, географов и специалистов по охране природы.

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Sixth International Symposium "Invasion of Alien Species in Holarctic. Borok-VI"

RUSSIA
Borok-Uglich
October 11-15, 2021

PREFACE

This book contains materials of reports presented at Sixth International Symposium, "Invasion of Alien Species in Holarctic. Borok-VI", which is to be held on October 11-15, 2021.

The traditions of these symposia originated 20 years ago, when a US–Russian conference of the same name was held in the settlement of Borok in Yaroslavl Region, on the basis of the Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences. There are many reasons for the fact that the first symposium was organized by Russia and the United States (also attended by representatives of Canada). The main one is that our countries are located within the Holarctic, one of the largest regions of our planet with approximately an identical set of natural zones and conditions. At the first symposium, it was decided to make it regular and call it "Borok" for brevity. Later, representatives of not only Holarctic countries but also other parts of the Earth took part in the "Borok" symposia.

Materials of this publication contain data on the main aspects of invasive biology: spatial and temporal dynamics of biological invasions in different types of ecosystems of the Holarctic; genetic and evolutionary aspects of biological invasions; consequences of alien species invasion for aboriginal species and ecosystems and human well being; the role of global climatic and anthropogenic factors in the processes of biological invasions, including new approaches and methods in research of invasions of alien species; creation and maintaining of the information systems for monitoring invasion processes, including the development of problem-oriented databases and mathematical modeling of the processes related to invasion of alien species.

This book is addressed to biologists, ecologists who are engaged in the issue of biological invasion of alien species and to decision-makers who are responsible for the control of invasion, university teachers, postgraduates, and students.

The Symposium is sponsored by the International Union of Biological Sciences (grants for Conferences and Young Scientists), and the Organizing Committee and Scientific Committee are very grateful to IUBS for the support.

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Sixth International Symposium "Invasion of Alien Species in Holarctic. Borok-VI"

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NATURALIZATION OF CHAMELEON GOBY *TRIDENTIGER TRIGONOCEPHALUS* (GILL, 1859) AS AN EXAMPEL OF INTRODUCTION STRATEGY OF INVADER FISH SPECIES IN THE BLACK SEA

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Chameleon goby *Tridentiger trigonocephalus* (Gill, 1859) is a small euryhaline fish species inhabiting the coastal zone, estuaries, and lower reaches of rivers in the basins of the Sea of Japan, the Yellow, East China, and South China Seas. It lives among the settlements of mollusks (mussels and oysters). Uses their valves as a refuge and spawning substrate. Due to this feature, during the transportation of oysters (broodstock), it settled and introduced on the west coast of the USA, Oceania and Australia. One specimen was caught in the south of the Mediterranean Sea of the coast of Israel.

In 2006, the chameleon goby was first caught in the Black Sea (estuary of the Chernaya River, Sevastopol). Apparently, an accidental introduction of this species occurred because of the release of several dozen fish brought from Posiet Bay (Sea of Japan) by an employee of the Sevastopol Aquarium about 40 years ago.

T. trigonocephalus has formed a population in Sevastopolskaya Bay. The biotope was the mussel colonies covering the waterworks. Salinity in this area from 2006 to 2018 ranged from 0.05 to 19.44 ‰, and the water temperature from 6.0 to 29.5 ° C.

During the observation period, 111 specimens of fish were caught (54 females, 30 males, 2 juveniles, sex of 25 specimens was not identified). The sex ratio of *T. trigonocephalus* is 1: 0.55. The maximum total body length of females reached to 7.1 cm, males – 7.7 cm. The maximum recorded age is 3 years old. Males are significantly larger than females in standard length. At the same time, the conditional factors (Clark and Fulton) of females are significantly higher than males.

The chameleon goby reaches sexual maturity at the age of one year and at the length 3.9 cm for males and 4.1 cm for females (Table).

Spawning takes place from April to September. During this period, the female lays up to 10 servings of eggs. The eggs laid on various substrates (valves of dead mollusks, crevices in the surface of stones, banks) are protected by the male.

Table. Morpho-physiological parameters of *Tridentiger trigonocephalus* from Sevastopol Bay (Black Sea)

Parameter	Females	Males	Both
Total length, cm	6.0±0.11	5.8±0.18	5.3±0.10
Standard length, cm	4.2±0.09*	4.8±0.15	4.4±0.08
Body weight, g	1.84±0.14	2.29±0.24	2.00±0.01
Clark conditional factor	0.55±0.06*	0.33±0.08	0.36±0.04
Fulton conditional factor	1.27±0,02*	1.10±0.06	1.24+0.02
Hepatosomatic index, %	4.49±0.79	-	2.22±0.44
Gonadosomatic index,%	1.67±0.23	1.38±0.35	1.17±0.16

Note: * differences are significant compared to males, $p \leq 0.05$

It can be concluded that, despite significant differences in the habitat of their native range and the Black Sea, *T. trigonocephalus* acclimatized and created a local population in the Sevastopol Bay. This indicates the high ecological plasticity of this species. Regarding the features of biology, it can be noted that the obtained differences indicate the presence of sexual dimorphism. Despite the rather long period of habitation, there is no settlement outside the Sevastopol Bay. The species is not recorded in other parts of the Crimean coast. We assume that the factor limiting its distribution in the sea is the lack of a suitable biotope. Currently, the populations of mussels in the Black Sea are in a depressed state. And without mussel druses, it cannot fully exist.

This work has been carried out within the framework of IBSS state research assignment “Regularities of formation and anthropogenic transformation of biodiversity and biological resources of the Sea of Azov – Black Sea basin and other areas of the World Ocean” (No. 121030100028-0) and partially within the framework of RFBR grant “Dynamics and consequences of introduction of invasive fish and invertebrate species into biocenoses of Sevastopol coastal zone and bays” (No. 18-44-920016).

HERACLEUM SOSNOWSKYI MANDEN. (APIACEAE) IN BASHKORTOSTAN

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Heracleum sosnowskyi Manden. – monocarp up to 2-3 m tall. The originating from the Caucasus and Transcaucasia, where it lives on meadows in beechwood, fir-beechwood forests of the middle and upper mountain belts, as well as in subalpine meadows. The species is named after the explorer of the flora of the Caucasus D.I. Sosnovsky. H. sosnowskyi in the middle of the 20th century began to grow as a highly productive silage crop in the northern and central regions of Russia and the Baltic states. In the future, he proved himself to be a dangerous invasion species in many regions of the Russian Federation. Included in the Black Books: Central Russia, Siberia, Udmurt Republic, Tver, Kaluga regions, black lists: Middle Volga, Yaroslavl, Sverdlovsk, Voronezh, Bryansk, Volgograd regions, and in the list of 100 most dangerous invasive species of Europe. In the Republic of Bashkortostan (RB) *H. sosnowskyi* was not cultivated in a wide culture, only test crops were carried out in experimental areas. In most cases, the species settled in RB on the roads from neighboring regions - mainly from the Perm and Sverdlovsk regions and the Udmurt Republic.

Distribution. On the territory of RB, 22 localities of *H. sosnowskyi* are known today in 10 districts of the North-West, North-East and the central part of the Urals. The species was first observed in 2004 in the vicinity of Ufa (village of Milovka), at the location of the experimental center of the Bashkir State Agrarian University, where *H. sosnowskyi* was experimentally cultivated. All other localities of this species appeared during the last 10 years. All locales are small - the majority are in the range of 100, in individual populations - up to 1000 or more plants.

Naturalization. In RB, it is found on roadsides, wastelands, abandoned farms, forest edges, damp banks of reservoirs with moist nitrogen-rich soil. Along the edges of forests and shady banks of reservoirs forms communities of the association *Urtico dioicae-Heracleetum sosnowskyi* Panasenko et al. 2014.

Characteristics of populations. The total density of the species in populations is high and amounts to 41-92 individuals/m^2, the effective density (density of generative individuals) is 1.9-3.4 individuals/m^2 Biomass can reach 2.3-4.6 kg from 1m^2. The part of *H. sosnowskyi* in the community is also very significant - 77.8-96.8%. Forms monodominant communities.

Reproductive ability. All indicators of seed productivity of *H. sosnowskyi* vary quite a lot, but in general, like the coefficient of seed productivity (42.9-58.7%), are characterized as high. Potentially, one plant can give from 18.5 to 39.5 thousand seeds, but the real seed productivity is much lower - from 9.5 to 16.7 thousand seeds. High seed productivity of the species determines its high invasion potential

Conclusion. The *H. sosnowskyi* provides a serious threat to the biodiversity of natural flora of RB and public health. That is why he is included by us in the Black Book of Flora of the Republic of Bashkortostan. Introduced in natural habitats, it disturbed of successional connections, forms monodominant communities. It changes the nature, environmental conditions and nature of native ecosystems, which allows it to be considered a transformer species. It is important to give it the status of a quarantine object.

For details see: Abramova L.M., Golovanov Ya.M., Rogozhnikova D.R. Sosnowsky’s Hogweed (*Heracleum sosnowskyi* Manden., Apiaceae) in Bashkortostan // Russian Journal of Biological Invasions. 2021. Vol. 12, No. 2. P. 127–135. https://doi.org/10.1134/S2075111721020028

INVASION OF *HORDEUM JUBATUM* L. (POACEAE) IN THE REPUBLIC OF BASHKORTOSTAN

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Hordeum jubatum L. – a herbaceous cereal plant up to 40-60 cm tall, leaves 10-12 cm long, 1.5-4 mm wide, spica with thick bones directed at acute beards. Fruit - caryopsis. The natural area – northern part of North America and northeast Asia.

Included in the Black Books: Central Russia, Siberia, Udmurt Republic and the Republic of Bashkortostan, black lists: Middle Volga, Sverdlovsk, Voronezh, Volgograd, Orenburg regions. In (Republis of Bashkortostan) RB, it has status 1 - a transformer species.

Distribution in RB. Within the republic it is found both in the Urals and in the Trans-Urals, rarely in the mountain forest zone. It grows mainly along ruderal habitats along communication routes, wastelands, streets in settlements, banks of water bodies of the steppe zone on solotetz soils.

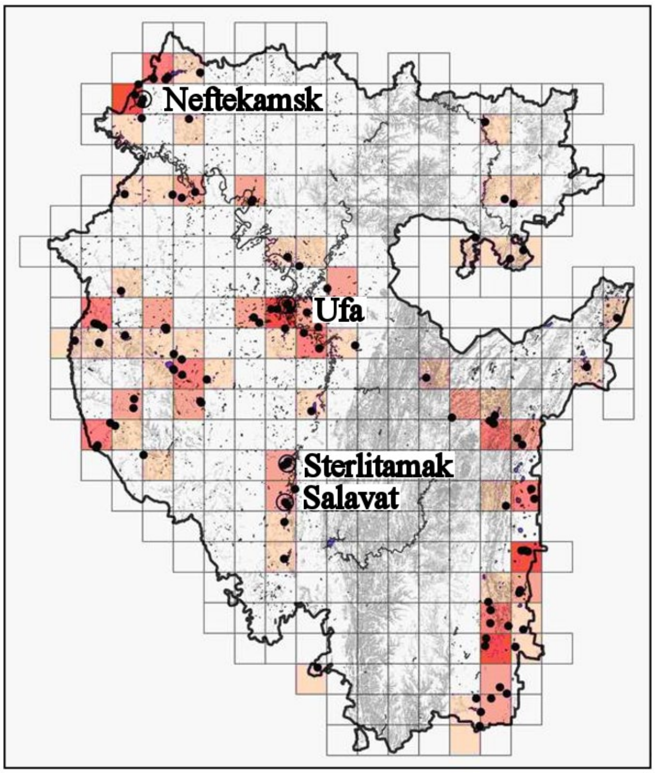

Figure. A modern map of the distribution of *Hordeum jubatum* in the RB.

Characteristics of populations in RB.

The height of the species varies from 15 cm to 40 cm. Plant density - from 9 to 40 individuals. The number of shoots from 350 to 800 pcs. per 1 m^2. Forms a small biomass from 0.2 to 0.5 kg/m^2. Dominates in communities with proportion of 50% to 88% of all plant species.

Pathways of invasion and naturalization. It was first identified in 1984 in the city of Beloretsk, along the road and gardens where it was grown as ornamental plant. In 1989 near the village of Semenovskoye (Baymak district of RB), extensive thickets on disturbed habitats were discovered. This suggests a significantly earlier invasion of the species. The wide distribution of this plant is associated with its rapid spread through the communication routes. Highways and railways correspond to the natural type of distribution of seeds of this cereal. The invasion area in RB is currently more than 500 hectares, and is rapidly increasing (fugure). It forms three types of monodominant communities: *Polygono avicularis-Hordeetum jubati* Abramova, Golovanov 2016 and the derivative communities *Hordeum jubatum-Poa pratensis* [*Cynosurion cristati*], *Hordeum jubatum–Juncus gerardii* [*Scorzonero-Juncetalia gerardii*].

Conclusion. The *H. jubatum* in the Southern Urals has a high invasion potential and is actively naturalized into natural halophytic and steppe communities. Changing their appearance and displacing native plant species. Forms unsuitable pastures. The large seed bank in the soil and the transfer of propagules by wind over long distances complicate the control of the distribution of the species in the region.

ALIEN LAND SNAILS IN THE SOUTH OF THE CENTRAL RUSSIAN UPLAND: POPULATION STRUCTURE AT THE BEGINNING OF EXPANSION

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The demographic, spatial and genetic structure of populations of alien gastropods *Xeropicta derbentina* (Krynicki, 1936), *Brephulopsis cylindrica* (Menke, 1828), and *Harmozica ravergiensis* (Ferussac, 1835) has been studied on the territory of Central Russian Upland. The native range of these species covers the Caucasus, Crimean Peninsula and other territories of the Black Sea region. However, they have been spreading in recent decades northwards and northwestwards the native range.

The population density, demographic structure, and spatial organization have been analyzed for three years of observations (2017, 2019, 2020). During this period, the changes in the population density have been noted for all studied species. *B. cylindrica* population had the highest density: in 2020, it has reached 405.5 ind./m2 on average, with the maximum of 1264 ind./m^2. Meantime, the population keeps the clustered spatial structure, which is explained by both high population density and adaptation to the arid conditions of its natural range. Another alien gastropod, *H. ravergiensis* is distributed throughout the city and has stable population density, accompanied by an increase in 2020. One of the main factor contributed an increase in the population density of two alien species is an increase in the mean monthly temperature of the cold season. The *X. derbentina* population density has significantly decreased in 2019 and 2020, the spatial structure has changed from clustered type to random distribution. Also, despite this species has an annual life cycle in the native range, the 52.94% of adult snails were registered in May 2020. An extremely high population density of *B. cylindrica* may locally suppress *X. derbentina*. Local cross-correlation for *B. cylindric*a and *X. derbentina* had negative, but statistically insignificant values in most cases. But the p-value in this case explained by low numbers of *X. derbentina* individuals.

Genetic structure of populations was studied with ISSR PSR method. Belgorod populations of *H. ravergiensis* have the same level of genetic variability that populations in Caucasus. Also Caucasian populations are distant from Belgorod populations as well as from each other (ΦST = 0.380, P = 0.001 for populations from Armenia). A similar situation occurs in populations of B. cylindrica. However, the significant differences were not observed, for Belgorod populations, all indices of polymorphism are lower than for in populations from Crimea. The level of genetic differentiation within B. cylindrica is high (ΦST = 0.582, Nm = 0.179) among all populations both alien and native. Two alien population of *X. derbentina from Belgorod region were* analyzed: high genetic differentiation (FST=0.746; p=0.01) of these populations from Central Russian Upland indicates their different origin from the natural area.

As a conclusion, I want to emphasize that the studied alien species are currently beginning to expand the territory of the Central Russian Upland. Today it is too early to evaluate the success of the invasion. But the populations of the studied gastropods have an invasion potential to continue the expansion of the new territory.

INVASIVE SPECIES AS ONE OF THE MAIN DRIVERS OF THE AZOV SEA ECOSYSTEM CHANGES

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Using a big array of hydrobiological data on the abundance, biomass and species composition of phyto, -zooplankton and benthos, the main stages of changes in the ecosystem of the Sea of Azov from 1970 to the present were analyzed. Several successive quasi-stable states of the ecosystem have been identified. The main drivers of the change were identified that contribute to the transition of the ecosystem from one quasi-stable state to another. These drivers included: 1) changes in salinity as a result of changes in the flow of the Don River, 2) long-term climatic changes, and 3) the introduction of invasive species. The most serious impact on the ecosystem of the Sea of Azov is exerted by the introduction of non-indigenous zooplankton and zoobenthos species. These groups have seriously changed directions and intensity of the flow of substances and energy. The most abundant group of invasive species belongs to zoobenthos and presents by bivalve mollusks. A number of them form significant biomass both at marine and freshwater ecosystems. Most stressful for marine water ecosystems is an invasion of euribiotic benthic and planktonic predators with wide food spectrum.

ADAPTIVE POTENTIAL OF RAGWEED (*AMBROSIA ARTEMISIIFOLIA* L.) AND ITS DISTRIBUTION TO THE NORTH

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A geographical experience of growing populations of ragweed (*Ambrosia artemisiifolia* L.) of different latitudinal origin was carried out. The study revealed differences in the thresholds of photoperiodic sensitivity in the southern (seeds were collected in the Krasnodar area) and northern (from the Belgorod and Kursk regions) ragweed populations. Populations from the northern border of the secondary distribution area bloomed on a longer day (about 15 hours), compared to the southern ones (about 14 hours). This was observed both at the southern station in the Krasnodar Territory (45.2 N) and in the northern ones - in the Moscow Region (55.7 N) and Ufa (54.7 N). For a short-day annual species such as ragweed, the transition to the generative phase on a longer day increases the duration of the seed ripening period by reducing the duration of the vegetative development period. This provides plants of northern populations with additional heat resources for seed ripening, although at the same time it decreases vegetative growth. Modification of photoperiodic sensitivity is the main mechanism for the adaptation of ragweed to north environment. Experiments have shown a significant intra- and interpopulation variation of ragweed in photoperiodic sensitivity, which indicates a large ecological potential for the distribution of this species to the north.

The maps of the potential distribution of ragweed with different thresholds of photoperiodic sensitivity were created.

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IMPACT OF ALIEN DOMINANTS ON THE SPECIES RICHNESS OF PLANT COMMUNITIES AT DIFFERENT SPATIAL SCALES

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It is known that alien dominants significantly limit the species richness of plant communities in microsites. However, the results of their impact on large areas of communities remains unclear (Hejda et al., 2009; Powell et al., 2013; Stohlgren, Rejmánek, 2014; Chase et al., 2015; Rejmánek, Stohlgren, 2015). It can be assumed that they may depend on the nature (selective, non-selective) influence of alien dominants on other species. Selective impact can have significant consequences for the species pool of plant communities; non-selective (random) – no, since in this case each of the accompanying species can be found with a certain probability in the areas of cenoses with any degree of dominance. We considered this issue using the example of 18 herbal communities dominated by alien species (the Western Caucasus, basins of Belaya and Khosta rivers, 85-680 m a. s. l.; dominants: *Helianthus tuberosus, Asclepias syriaca, Solidago canadensis, Impatiens glandulifera, Ambrosia artemisiifolia, Silphium perfoliatum, Paspalum thunbergii, Xanthium albinum, Bidens frondosa* and *Duchesnea indica*). Within each of them, biomass samples were taken from 25-30 plots of 0.25 m^2, which were then disassembled by species and weighed. The participation of dominants (the degree of dominance) was assessed through the ratio of their biomass and biomass of samples as a whole. For each community, we assessed the closeness of the relationship between the degree of dominance and species richness, as well as the nature of the disappearance of accompanying species from microsites as the degree of dominance increased. To solve the second problem, two tests were used: 1) 18 series of biomass samples with different participation of dominants were compared with by a series of model cenoses with a random distribution of species; 2) the groups of samples with the lowest and highest participation of the dominant, but with approximately equal total biomass of the accompanying species (due to the different number of samples in the groups) were compared. In addition, we compared the total number of species in two groups of samples taken in 12 communities located in the vicinity of the Maykop city (dominants: *A. syriaca, S. canadensis, A. artemisiifolia,* and *S. perfoliatum*). The first group consisted of 60 (5x12) samples with the lowest participation of dominants (total area of microsites – 15 m^2, average degree of dominance – 0.29 ± 0.02). The second one out of 179 samples with the highest degree of dominance (each community is represented by 11–21 samples, the total area of microsites is 44.8 m^2, the degree of dominance is 0.83 ± 0.01). The total biomass of accompanying species in these groups of samples is approximately the same – 16234 and 16254 grams respectively. The following results were obtained: 1. In 14 out of 18 communities, a moderate or strong relationship was found between the degree of dominance and species richness in microsites. 2. Only in two communities (in one of two communities with the dominance of *A. syriaca*, as well as in one of six communities with the dominance of *S. canadensis*) both tests showed signs of selective displacement of accompanying species. 3. In total, 95 species were identified in 60 samples with the least participation of *A. syriaca, S. canadensis, A. artemisiifolia*, and *S. perfoliatum*; in 179 samples with the greatest participation of these dominants – 103 species. Thus, our results indicate that the majority of alien dominants have a significant local impact on the species richness of communities, but are not able to significantly change the size of their species pool. Previously, in the same way, we studied 15 plant communities dominated by predominantly native species (from the macrophytobenthos of the Azov Sea to alpine meadows of the Western Caucasus) and obtained similar results (Akatov et al., 2021).

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CHANGES IN THE ARTIODACTYLA POPULATION IN THE PRIOKSKO-TERRASNY RESERVE AS A RESULT OF INVASION

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The Prioksko-Terrasny Nature Biosphere Reserve was established in 1945. During its existence, the Reserve has seen significant changes in the Artiodactyla populations.

The history and essence of these changes are as follows:

1945–1949 – the Moose (*Alces alces* Linnaeus, 1758) – native species – was the only representative of artiodactyls on the territory of the reserve. Moose numbers varied within the 5 to 26-head range.

1950–1958 – the Moose and Siberian Roe Deer (*Capreolus pygargus* Pallas, 1771) inhabited the reserve. Moose dominated. Moose numbers in 1950 were 19 heads, later – 41–130 heads. The Siberian Roe Deer was intentional introduced into the reserve with the aim of “enriching the fauna” in 1950 (4 heads) and in 1954 (8 heads). Annual number: 2–18 heads.

1959 – the European Roe Deer (*Capreolus capreolus* Linnaeus, 1758) entered the territory from its surroundings. Moose population in the 1959 census was at 99–298 heads. The combined count of Siberian and European Roe Deer was 63 heads.

1960–1963 – the fauna of artiodactyls was enriched by the Wild Boar (*Sus scrofa* Linnaeus, 1758). A herd of 20 wild boars entered the reserve from the surrounding hunting grounds in 1960; by 1963, 12–15 wild boars lived in the reserve. Moose dominated: in 1960 – 426 heads (a record level), later – 101–340 heads. The total number of Siberian and European roe deer was 40–70 heads. During these years, hybrid individuals of these 2 species appear in the reserve (Albov et al., 2010, 2015).

In 1964, the European Red Deer (Cervus elaphus Linnaeus, 1758) moved into the reserve from the surrounding hunting grounds, but the Moose (64 heads) dominated. In 1965, the Sika Deer (*Cervus nippon* Temminck, 1838) moved in.

Between 1965 and present day, there have been 4–6 species of artiodactyls in the fauna of the reserve: Wild Boar, Moose, Siberian and European Roe Deer (and their hybrids), European Red Deer and Sika Deer (and their hybrids). The existence of pure-blooded Siberian Roe Deer and European Red Deer is in doubt.

1965–1970 – the Moose continued to dominate among ungulates, although it numbers gradually declined from 227 in 1965 to 99 in 1970.

1971–2018 – the Wild Boar dominated among artiodactyls more often than other species. Boar was the sole dominant species for 25 out of 48 years. For another 16 years, the Wild Boar dominanted together with the Moose (1971, 1977, 2005), or with Roe Deer, mainly with European Roe Deer (1973, 2002, 2004, 2006), or with the Moose and Roe Deer (2010), or with Deer, mainly with Sika Deer (1975, 1976, 1982, 1988, 1989, 1992, 2017, 2018). During this 48-year period, there were also years when, against the background of a decrease in the number of wild boars, other species of artiodactyls occupied a leading position: in 1994 European Red Deer (54 individuals), in 1995 European Red Deer (33 individuals) and Roe Deer (33 individuals), in 1996 – European Red Deer (28 individuals) and Sika Deer (27 individuals), in 1999–2001 and in 2007 – Roe Deer (42–55 individuals).

2019–2020 – the number of Wild Boars fell: 5 heads in 2019 and 11 in 2020. The total number of artiodactyls has also declined. The Moose became the most abundant ungulate again (35 heads in 2019 and 46 in 2020).

Thus, as a result of intentional introduction and self-introduction of artiodactyls into the reserve, the species diversity of this group has increased significantly. Hybridization is observed between closely related species of Roe Deer and Deer, as a result of which it is not possible to accurately indicate the number of artiodactyl species in the reserve. The dominant species changed. More often the number of Wild Boar was higher than that of other artiodactyls. With an increase in species diversity, the total number of artiodactyls does not increase, which is associated with the aging of forests and the high impact of artiodactyls on the reserve ecosystems.

ANTHROPOGENIC, BIOLOGICAL AND CLIMATE-DEPENDING MECHANISMS THAT ENSURED THE SUCCESSFUL INVASION OF *ACANTHOCYCLOPS AMERICANUS* (MARSH, 1892) (COPEPODA: CYCLOPOIDA) FROM NORTH AMERICA TO PALEARCTICA

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Acanthocyclops americanus (Marsh, 1892), first described in Wisconsin (USA), was discovered shortly thereafter in Great Britain, and then widely distributed in the Palearctic. At the moment, its range includes Europe, North Africa, western and central Siberia with the largest number of findings along the migration tracks of aquatic birds. Until recently, the northern border was the 60th parallel, but in the last decade it has tended to expand further into the Arctic. The most rapid expansion of its range in Europe happened in the middle of the last century, which was partially hidden from scientists due to a taxonomic mistake caused by the merging of its name with the native Palearctic form *A. robustus* (Sars, 1863). This problem was solved only recently with the help of molecular genetic tools, allowing a return to the study of biological, anthropogenic and possible climate-dependent mechanisms of the successful rapid invasion of *A. americanus* into the Palearctic. This paper, along with a detailed description of the life cycle parameters, adaptive behaviour of nauplii and population dynamics in *A. americanus* compared to those in two others native *Acanthocyclops* species (*A. vernalis* and *A. robustus*), provides a possible history of the biological invasion of *A. americanus* in the Palearctic. Special attention is paid to the climate-dependent mechanism of the following expansion of its range to the north and far east of Asia.

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INVASION OF MALARIA MOSQUITOES *ANOPHELES DACIAE* IN NOTHERN TERRITORY OF THE OB RIVER BASIN

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Malaria mosquitoes, *Anopheles*, is one of the most dangerous insects, which are transmit disease pathogens of human and animals. The importance of anophelines mainly connected with malaria plasmodium vector capacity in Africa, South and Central Americas, Middle East and Southern-East Asia whereas in Europe they can also transmit other diseases, such as dirofilariasis and seteriasis, caused by parasitic nematodes.

Malaria mosquitoes species diversity in Eurasia decrease from southern part of the continent to the north and for temperate zone from western Europe to Far East. In West Siberia there are four species – *Anopheles messeae* and cryptic species *An. daciae* (Nicolescu et al., 2004), *An. beklemishevi* (three from Maculipennis group) and *An. claviger* from eponymous complex. *An. messeae* and *An. daciae* considered be the main vectors of malaria plasmodium in West Siberia in the past and due to well-developed chromosomal inversion polymorphism are able to adapt divergent ecological conditions.

An. daciae for a long time thought to be a southern «chromosome race» or «form» represented mainly in Europe part of former USSR and Russia which are observed in the low frequency in Western Siberia. However, from the beginning of 1980s the frequency of this species and corresponding inversion composition became to be dominated at least in model populations Kolarovo and Teguldet villages (Tomsk region, Novikov, 1997; Gordeev and Ezhov, 2004, Stegniy et al., 2016) Despite of several decades history of species composition and inversion polymorphism study the dynamics and patterns of *An. daciae* invasion in northern territories of Western Siberia are poor investigated. In present study we analyze species composition and inversion polymorphism of malaria mosquitoes from tens geographical points of Tomsk region, Khanty-Mansi and Yamalo-Nenets Autonomous Okrugs.

Basing on the sequence of the second internal transcribed spacer (ITS2) of ribosomal DNA (Vaulin et al., 2018; Artemov et al., 2021) we found that *An. daciae* dominates up to 57 parallel of Tomsk region (Kolarovo, Bakchar and Bazoy villages). Farther north in the Ob River basin it is in sympatry with other *maculipennis* species with different frequencies. The northernmost point, where this species was Labytnangi town (66°39'), where it was found with 44 % (9 imago females in total) in the first decade of august 2020. Nevertheless *An. daciae* has not been found in Pur River basin in Korotchaevo village and Noyabrsk town.

We suggest Ob River basin as a magistral of distribution *An. daciae* from southern territories to the north.

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THE EFFECT OF THE INTRODUCED RACCOON (*PROCYON LOTOR* LINNAEUS, 1758) ON AMPHIBIAN POPULATIONS IN DAGESTAN

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The widespread introduction of fur-bearing mammals in many regions of the former USSR in the past century has led to negative changes in many natural ecosystems. One of them is a species from North America - the raccoon (*Procyon lotor* Linnaeus, 1758), which was introduced in the 50-60s of the last century in Dagestan in the lower rivers Sulak and Samur. The species has now successfully colonized lowland and foothill areas in the region, inhabiting natural and anthropogenically transformed semi-desert, steppe, forest-steppe and forest landscapes. According to expert judgment, its average number in some areas is 0.016-0.66 individuals per hectare. According to our data, the number of raccoons is much higher in areas with a high abundance and species diversity of amphibians. Such territories in Dagestan include low-lying floodplain forests, foothill deciduous forests and their surroundings. The amphibian species inhabiting these areas are most active at dusk and at night. During the breeding season, they gather on the spawning grounds, where they become food for the raccoon, which characterized by nocturnal activity. Its diet includes Syrian spadefoot toad (*Pelobates syriacus* Boettger, 1889), Pallas' spadefoot toads (*Pelobates vespertinus* Pallas, 1771), Eastern tree frog (*Hyla orientalis* Bedriaga, 1890), balearic green toad (*Bufotes balearicus* Boettger, 1880), thirsty toad (*Bufotes sitibundus* Pallas, 1771), lake frog (*Pelophylax ridibundus* Pallas, 1771) and Caucasian brown frog (*Rana macrocnemis* Boulenger, 1885).

Thereby, the raccoon appreciably reduces the number of these species in the populations of the relevant ecosystems. Long-term existence of this factor will inevitably lead to the contravention of the integrity of many natural ecosystems in the future. In order to preserve the populations of these amphibian species and the stability of the corresponding natural ecosystems, constant monitoring is necessary in order to regulate the number of raccoons in them.

THE STATE OF INVASIVE SPECIES IN AZERBAIJAN

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During the period of 1930-1970 nine species of mammals (*Myocastor coypus, Chinchilla brevicauda, Nyctereutes procyonides, Procyon lotor, Mephitis mephitis, Neovison vison, Cervus nippon, Saiga tatarica* and *Bison bonasus*) have been introduced or reintroduced after a long absence in Azerbaijan by zoologists who had in mind to enrich and reconstruct the local fauna. Besides those species introduced by scientists two more species were released by local people or they entered from neighboring countries. The wild rabbit (*Oryctolagus cuniculus*) was released on the islands of Baku archipelagos in XIX century and they reproduced so fast that every year fishermen used to catch about 2000 rabbits on islands of Caspian Sea (Hajiyev, 2000). They still exist on Khara-Zira and Gil islands. On Khara Zira Island they compete with gazelles (*Gazelle subgutturosa*) for local scarce food and water resources (Sarukhanova, 2021). The Red squirrel (*Sciurus vulgaris*) entered Azerbaijan from Georgia, where it was introduced in soviet period and also entered from Northern Caucasus. First years it was aggressively competing with local squirrel species (*S.anomalus*) along the southern slopes of the Greater Caucasus range, then it became rare and now could be found only on timberline. Some of them were released in parks of Baku city by local population and some organizations, where they still survive (Askerov, 2001).

Among nine species introduced by scientists only Coypu and Raccoon could survive in Azerbaijan conditions and even become a pest in freshwater and forest ecosystems. In soviet period they were intensively hunted for the fur industry, but with the collapse of soviet system and its fur industry the control over the population was lost and animals became a disaster for ecosystems, farmlands and game reserves. Raccoons could distribute easily because they found a free niche after decreasing population numbers of local species of mesopredators as Beach and Pine martens (*Martes foina* and *M. martes*). In the XXI century when the populations of mustelids recovered the number of raccoons also stabilized and their further distribution seems to have stopped. They are still common in forested areas of the Greater Caucasus and Talysh mountains. In Talysh Mountains sometimes they become the prey for leopards (*Panthera pardus*). In the n-w part of Azerbaijan local people hunt raccoons for meat. Since the raccoon's fur has become rough in local climatic conditions nobody hunts them for fur any more. Raccoons are recognized as a pest by the government of Azerbaijan and can be hunted year round. Even though Coypu serves as a good prey base for Jungle cats (*Felis chaus*), Golden jackal (*Canis aureus*) and other carnivores, they still compete with waterfowl birds for food and space. Local population rarely hunts them for fur. They are numerous in inland waters of Kura-Arax lowland and even bays along the Caspian Sea coast. The mass mortality of Coypu can be observed in cold winters, which serves as a limiting factor against their further distribution.

FRESHWATER MUSSELS OF THE GENUS *UNIO* RETZIUS, 1788 (BIVALVIA: UNIONIDAE) IN SIBERIA AND KAZAKHSTAN: RELICTS OR CONQUERORS?

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It was thought that large freshwater mussels of the genus *Unio* Retzius, 1788 are absent from the fauna of Siberia (Zhadin, 1952). These mollusks were present in Northern Asia during the Neogene but have became totally extinct as a consequence of the Pleistocene glaciations (Starobogatov, 1970). However, since the middle of the 19th century, a few occasional records of *Unio* from Western Siberia appeared in the malacological literature. Since the end of the 20th century, two freshwater mussel species of the genus *Unio* – *U. pictorum* (Linnaeus, 1758) and *U. tumidus* Retzius, 1788 – have been repeatedly recorded in the Ob' River basin, which possibly indicates an ongoing biological invasion. The goal of our study is to clarify the origin of the Siberian populations of *Unio* and their phylogenetic relationship with native populations of Europe. We summarize and analyze all the information available to date on the distribution of the genus *Unio* in Siberia and the Upper Irtysh River basin, based on the extensive search through accessible literature, the examination of museum collections, as well as the results of our own fieldwork. We studied, both morphologically and genetically, 421 specimens of *Unio* mussels. The COI gene sequences were generated, and a haplotype network-based phylogeographic approach was applied.

Our molecular analysis confirms the presence of two abovementioned *Unio* species in Siberia and East Kazakhstan. A few empty shells of the third species, *U. crassus* Retzius in Philippson, 1788, were found in the western part of the Ob' River basin. During this study, *U. pictorum* has been identified from samples collected from the Tobol River basin, whereas *U. tumidus* was found in a sample from the upper reaches of the Irtysh River basin (Black Irtysh). Both species were also recorded from Lake Kenon, Transbaikalia.

Unio pictorum from the Tobol River basin shares a single COI haplotype that was previously found in populations of the European part of Russia. Probably, this species entered the Ob' River basin via direct connections with the European riverine systems, most likely the Volga-Kama River basin. This hypothesis is confirmed by molecular genetic data. One may suggest that we are observing a gradual northeastward spread of this species, which can be seen as an ongoing process of the recovery of *Unio* former (North Asiatic) range's part.

The origin of invasive *Unio* mussels in Lake Kenon, as well as the presence of a European haplotype of *U. tumidus* in the Upper Irtysh basin, should, most likely, be explained by human-mediated introductions. Conversely, in the lower courses of the Irtysh Basin, we probably observe the continuing natural expansion of *U. pictorum* from the Volga-Kama Basin, occurring without direct human participation. The unique *U. tumidus* COI haplotype from the Upper Irtysh is probably of relic origin, which may indicate the presence of a Pleistocene refugium in this area.

As a consequence of natural environmental changes during the last century, several genera of freshwater Mollusca that previously inhabited Western Siberia, but went completely extinct in the Pleistocene, have started to recover the North Asiatic part of their former ranges. There are at least four alien mollusk genera of European origin (*Unio*, *Viviparus*, *Borysthenia*, and *Lithoglyphus*) in the Bukhtarma Reservoir alone (Devyatkov, 2013, 2009; Yanygina, 2016; our data). The case of *Unio* is, however, exceptional, since the recovery of its lost range in Siberia goes not exclusively with the humans' help but also involves the natural mechanisms of dispersal and range extension.

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NEW DATA ON BIOLOGICAL INVASIONS IN FRESH WATER OF PRIMORSKY TERRITORY

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In the Primorsky Territory, biological invasions continue in freshwater bodies. The number of animal species is gradually increasing every year. The growth of biological diversity of aquatic biota is associated with human economic activities.

Previously, only one native species of turtles was recorded in the water bodies of Primorsky Territory – the Amur softshell turtle *Pelodiscus maackii*. In Primorye, this species is found in the basins of Khanka Lake, the Ussuri, Razdolnaya and Artemovka rivers (Barabanshchikov, 2004; Maslova et al., 2018). Recently, the red-eared slider *Trachemys scripta* has been observed in some water bodies. These animals get into water bodies, running away from their owners, or the owners themselves release them. In September 2016, a red-eared turtle was caught in a discharge channel near the village of Sivakovka (basin of Khanka Lake). It had a mass of 245 g, a carapace length of 12.9 cm, and a carapace width of 9.5 cm.

Until 2016, the Chinese mitten crab, *Eriocheir sinensis*, was not observed in Khanka Lake. Only the Japanese mitten crab *Eriocheir japonica* was found in the water body (Svirsky and Barabanshchikov, 2009). *E. japonica* has been observed in Khanka since the 1970s. His finds were first associated with the activities of the Khanka fish factory, which worked in the estuarine systems of Primorsky Territory and accidentally imported crab. Subsequently, the crab began to be found in Khanka Lake as a result of the release of seized products into the reservoir at customs. The Chinese mitten crab began to be found in the lake as aquaculture of this species developed in the basin of the water body. He began to run away from fish farms located in China. In recent years, the number of *E. sinensis* finds has begun to grow. There are males and females of this species with a carapace width of 53-68 mm and a weight of 76.4-174.5 g.

In the water bodies of the basin of the Japan Sea coast of Primorye, only the Japanese mitten crab natively lives (Vinogradov, 1950; Barabanshchikov, 2002; Kolpakov and Semenkova, 2012). It occurs from the Tumannaya River (southern part of the Khasansky District of Primorye) to the Serebryanka River (southern part of the Terneisky District of Primorye). According to data from Chinese fish farmers, up to 0.5 million juveniles of Chinese mitten crab have been released into the Tumannaya River since 2010. So far, in the water bodies of the Amur Bay (basin of the Peter the Great Bay of the Sea of Japan), this species has not been recorded in catches. However, since 2017, in the Razdolnaya River, individual specimens of mitten crabs with morphological features of Japanese and Chinese, i.e. hybrids. Most likely, the Chinese mitten crab got into the Razdolnaya River from fish farms located in China and hybridized with the local population of the Japanese mitten crab.

Clearhead icefish *Protosalanx chinensis* (= *Protosalanx hyalocranius*) in Khanka Lake was first recorded in the Russian part of the water body in 2006 (Svirsky et al., 2006; Svirsky and Barabanshchikov, 2009; Goryainov et al., 2014). According to information from Chinese fish farmer, work on breeding this species of fish in Malaya Khanka Lake (basin of Khanka Lake) began in 1996. From Malaya Khanka Lake, clearhead icefish got into Khanka Lake and subsequently its larvae of several hundred million things began to be regularly released into the water body. At the present time, it began to form the commercial volumes and is mined by Chinese fishermen in some years up to 2 thousand tons.

Fish, mainly from the basin of Khanka Lake, enter the water bodies of the basin of the Japan Sea coast of Primorye as a result of fish farming activities of Russian farms and transfers by amateur fishermen (Barabanshchikov, 2001; Shedko, 2001; Barabanshchikov, Magomedov, 2002; Kolpakov et al., 2008). In the same way, the freshwater prawns *Macrobrachium* sp. and Schrenk's crayfish *Cambaroides schrenkii*. In recent years, the ichthyofauna of the water bodies of the Khasan District, the Razdolnaya, Artemovka and Avvakumovka rivers, as well as other water bodies, has been «enriched» with the *Channa argus*, *Sander lucioperca*, *Tachysurus sinensis*, *Culter alburnus*, *Sarcocheilichthys czerskii* other species of fishes.

Thus, human economic activity can significantly change the composition and structure of fish communities. Some species are recorded occasionally, while others become common commercial species.

FEMALE MOTH PROPENSITY TO FLIGHT – THE MAIN ATTRIBUTE OF "ASIAN GYPSY MOTH", A QUARANTINE STRAIN OF HOLARCTIC FOREST PEST

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Among three subspecies of the gypsy moth *Lymantria dispar* L. (Lepidoptera: Lymantriidae): European (*L.d. dispar*), Asian (*L.d. asiatica*) and Japanese (*L.d. japonica*) only last two have female moths capable for active flight. It was suggested (Baranchikov, 1987) that flight helped females to hide egg clusters in natural "thermostats" - rocky outcroppings - for prevention of early hatching of larvae during spring temperature provocations. The gap between early larval hatching and appearance of leaves on host plant may be critical for survival of young caterpillars. In warm European habitats there was no need in such adaptation, so there females used saved energy for an "extra" egg production.

Female moth propensity to flight is associated with a trail of morphological and physiological characteristics of individuals, which ultimately affected the ecological features of populations and their harmful potential. For females from flight capable populations weight of thorax and muscle strength is significantly larger, average wing loading is lower, while average wing area is larger; total fecundity is lower, but an egg in general is heavier. First instar larvae hatched from the larger egg has higher survival and resistance to starvation. It is critical that young larvae has to disperse by wind from rocks, so high unpredictability of future host plant forced them to be highly polyphagous. The list of host plants for Asian gypsy moth populations is very wide, including even coniferous trees.

The speed and distance of direct flight of female moths are critical characteristics for pest distribution predictions. It was evaluated in laboratory on the flight mill as 4-8 km. In the course of a direct experiment in the field, we for the first time established the maximum distance of a single flight of females of the South Siberian gypsy moth population (3 km) and the flight speed of moths (25-50 m/min).

Currently, the quarantine services of Russia determine the belonging to the "Asian race" of the gypsy moth populations by a set of genetic markers. According to these markers, gypsy moth populations to the west of Irkutsk belong to European subspecies of *L. dispar*. However, it has long been known that these markers have nothing to do with the females' ability to fly. Thus, in the south of the Yenisey Siberia and in Altai, there are populations of gypsy moth with superpolytrophic caterpillars, large and actively flying females - a thunderstorm for the forests and gardens of Europe, which are "officially" excluded from the attention of quarantine services.

The main task for today is finding a tool to rapidly identify the female gypsy moth flight capability. It should be a must approach to newly introduced gypsy moths. It will be a critical component of any system instituted to evaluate the risks associated with the introduction but currently such a tool is not available.

CAN THE INVASIVE PATHOGEN CAUSING ASH DIEBACK IMPACT THE QUALITY OF FOOD FOR THE EMERALD ASH BORER LARVAE?

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The secondary ranges of the two Far Eastern invaders the emerald ash borer *Agrilus planipennis* Fairmaire (EAB) and the phytopathogenic fungus *Hymenoscyphus fraxineus* Baral et al. causing ash dieback disease (AD) partially overlap in the European part of Russia. Here we studied whether or not the fungus infestation may impact the quality of ash phloem where EAB larvae develop.

For that we cut stems of 20 young trees of European ash *Fraxinus excelsior*, 10 fungus-infected and 10 visually healthy trees, in mixed deciduous forest in Central Belarus. Simultaneously we collected alive beetles of EAB in the forest shelter belts near southern border of EAB secondary range at Voronezh District (Russia). Both ash minilogs and beetles were transported to the quarantine facility in Russia. In laboratory conditions, minilogs (60 sm long) were artificially infected by EAB eggs.

The experiment was carried out in 10 replicates. The minilogs of the fungus infected and healthy trees were incubated in the plastic containers with a thin layer of water at the bottom. In few weeks after the experiment began, the bark was removed from each log to document the presence of larvae, define their instar and measure width of the larval gallery.

We found no significant differences in the estimated parameters between the fungus-infected and healthy trees. This result should be taken into account for the prognosis of EAB invasion in Western and Central Europe where millions of *F. excelsior* trees suffer from AD.

ECOLOGO-GENETIC CHARACTERISTIC OF POTENTIALLY INVASIVE MOSQUITO SPECIES OF THE SUBGENUS *STEGOMIYA* OF THE RUSSIA FAR EAST

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We investigate mosquito fauna of the genus *Aedes* subgenus *Stegomiya* of the Russian Far East. Species identification was based on a combination of morphological identification of mosquito imago and molecular-genetic analysis of the nucleotide sequence of the COI mitochondrial gene. We revealed for the first time signs of the formation of synanthropic populations of *Aedes flavopictus*, including the emergence of cohesive populations feeding predominantly on humans. The observed changes suggest the emergence of the possibility of local transmission of arbovirus fevers in Primorskiy and Khabarovskiy regions.

At present, two mosquito species of the genus *Aedes*, subgenus *Stegomiya*, live in the Russian Far East: *Aedes flavopictus* Yamada, 1921 and *Aedes galloisi* Yamada, 1921. This subgenus also includes the invasive species *Aedes albopictus* Skuse, 1895 and *Aedes aegypti* L, 1762, the main vectors of severe human arbovirus fevers. Under experimental conditions, *Ae. flavopictus* and *Ae. galloisi* are permissive for arboviruses and can potentially act as vectors. According to A. Gutsevich and A. Khalin, these mosquito species in the Far East of Russia were found in single specimens until the beginning of the 21st century. Since 2018, there have been reports of large populations of blood-sucking mosquitoes similar to *Ae. albopictus* in Khabarovsk.

In the summer season of 2020, we conducted an expedition in the Far East of Russia and studied blood-sucking mosquitoes of Primorsky Krai, Khabarovsky Krai, Amur Oblast, and Jewish Autonomous Oblast. We collected mosquitoes in 35 localities. *Ae. flavopictus* was found in the south of the Khabarovsky Krai and in Primorsky Krai. The greatest activity of attacks by females of this species (more than 50 individuals per 30 min) was observed in the major cities of Khabarovsk, Vladivostok, and Nakhodka. In the Amur region, we found only *Ae. galloisi*. Thus, *Ae. flavopictus* and *Ae. galloisi* are allopatric in the Russian Far East. The ranges of both species are separated by a zone in the center of the Jewish Autonomous Region, where *Ae. flavopictus* and *Ae. galloisi* are not found. The northern and eastern borders of the range of *Ae. flavopictus* coincide with isotherms of +20°C in July and –24°C in January. *Ae. galloisi* is found in the colder zone in areas with isotherms of +16°C in July and –28°C in January, the northern border of its range has not yet been established.

The morphological identification of mosquito imago was confirmed by sequencing the BOLD fragment of the mitochondrial COI gene. Nine mitochondrial haplotypes were detected for *Ae. galloisi* and ten haplotypes for *Ae. flavopictus*. All detected mitochondrial haplotypes are new for these species. In the case of *Ae. galloisi* we found two mutations leading to amino acid substitutions. The phylogenetic analysis of the obtained nucleotide sequences reveals the exact clustering of haplotypes, corresponding to the species *Ae. flavopictus* and *Ae. galloisi*. No cases of mitochondrial introgression were detected.

Our observations reveal changes in the ecological strategy of *Ae. flavopictus* and *Ae. galloisi* in the Russian Far East. They switched to synanthropic behavior and occupied ecological niches similar to *Ae. albopictus*. They began to choose containers of anthropogenic origin with hard walls as places for oviposition. Adults of mosquitoes accumulate in bushes near larval biotopes. Females actively attack humans during all daylight hours. The transition to a synanthropic behavior significantly increases the invasive potential of these species and makes local transmission of human arbovirus fevers pathogens more likely in the Russian Far East.

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INVASIVE AND POTENTIALLY INVASIVE PLANTS OF ST. PETERSBURG

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There is a lot of literature on invasive species of urban areas, including the territory of St. Petersburg (Sorokina, 2015; Sorokina, Chepik, 2015). It is relevant to depict the main characteristics of invasive species of vascular plants on the territory of St. Petersburg. As to the term "invasive plants" we mean alien plant species that have invaded other regions and have a "negative impact" on the native plant communities. The naturalization degree (acclimatization) and further invasiveness depends on many factors (Hierro et al., 2005; Vinogradova et al., 2010). The vast material of invasive species was collected in the urban flora of St. Petersburg during the filed studies in 2016-2021.

52 species of invasive and potentially invasive plants were found on the territory of St. Petersburg (Black Book, 2010). In addition, we also include here some alien species that are widely distributed on the territory of St. Petersburg, but not included in the Black Book yet (2010), that may have status of "invasive and potentially invasive species". Such plants are *Arabidopsis arenosa* (L.) Lav., *Cicerbita macrophylla* (Willd.) Wallr., *Erigeron annuus*, *Petasites hybridus* (L.) Gaertn., Mey et Scherb., *Symphorycarpos rivularis* Suksdorf., *Trisetum flavescens* (L.) Beauv.

(1) The similar climatic conditions of the native distribution area and regions of secondary distribution pattern. The percentage of North American alien species is (51.9%). There is also a large proportion of invasive plant species from Asia (*Impatiens grandulifera* Royle, *Reynoutria sachalinensis* (Fr. Schmidt.) Nakai, *Rosa rugosa* Thunb., *Sorbaria sorbiflia* (L.) A. Br.). Central and Southern Europe are also among the leaders (7%). Many ornamental plants were previously brought from Europe for landscaping (*Luzula luzuloides* (Lam.) Dandy et Wilm., *Veronica filiformis* Smith.), with further naturalization; (2). Neophytes as the plants invaded since 1492 are the most common group leading in terms of the time of driftof invasive plants (94%). The species belonging to the archeophytes (*Anisantha tectorum* (L.) Nevski, *Puccinellia distans* (L.) Parl.), here, on the territory of the city, we consider as brought from other territories where they are archeophytes. (3) The percentages of "xenophytes – ergaziophytes" are approximately equal (27%, 25%). In NW Russia including St. Petersburg town, invasive species have been penetrated in two ways, both as a result of introduction and subsequent wildness, and accidentally due to transport routes, etc. The contribution of both ways of skidding is approximately the same. (4) The analysis by the category of the naturalizacion degree shows the predominance of epecophytes (36.5%) and agriophytes (32.5%). Epecophytes and agriophytes are species confined to various weed distirbed sites. Among the invasive plant species, this group mainly includes species of the 3 invasive status. Based on the numerous Black Books it is the most representative group of invasive species that thrive in the most optimal conditions like dump areas, absence of competition etc. This group includes the most aggressive transformer (e.g., *Heracleum sosnowskyi* Manden.). 5. The analysis of invasive plants in relation to moisture shows the predominance of mesophytes (90%). The number of hydrophytes (*Elodea canadensis* Michx., registered for the first time by K. F. Meinshausen in the 1880s-1881s in the Neva River basin (cit. LE! "Lachta prope Petropoli, via Krestoffsky") and hygrophytes (*Acorus calamus* L., *Bidens frondosa* L., *Phragmites altissimus* (Benth.) Nab.) are relatively small. 6. The analysis of life forms according to I. G. Serebryakov and K. Raunkier shows the predominance of perennial grasses and hemicryptophytes. The percentage of annuals and therophytes, and shrubby plants is high. There are many ruderal plants among the invasive species, which in fact are juveniles, the shrubby plants are mostly escaped from cultivation with subsequent naturalization.

INVASION OF ASH-LEAVED MAPLE (*ACER NEGUNDO*) INTO AREAS OF THE SUGAR INDUSTRY TREATMENT FACILITIES AND ITS ADAPTATION TO NEWLY FORMED HABITATS (CHERNOZEM ZONE, KURSK REGION)

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Specific anthropogenic landscapes, which are formed at the existing and abandoned treatment facilities of sugar factories, play an important role in the Chernozem zone of Russia.

The treatment facilities represent the series of settling ponds with the area 50x150 (200) m separated by ground walls 2-3 m high. The settling ponds are alternately filled with wastewaters and drained; part of them are gradually abandoned. Over the decades of functioning, the complexes of treatment facilities have been transformed into specific anthropogenic landscapes, occupying large territories and playing a significant role in the land of the sugar industry regions.

The landscapes formed on the active and abandoned treatment facilities of the sugar factories in the L'gov district (Kursk region, forest-steppe zone) were studied. The anthropogenic plant communities with ash-leaved maple (*Acer negundo*) and other invasive species were described. The correspondence of these species' ecological traits to their habitats is considered.

A wide range of soils of varying degrees of drainage, strongly alkaline and even calcified, enriched with organic matter and actively processed by soil mesofauna, has formed within the treatment facilities. Depending on the degree and duration of drainage on the soils, a number of plant communities are formed in the bottoms of settling ponds: reed, tall grass, young thickets of ash-leaved maple (*Acer negundo*). There, can often be found the weed *Lactuca serriola*, a native of Western Europe that "escaped" from neighboring orchards, as well as alien species from North America: *Bidens frondosa, Echinocystis lobedifolia*. Tree communities grow on the ground walls.

Thickets of the aggressive invasive species *Acer negundo* occupy a significant area. Nowadays, *Acer negundo* grows in different habitats: it dominates both in natural oak forests of the forest-steppe replacing common oak (*Quercus robur*), and in artificial forest shelterbelts, city parks and squares in settlements of the Kursk region and, in particular, in the L'gov district. *Acer negundo* spreads especially quickly in disturbed technogenic territories, such as, for example, abandoned waste treatment facilities of sugar factories, where the main limiting factors for it are the time of flooding and mechanical disturbance of the substrate.

It was revealed that *Acer negundo* is actively spreading on the ground walls separating the settling ponds. In these habitats, trees usually replace tall-grass communities and quickly obtain a bush-like shape (several trunks 12-15 cm in diameter and 6-8 m in height grow from one root) forming dead-cover parks.

In the bottoms of the operating and abandoned settling ponds there are formed communities with *Acer negundo* of various structure. In the active settling ponds, the emerging maple seedlings die when flooded. On the abandoned 30 years ago and dried-up bottoms of ponds, dense, with a density of 0.9, thickets of young trees of 3-5 m high and 1-3 cm in diameter are formed. In the bottoms of ponds abandoned 40 and more years ago, there are communities of old-growth ash-leaved maples 10 m high, with a density of 0.6. In the tree layer, the admixture of white poplar (*Populus alba*) and several species of willows (*Salix triandra, S. viminalis*) is common. At the periphery of treatment facilities, in old 80-year-old shady gardens the gradual replacement of *Acer negundo* with aboriginal broadleaf trees is observed.

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INVASIONS OF SOME MALACOSTRACAN CRUSTACEANS IN THE NORTH OF RUSSIA: THE ROLE OF CLIMATIC AND OTHER FACTORS IN THEIR SUCCESS

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Aquatic ecosystems in the north and northwest of Russia with naturally low biodiversity or, secondly, low due to anthropogenic impact, are especially vulnerable to invasions of new species. Invasive species occupy vacant niches, often increasing the number of links in the benthopelagic food web and affecting the functions of the ecosystem as a whole. In the last century, the number of invasions of new species of higher crustaceans and the rate of their dispersal in the northern region of Russia have increased significantly due to human activities, primarily with the development of shipping, and climate change. The construction of canals between rivers on the territory of the European continent led to the formation of a transcontinental waterway - the Northern Invasion Corridor, connecting the reservoirs of the basins of the White, Baltic, Black, Azov and Caspian Seas. Many crustaceans appeared in lakes and rivers with ballast waters of ships and took root in new conditions, which became possible due to the high tolerance of these animals to the regional climate. In addition, the appearance of amphipods, mysids, and decapods outside their natural range was in many cases the result of deliberate introduction, the most widespread in the 1950s – 70s in the territory of the former USSR.

We analyzed the modern range of species-invaders of the order Amphipoda of the class Malacostraca and provided new habitats in the continental water bodies of the North-West of Russia to the decapod *Pontastacus leptodactilys*, which in recent years has significantly moved to the north. In the continental waters of the northern and northwestern parts of Russia, 44 species of various-legged crustaceans (order Amphipoda) have been recorded to date, of which 17 species are invaders, with the largest contribution from the species of the Ponto-Caspian faunistic complex, whose ancestors originate from the coastal regions of the three southern seas: Black, Azov and Caspian and at the mouths of the southern rivers. The mass alien species, the amphipod Gmelinoides fasciatus, the decapods, Chinese mitten crab *Eriocheir sinensis* and the narrow-clawed crayfish *Pontastacus leptodactilus* have established in the northern regions in the last two decades as a result of human activities using direct and indirect vectors to increase the range. *Pontastacus leptodactilus* is an alien species for most of the Eastern European territory and especially for the northern part of Russia. The area of origin of *P. leptodactylus* covers water bodies of southwestern Europe and Asia, including the basins of the Caspian, Black and Azov seas. After the opening of the canals connecting the southern seas (Ponto-Azov-Caspian), the Volga and reservoirs of the White and Baltic Sea basins, this species moved to Northern and Eastern Europe. In addition, since the second half of the 20th century, *P. leptodactylus* was introduced as a valuable commercial object into the water bodies of more than 14 European countries, and also naturally expands in each of them. In the 1950s and 70s, it was also actively introduced in northwestern Russia for commercial purposes, especially in small lakes in Karelia and the Leningrad region. Since the middle of the last century, *P. leptodactylus* has spread widely in small lakes in Karelia: the basin of the Shuya, Padas, Suna, and Lizhma rivers. They are also noted in the Onega and Ladoga lakes. Field research of the lakes of Karelia and the Arkhangelsk region in 2009-2020 confirmed the presence of *P. leptodactilys* in the bottom fauna of some lakes in the Shuya, Onega, and Northern Dvina river basins. Recently, narrow-clawed crayfish have been recorded in the lakes of Bolshoy Solovetsky Island in the White Sea, where they adapted (Borovikova et al., 2016). In 2020, it was discovered in Lake Krugloye, only 30 km below the polar cycle (Berezina et al., 2021).

Climate change with warming can lead to a decrease in biomass or even to the extinction of cold-loving stenothermal species; and, at the same time, it can contribute to the successful introduction of more southern species. For example, over the past 20 years, there has been a noticeable transformation of the ecosystems of large and small lakes in Karelia (for example: Lake Onega and Krivoye), associated with the effect of climate. For example, during the period from the 1980s to the end of the 2010s, the average annual air temperature on Lake Onega increased by 1-2 ° C compared to the previous 40 years. As a result of these changes, the annual rainfall and the length of the ice-free period also increased. Taking into account that some records are located in uninhabited areas, zoogenic vectors of distribution may be important for increasing the rate of spread of this crayfish.

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MOLECULAR TAXONOMY AND BIOGEOGRAPHY OF *CORBICULA* (BIVALVIA: CYRENIDAE) LINEAGES

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Currently, freshwater clams belonging to the genus *Corbicula* are one of the most popular objects for research attracting the full attention of a number of scientists from all over the World (Pigneur et al. 2014; Gomes et al. 2016). The native range of the genus covers Africa, Asia (up to Japan and the Russian Far East), the Malay Archipelago, the Philippines, New Guinea, and Eastern Australia (Araujo et al. 1993; Haponski & Ó'Foighil, 2019). The invasive *Corbicula* clams are widespread throughout Asia and are successful invasive lineages in Europe, and North and South America (Hedtke et al., 2008; Pigneur et al., 2014; Gomes et al., 2016; Etoundi et al., 2019; Bespalaya et al., 2018, 2020). The great invasive potential is related to their wide spectrum of reproductive strategies (Sousa et al., 2014). The *Corbicula* clams are able to reproduce sexually and asexually, and their high genetic variability is generated by polyploidy, hybridization, clonal reproduction, and by the presence of unusual ameiotic breeding systems (Glaubrecht et al., 2003; Byrne et al., 2000; Rajagopal et al., 2000; Pigneur et al., 2011; Cao et al. 2017). Despite such close attention of scientists to the genus *Corbicula,* some questions regarding the taxonomy and systematic position of certain species remain unresolved (Korniushin 2004; Pigneur et al., 2011). The confusing taxonomy significantly complicates basic and applied researches on this important group of aquatic organisms. Altogether 91 *Corbicula* species are distinguished globally (Graf & Cummings 2013). However, the validity of many species has yet to be established (Korniushin, 2004). Herewith, the endemic species of this genus remain the least studied (Byrne et al., 2000; Glaubrecht et al., 2003).

The present study reports on the analyses of comprehensive *Corbicula* samples from different regions of the world (Europe, Africa, East and Southeast Asia, India, and North America). The molecular genetic analysis included amplification and sequencing of mitochondrial (COI and 16S rRNA) and nuclear (28S rRNA) markers. The method of DNA isolation, primer combinations, PCR conditions, sequencing, primary sequence processing, and phylogenetic analysis are described in our previous papers (Bolotov et al., 2015; Bespalaya et al., 2018). In summary, 17 *Corbicula* species have been identified based on our samples. Three endemic species sharing high genetic distance from other taxa, sequences of which are present in GenBank and BOLD IDS, were recorded in Indochina. The validity of *C. tobae,* endemic to Lake Toba, was confirmed by means of integrative taxonomic approach (Bespalaya et al., 2021). A broad-scale taxonomic revision of *Corbicula* spp. from eastern Asia is completed. The vectors of dispersal of the invasive lineages are discussed. Our data support the hypothesis that *Corbicula fluminea* (Müller, 1774) (=*Corbicula* sp. clade FW5; = *Corbicula* sp. form A/R) was likely introduced to Europe from eastern Asia (Bespalaya et al., 2018).

Four genetic groups were identified, three of which contain individuals that are able to reproduce clonally through androgenesis. At the same time, the isolated fourth group clearly differs from all the others based on morphology and genetics, while other groups cluster with androgenetic lineages due to the presence of common alleles.

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FLORA OF THE GREATER RING OF THE MOSCOW RAILWAY

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The Greater Ring of the Moscow Railway, fully complete by the late 1940s, surrounds the city of Moscow at distances of 25-80 km from the MKAD within the territory of 3 federal subjects (Moscow Oblast, Moscow itself – i.e., “Greater Moscow”, and Vladimir oblast) and totals c. 585 km of tracks. Furnishing mostly freight transport, the Greater Ring crosses all the radial railway lines of Moscow and is mainly used for transfer from one radial railway line to another while bypassing the city. Two major railway yards (Bekasovo and Orekhovo-Zuyevo) are located on the Greater Ring. The aim of this study was to analyze the extant data on the flora of the Greater Ring of the Moscow Railway.

Needless to say, the Greater Ring has largely remained a neglected object of study by floristic botanists. As of late 2020, the Moscow State University Herbarium (MW) houses less than 150 specimens collected from habitats linked to this railway. Only a few segments of the railway have been examined for their plant diversity, most of the specimens represent occasional collections of peculiar alien plants. The accessioned herbarium specimens along with other available data (literature records, some data collected by amateur naturalists and published at iNaturalist) were combined into a database on the flora of the Greater Ring of the Moscow Railway.

Some 23 specimens accessioned into MW were collected from the eastern segment of the railway by members of the Meshchera Expedition in 1973. A few segments of the railway were examined by A. V. Chichev in the late 1970s during a general study of Moscow railways. These were some of the very few events of precise examination of parts of the railway to date. Many parts have never been studied by botanists at all.

The Greater Ring has been proven to serve as a source of alien species for the Moscow Region. A notable example, the ragwort *Senecio dubitabilis* C.Jeffrey & Y.L.Chen was first reported within the region from the Greater Ring, specifically from its western part (near Zvenigorod), in 2006 (Sukhorukov, 2006), and has since been expanding its distribution within the region. This segment of the Greater Ring has been studied several times by students and instructors of the Moscow University working at the Zvenigorod Biological Station, which has led to the finding of several rare alien species. Located here is the only known population of the Siberian vetch *Vicia amoena* Fisch. within the Moscow Region, extant since at least 1984 (Mayorov et al., 2012).

Some segments of the Vladimir part of the Greater Ring have been examined in the 2000s during general studies of the oblast’s flora (Borisova, 2006; Seregin, 2012). Several species were reported as new findings for the region. These include *Diplotaxis muralis* (L.) DC., *Rosa dumalis* Bechst., *Prunus virginiana* L.

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THE FIRST FINDING OF THE *MUS SPICILEGUS* (RODENTIA, MURIDAE) IN KURSK OBLAST' OF RUSSIA (GENETIC IDENTIFICATION)

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The mound-building mouse (*Mus spicilegus* Petényi, 1882) is a wild-living species of the genus *Mus*. The differentiation of this species from other mice of this genus by morphological characteristics is rather sophisticated. The construction of mounds is unique feature, characteristic only of *M. spicilegus*. However, mice caught on the mound need to be identified by genetic diagnostic features. The mound-building mouse inhabits the steppes of Europe to the east from Austria (Lake Neusiedl). There are no data on the habitation of *M. spicilegus* eastward of Ukraine in the publications of the late XX – XXI centuries (Lyalukhina et al., 1989; Kotenkova et al., 1994; Sokolov et al., 2008). According to earlier or archival publications, the mound-building mouse was a common species of the Rostov oblast' steppes in the 1920s, but in the 1940s and 1950s it disappeared here (Lipkovich, 2005, 2010). A new wave of *M. spicilegus* population growth began in the last years of the 20th century. This species was found on the right bank of the Don River in 8 administrative districts of Rostov oblast' (Zagorodnyuk, 1994; Lipkovich, 2005). Later, it was shown that *M. spicilegus* specimens from the Rostov oblast' belong to the eastern phylogroup (Maltsev et al., 2018). At the beginning of the 21st century, the first reliable information about the finds of *M. spicilegus* in Belgorod oblast' appeared (Bulatova and Kovalskaya, 2004; Tokarsky et al., 2011). In the same years *M. spicilegus* specimens began to occur in some regions of Ukraine, where they had not been previously recorded (Tokarsky et al., 2011; Polishchuk, 2012). The current expansion of the *M. spicilegus* range is associated with climate changes that is confirmed by niche models (Tytar et al., 2019).

In 2018, the employees of the Central-Chernozem Reserve discovered the mouse mounds in the protection zone of the Reserve near Streletskaya steppe (Kursk oblast', 51.59 N, 36.11 E). They were located in the neighborhood of arable land on a narrow strip of steppe vegetation, which was preserved along the road. The mound length varied from 70 to 260 cm, height from 20 to 50 cm. In January 2019, 3 mice were captured. They had relatively short tail and, according to cranial features, belonged to *M. spicilegus.* Genetic identification of these mice was performed by nucleotide sequences of the nuclear gene *Brca1*, coding breast and ovarian cancer susceptibility protein, and by the mitochondrial gene *Cox1,* coding first subunit of cytochrome oxidase. Segments of the *Brca1* (612 bp) and *Cox1* (681 bp) genes, sequenced in the present work, coincide with initial areas of more extended fragments, which were studied earlier in some species and subspecific forms of the genus *Mus* (Bogdanov et al., 2020). The analyzed short sequences of both genes include a great number of diagnostic nucleotide sites and are sufficient for reliable differentiation of *Mus* species. Along mice from Kursk oblast', we included into analysis the earlier published data for *M. spicilegus* specimen from vicinities of Chisinau, Republic of Moldova (Bogdanov et al., 2020), and 1 mouse of the same species from Feodosia district, Republic of Crimea.

According to our results, all 3 mice from Kursk oblast' belong to *M. spicilegus*. They have the same *Brca1* genotype, as mound-building mice from Moldova and Crimea. Moreover, even *Cox1* fragments of mice from Kursk oblast' and Crimea were identical and differed from specimen from Moldova by only one nucleotide substitution. The Central Chernozem Reserve was established in the 1935, but biological research began to be carried out in Kursk oblast' in the first decade of the 20th century. Over the years, despite a thorough ecological survey of the area, no mouse mounds have ever been seen here. Our results indicate the presence of *M. spicilegus* in Kursk oblast' for the first time**;** the reliability of these data has been confirmed by genetic studies. Thus, the northern border of the *M. spicilegus* distribution range has reached the central regions of the Kursk oblast' today. Low genetic differences between *M. spicilegus* specimens from very remote areas may indicate the recent spread of this species throughout the East European Plain. We agree with the opinion of Tytar and coworkers (2019) that the movement of *M. spicilegus* in the northeastern direction is associated with the observed climate changes, primarily, with an increase in winter temperatures.

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SUCKING PESTS OF THE GRAPE VINE IN THE CONDITIONS OF THE SOUTH OF UKRAINE

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In recent years, the change in the modern climate is due to the atypical distribution of warm air masses in the traposphere, which is a consequence of global warming and leads to anomalous air temperature, precipitation and an increase in natural meteorological phenomena.

Displacement of climatic zones, weather instability (large amplitude temperature fluctuations over a short period of time, heavy rains, floods, flooding agricultural land and strong winds) leads to a change in the landscape and causes a change in the habitat of living organisms.

Due to climate warming, there is a change in the duration of the growing season of a grape plant, an increase in the number of sucking phytophages, a change in the structure of their population, the level of damage and acclimatization zones. Especially, recently, the harmfulness of ticks of various trophic groups (spiderweb, leaf, bud), thrips, leafhoppers, grape aphids - phylloxera has increased.

These pests have a high adaptive potential, which is determined by their biological characteristics - polyvoltin, large fertility and high ecological plasticity.

Currently, the main means of protecting grape plantations from sucking pests are pesticides, the use of which is steadily increasing. This, in turn, is fraught with a number of difficulties and leads to negative consequences, such as the formation of resistant populations of pests, suppression of useful fauna, accumulation of residues of pesticides in plants and soil.

However, despite this, chemical protection is recognized one of the links in the intensification of agriculture, which humanity cannot refuse, since population growth still exceeds the adequate increase in food.

The core of modern agricultural production remains the principle of optimization, which is based on an organic combination on a biological basis of methods and means of protection that, if possible, preserve the natural mechanisms of regulating the number of pests and which provides for the use of chemical pesticides only in cases of extreme necessity and only when the economic thresholds of harmfulness are exceeded.

A modern plant protection system against harmful organisms must be not only biologically effective, environmentally safe, but also economically justified.

When developing control measures for sucking pests of grapevine, it is necessary to take into account the existing biocenotic relationships in the agroecosystem as much as possible.

The creation of such a system is possible only with careful phytosanitary monitoring of the complex of pests, that is, with constant control of their species composition and number in the agrocenosis. To characterize the phytosanitary state of vineyards and predict its productivity, it is of great importance to assess the degree of damage to plants by pests, as well as yield losses.

Development of an ecological approach to plant protection in conditions of intensification of agricultural production is an extremely difficult task, but extremely necessary.

ALIEN MICROFUNGI ON INTRODUCED PLANTS IN COLLECTIONS OF DONETSK BOTANICAL GARDEN

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The process of plant introduction into new regions sometimes accompanies by co-introduction of alien phytopathogens (including plant pathogenic fungi), often naturalizing in artificial and natural phytocenoses (Gorlenko, 1987). The environmental and economic consequences of such introductions are usually unpredictable, because of that a constant monitoring of alien species is strongly needed.

As a part of the implementation of the research topic «Biological invasions as a new factor of historical changes in biodiversity of steppe in the Eastern Black Sea region», a regular monitoring of plant pathogenic fungi in the collections of trees and shrubs, many herbal ornamental plant outdoor and subtropical plants indoor in the Donetsk Botanical Garden (abbr. as DBG) has been carried out during the period 2017–2021. As a result of these researches, we found and identified more than 50 species of alien plant pathogenic fungi causing various plant diseases. Specialized plant parasites associated with certain species, genera, or families of host plants have been predominant (by the number of species) among all recorded alien fungi.

During five years of research in the Arboretum of DBG, 18 alien powdery mildew fungi (Erysiphaceae) were recorded on introduced trees and shrubs. Additional six alien fungal species were found on the aboriginal woody plants (Bondarenko-Borisova, Bulgakov, 2019). Beside the Erysiphaceae species, we recorded other alien plant pathogenic fungi growing on trees and shrubs: *Apiognomonia erythrostoma* on *Prunus armeniaca*, *A. veneta* on *Platanus acerifolia* and *P. occidentalis*, *Kabatina juniperi* on *Juniperus sabina* and *J. squamata*, *Ophiostoma novo-ulmi* on *Ulmus pumila*, *Pseudonectria buxi* on *Buxus sempervirens*, *Phyllosticta sphaeropsoidea* on *Aesculus hippocastanum*, *Acervuloseptoria fraxini* on *Fraxinus pennsylvanica*, *Ophiognomonia leptostyla* on *Juglans regia*, *Taphrina coerulescens* on *Quercus rubra*, *Cumminsiella mirabilissima* on *Mahonia aquifolium*, and some others.

We found 14 alien microfungi causing various diseases of herbal ornamental introduced plants in the collections of DBG, mostly causative agents of blights and leaf spots: *Alternaria florigena* on *Callistephus chinensis*, *A. zinnia* on *Zinnia* spp., *Cercospora calendulae* on *Calendula officinalis*, *Phyllosticta chrysanthemi* and *Septoria chrysanthemella* on varieties and cultivars of *Chrysanthemum* × *morifolium*. Also several poor-known powdery mildew fungi were found as parasites of herbal ornamental plants: *Erysiphe macleayae* on *Maclea cordata* and *M. microcarpa*, *E. paeoniae* on *Paeonia tenuifolia*, *Golovinomyces asterum* on *Bellis perennis*, *Solidago canadensis*, *Symphyotrichum dumosum*, and *S. novae-angliae*, and *G. ambrosiae* on *Coreopsis* spp., *Dahlia* × *cultorum*, *Rudbeckia laciniata* L., and *Zinnia* spp. Also new rust diseases caused by the following alien rusts fungi (previously unknown for Donetsk region) were revealed: *Coleosporium asterum* on *Callistephus chinensis* and *Symphyotrichum* spp., *Phragmidium mexicanum* on *Potentilla indica*, and *Puccinia balsamitae* on *Tanacetum balsamita*. The leaf spot caused by smut fungus *Entyloma gaillardianum* was recorded on *Gaillardia aristata* and *G. hybrida.*

In greenhouses we identified 6 aliens highly specialized microfungi growing on tropical and subtropical plants, which cause anthracnoses (*Diaporthe aucubae* on *Aucuba japonica*, *Gloeosporidiella nobilis* on *Laurus nobilis*), leaf spots (*Coniothyrium palmarum* on palm species), scabs (*Fusicladium eriobotryae* on *Eriobotrya japonica*) and powdery mildews (*Erysiphe euonymicola* on *Euonymus fortunei* and *E. polygoni* on *Muehlenbeckia platyclada*).

PECULIARITIES OF THE BIOLOGY OF *METCALFA PRUINOSA* (SAY) (HEMIPTERA: FLATIDAE) ON THE TERRITORY OF M.M. GRYSHKO NATIONAL BOTANICAL GARDEN NATIONAL ACADEMY OF SCIENCES OF UKRAINE

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Globalization and increased trade lead to a higher risk of accidental invasion of alien species into new regions. One of these insects that adapt well to new conditions is *Metcalfa pruinosa* (Say, 1830). Although *M. pruinosa* is not a problem in its native regions, it caused serious economic consequences in the occupied countries due to its massive spread. Nutrition of *M. pruinosa* usually does not lead to leaf deformation, but turgor decreases, the plant weakens, and shoots drying out as well as fruit falling off is observed. The aesthetic appearance of the damaged plant deteriorates due to white sticky secretions, which are kept throughout the vegetative season. Sooty fungi, which interfere with normal photosynthesis, settle on them. In the process of larvae and adults feeding, plants form defective or deformed seeds that are incapable to develop the next generation. This leads to a significant decrease of plant seedlings or even their absence. Therefore, the study of the leafhopper’s biology in the regions, which are new to it, will be useful for determining the optimal time of controlling the number of this pest in various landscapes.

Metcalfa pruinosa overwinters in the stage of an egg, which it lays in the cracks of trees and shrubs bark, which undoubtedly contributes to its penetration with ornamental shrubs into different countries, including Ukraine.

In the conditions of M.M. Gryshko National Botanical Garden (NBG), National Academy of Sciences of Ukraine, which is located in the center of Kyiv, the development of *M. pruinosa* lasts on average from May to August. Daytime and nighttime air temperature, amount of precipitation and their duration are of decisive importance in the rate of insect development.

In 2016 - 2020, the appearance of the first larvae of *M. pruinosa* was observed in the first ten days of May. During this period, the minimum daytime temperature was about 20 ° C, and the minimum nighttime temperature was 17 ° C, the amount of precipitation was about 50 mm. Subsequently, with an increase in air temperature, the number of insect larvae increased. The larvae are inactive and do not go far from the place where they first start eating. They are white in color and have different degrees of edging; when they feed on plant sap they abundantly emit a waxy coating (threads) of white color, resembling a thin layer of cotton wool. The development of larvae takes about two months, passing through five stages. The last two larvae stages have the ability to hop.

The first imago appears in early or mid-July, depending on meteorological conditions, with a minimum nighttime temperature of 22°C and a daytime temperature of 26°C. From the second decade of July, the number of adults increased and at the end of the month, their number was three times higher than the number of larvae. Adults live for several weeks and become fully mature in early August. Males and females produce calling signals during the day and especially intensively at night, when copulation and laying winter eggs occur.

The disappearance of the larvae was recorded in late July - early August. In the first ten days of August, a decrease in the number of adults was observed and it continued until the end of August, when the nighttime temperature dropped below 17°C. The exceptions were the years 2018 and 2020. These years, in the first ten days of September, the average daily temperature exceeded the norm (13.9°C), and averaged 17.3°C - 18.4°C, and the lack of precipitation during this period had a favorable effect on the lifespan of *M. pruinosa* until mid-September. It should be noted that in 2019 the climatic conditions also influenced the timing of development of *M. pruinosa*. Due to heavy rains and decreasing of air temperature in the third decade of July and the first decade of August, the number of larvae and adults of *M. pruinosa* cut down significantly. The disappearance of adults occurred in mid-August.

Consequently, in the conditions of Kyiv, *M. pruinosa* has one generation, which develops on average from May to August. Both a minimum air temperature of 17 - 20°C and a significant amount of precipitation limit the insect’s development.

QUATERNARY PALEOINVASIONS OF THE VENDACE (*COREGONUS ALBULA*) AND CONTEMPORARY PATTERN OF GENETIC POLYMORPHISM OF THIS SPECIES

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The formation of the ichthyofauna of northern cold-water ecosystems is closely related to the Pleistocene glaciations. Under the influence of glaciers, freshwater reservoirs were radically altered, some water systems were destroyed, and new lakes and rivers were formed (Behnke, 1972; Bernatchez, Wilson, 1998). All this became the reason for the mobility of the ichthyofaunas of some regions, and the penetration of fish into new areas, basins, and reservoirs. Undoubtedly, such paleoinvasions played a significant role in the formation of the contemporary pattern of genetic diversity in many species, including the vendace (*Coregonus albula*). The study of the nucleotide sequences' polymorphism of two mitochondrial fragments (*nd1* and *co1*) of the vendace, made it possible to draw interesting conclusions about the peculiarities of its spreading in European and Siberian water bodies. Our and literature data suggest that the modern vendace formed as a species in Siberia and only then spread to Europe. Apparently, there were two waves of paleoinvasions of the vendace to Europe. The first migration is likely to have occurred more than 90 000 years ago. The ALBP2 and L mitochondrial phylogenetic lineages carrying the haplotypes most differentiated from the common haplotypes of the vendace are traces of these events. Representatives of these lineages are preserved in the Volga River basin (Lake Pleshcheyevo and the Rybinsk Reservoir) and the western White Sea basin (Lake Lyokshmozero).

Representatives of the second migration wave from Siberia originally appeared in Europe in the area of the Pechora River basin. In this region, there was a large periglacial paleolake (Lake Komi) 90 000 to 80 000 years ago (Mangerud et al., 2004). Later, the fish migrated via an overflow stream in the centre of the modern Timan Ridge, or Tsilma Pass, to the basin of a periglacial water body that encompassed the modern White Sea, western White Sea basin, and eastern Baltic basin. Lakes Lyokshmozero, Vodlozero, and Beloye are now located in this area, and these are the lakes where haplotypes of the ancient L lineage coexist with haplotypes of the E cluster, which is the most closely related to the Siberian cluster.

Another wave of the vendace migration to the Volga basin, where Lake Pleshcheyevo is located, may have occurred approximately 20 000 years ago, when an overflow stream to this basin from periglacial water bodies located in the southern part of the modern White Sea basin was formed. As a result, haplotypes of cluster E appeared in the vendace population of Lake Pleshcheyevo, which, until that moment, consisted of carriers of the ALBP2 mitochondrial phylogenetic lineage. Thus, the *C. albula* population of Lake Pleshcheyevo has a complex polyphyletic origin, with this species having migrated into the lake at least twice during its history.

The paleogeographic reconstructions can also explain how the carriers of haplotypes of the E cluster spread to Lake Sobach'ye on the Taimyr Peninsula. This is most likely to have occurred approximately 60 000 years ago, when a desalinated periglacial water body covered the wide area between the Yugorsky and Taimyr peninsulas. In that period, fish with haplotypes belonging to cluster E could only migrate to Siberia from the region of the former paleo Lake Komi because the other European regions populated by vendace were separated from Siberia by a glacier. It should be noted, that migrants from the west have not passed east of the Taimyr Peninsula: in the Lena, Yana, Kolyma, and Indigirka basins there are not haplotypes typical for the vendace from western water bodies. Vast plateaus and mountain ranges bothered the migrations of the vendace between these basins; therefore, a rather unique polymorphism was formed in the basin of each of these rivers.

The phylogeographic data for other species of the cold-water ecosystems – the Arctic charr (*Salvelinus alpinus*), the northern pike (*Esox lucius*), and the roach (*Rutilus rutilus*), confirm our conclusions and indicate the large scale of paleoinvasion events (Levin et al., 2016; Nikulina et al., 2017; Makhrov et al., 2019).

The understanding of the origin of fish populations is very important for protection of rare communities and conservation of unique endemic populations. Thus, the mixing of fish from different populations leads to the breakdown of local adaptations as a result of outbreeding depression and may even cause the loss of unique phylogenetic lineages.

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INVASIVE SPECIES IN THE SOUTHEAST REGION, USA

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Invasive species are part of the landscape and are expanding in the Southeast Region. Every Southeastern state has at least one exotic species, either terrestrial or aquatic and most have a multitude of invasive species. Asian Carp, swamp eels, lion fish, northern snakeheads, zebra mussels, hydrilla, Eurasian milfoil, and water hyacinth are just a few of the invasive species that are abundant in the Southeast. In fact, over 150 fishexotic species occur in the SE. These invasive species severely threaten our nation's natural resources as well as having huge economic impacts. These species contribute to native species extinction, impact ecosystem function and integrity, and ultimately prevent the FWS from achieving our mission: Trust Species Conservation. Working with local, state, Tribal, NGO's and other Federal partners, the U.S. Fish and Wildlife Service is working toward developing innovative detection methods, improving early detection and rapid response protocols, reversing impacts of existing populations, limit intra-state and interstate movement, identify pathways of introduction and wherever possible, eradication. Several new and innovative techniques have been developed that will assist in limiting spread of invasive species across the United States and across the globe.

ALIEN PHYTOPATHOGENIC FUNGI ON WOODY PLANTS IN SOUTHERN EUROPEAN RUSSIA: PAST EVENTS AND POTENTIAL INVASIONS IN THE FUTURE

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Modern globalization contributes to the massive movement of animals, plants, fungi and other organisms outside their natural habitats. Today scientists can talk about the global 'homogenization' of the Earth biota, including expansions of natural habitats and global invasions or introductions of many species in new territories or even new continents – where they were previously absent.

This phenomenon is also common for numerous phytopathogenic organisms, including phytopathogenic fungi infecting many woody plants. The increased international trade in plants and the introduction of plants from one region to another (especially transcontinental transfer) is often accompanied – which usually follow their host plants.

However, invasions of phytopathogenic fungi have significantly accelerated in Europe over the past 40–50 years, like invasions of plants, animals and other organisms in general (Desprez-Loustau, 2009). This modern acceleration is mainly associated with the rapid development of international trade in plants and timber, especially transcontinental introductions of live plants associated with a high risk of potential unintentional co-introduction of many alien fungal phytopathogens due to insufficient phytosanitary control of imported plants (Cushman, Meentemeyer, 2008; Santini et al., 2013, 2018; Jung et al. 2016; Lovett et al., 2016; Potter, Urquhart, 2017).

Often such co-introduction of alien (non-indigenous) plant pathogens occurs asymptomatically, and researchers record it only many years ago. However, sometimes introductions, naturalizations, and further invasions of some alien fungal plant pathogens into local plant communities (invasion) can be a cause of significant ecological and economic damage, as in the case of invasions of phytopathogenic fungi affecting forest-forming woody plant or important fruit crops (Santini et al., 2013; Lovett et al., 2016). Such invasions usually are not limited to a country or a region, but cover almost all of Europe from the Atlantic Ocean to the Ural Mountains, or at least certain types of forests or other woody plant communities formed by host plants of a new phytopathogen – natural and artificial forests, urban locations, artificial tree plantations and orchards (Gninenko, 2008; Desprez- Loustau, 2009).

The examples of catastrophic invasions of phytopathogenic fungi in forests of Southern European Russia (and the European forest at general) in the XX century are: *Erysiphe alphitoides* (Griffon & Maubl.) U. Braun & S. Takam. (oak powdery mildew); this fungus considered as one of the main factors in the degradation of oak forests in the steppe and forest-steppe zones of Russia since 1900s; *Ophiostoma ulmi* (Buisman) Nannf. and *O. novo-ulmi* Brasier (Dutch elm disease), caused mass death of elms in the forests of Southern European Russia since the end of the 1930s; *Cryphonectria parasitica* (Murrill) M.E. Barr (chestnut blight), caused degradation of chestnut forest in Western Caucasus since 1920s.

The alien fungi that invaded Southern European Russia in the late 19th and early 20th centuries cause serious damage to cultivated fruit trees and shrubs: *Erysiphe necator* Schwein. (grapevine powdery mildew) – since the late XIX century and *Plasmopara viticola* (Berk. & M.A. Curtis) Berl. & De Toni (grapevine downy mildew) – since the middle of XIX century, *Podosphaera mors-uvae* (Schwein.) U. Braun & S. Takam. (powdery mildew of gooseberry and currant) – since the 1900s, *Podosphaera leucotricha* (Ellis & Everh.) E.S. Salmon (apple powdery mildew) – since the 1920s; *Blumeriella jaapii* (Rehm) Arx (cherry leaf spot) – since the 1960s. The dangerous plant pathogen *Monilinia fructicola* (G. Winter) Honey (American brown rot of stone fruits) have started to cause a significant damage to stone fruits (plum, cherry plum, sour plum, sweet cherry, apricot, peach, almond) in orchards of Southern European Russia since the 2010s (Mikhailova et al., 2020).

The presence of susceptible plants and similar climatic conditions suggest a high probability of the invasions of a number of the several alien phytopathogenic fungi already known in many European countries (Desprez-Loustau, 2009): *Hymenoscyphus fraxineus* (T. Kowalski) Baral, Queloz & Hosoya (ash dieback), *Eutypella parasitica* R.W. Davidson & R.C. Lorenz (maple trunk canker), *Fusarium circinatum* Nirenberg & O'Donnell (pitch cancer disease of pines), *Monilinia polystroma* (G. Leeuwen) L.M. Kohn (Asian fruit rot), *Phytophthora* × *alni* Brasier & S.A. Kirk (alder Phytophthora disease) and *Ph. ramorum* Werres, De Cock & Man in 't Veld (sudden oak death).

MODELING THE EXPANSION OF PARASITIC NEMATODES IN THE NORTHERN REGIONS BY THE TEMPERATURE FACTOR

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Dirofilariae are heteroxenic biohelminths that pose a significant medical and veterinary problem. Over the past two to three decades, there has been an intensive expansion of the parasite to the north and east, as well as an abrupt increase in human cases of subcutaneous dirofilariasis. Dirofilariae use humans and domestic predators (dogs and cats) as definitive hosts, blood-sucking mosquitoes – as an intermediate host. Mosquitoes transmission of the parasites and their adaptation to the environmen. Temperature is the main abiotic factor that requires adaptation of the parasite. The aim of our study is the construction of temperature models for studying the adaptive capabilities of the parasite based on natural and laboratory experiments, the infestation of natural populations of the vector (malaria mosquitoes), as well as the detection of the current boundaries of the parasite's range in the Ob basin (from Tyungur (Altai Republic) to Labytnanga (YaNAO) — only about 17 latitudinal degrees). The species of the malaria mosquitoes and the parasites were determined by conventional methods of molecular diagnostics.

To date, the northernmost point of detection of the parasite in the mosquitoes it is located in the Priobye village in the Oktyabrsky district of the KhMAO (N 62° 32'). To the north — in Berezovo (KhMAO), Shuryshkary village, Salekhard sity and Labytnangi sity (YaNAO), the parasite has not been found in 2020. Local transmission of the disease to humans is actually limited to 58-59 parallels. Our findings show that the risk of transmission of the disease persists at least 3 — 4 degrees further north.

To determine how successfully the parasite adapts to the temperature factor, natural and laboratory experiments were conducted using with natural mosquitoes collected in natural populations of Kolarovo village (Tomsk region). Experiments revealed a very unexpected resistance of dirofilariae to sub-threshold temperatures in the range of 0 — 14 °C. At 0 °C, the microfilariae remained viable after 48 hours of exposure. The result of the adaptation of dirofilariae to the sharply continental climate of Western Siberia was the switching of their development from a continuous type to a discrete (fractional) one, which was determined by daily temperature differences. It becomes to be obvious, that the natural selection to cold resistance causes, a decreasing of the sum of the effective temperatures required for the development of the parasite, as well as a decrease in the threshold temperature.

The construction of models based on effective temperatures showed the possibility of dirofilaria northern habitat boundary up to the 64th parallel. In this area, the parasite can maintain the population above the critical one. The change in the parameter varied during the 11-year solar cycle, which maintained a two-peak structure throughout Western Siberia. Four cycles were studied in total (from 1976 to 2019 years). In the Ob basin, the average long-term indicator decreased from 501 Units of Dirofilariae Development (UDD; Barnaul sity) up to 222 UDD (Berezovo village). To the north (Salekhard sity), the average long-term sum of effective temperatures did not reach the value necessary for the maturation of microfilariaes (130 UDD). However, three of the eleven seasons were suitable for local transmission of the parasite.

Models based on average annual temperatures have shown a fairly rapid increase in this parameter over the past half-century. At the same time, the growth rate in the northern habitats (Ugra Ob region) was about twice as fast as the growth rate in the southern one (Novosibirsk and Altai Ob regions). The variation of the parameter was weakly correlated with the increase in effective temperatures, which was explained by the main warming outside the growing season. In summer, warming was slower due to the high waterlogging of the northern territories of Western Siberia, which stabilizes the climate by absorbing excess atmospheric carbon.

An analysis of the average monthly temperatures over last 50 years revealed warming trends in March, April, August and October. The early start of the dirofilaria development season leads to the involvement of early-spring mosquito species, the expansion of the range of vector species and, as a result, the increase in the intensity of the epidemic situation.

INVASIVE SPECIES *PROSOPIS JULIFLORA* (MIMOSACEAE) IN FUJAIRAH (UAE): DISTRIBUTION IN EMIRATE OF FUJAIRAH BY USING NEW FIVE-LEVEL BASED ASSESSMENT METHOD AND PREREQUISITES FOR ITS INVASION SUCCESS

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We studied the distribution and the development of the population of *Prosopis juliflora* (Sw.) DC., also known as mesquite, on the territory of the Fujairah emirate, United Arab Emirates (UAE). The distribution research start on January 2019 and ongoing. The distribution map was compiled by analyzing results after using traditional route method, which took place on November—December 2019. We applied a new original five-cathegories method of the degree of population development. Seed germination and early stages of seedling development has been studied from relevant publications. Examination of two anthropogen disturbed areas with high solinity soil and with start of occupation by *P. juliflora* showed its invasion success.

The identified sites of mesquite invasions were divided by us into five categories (1–5) according to the degree of development of the site by the species, starting with the initial penetration of seedlings and young nonfruiting undergrowth (1) and ending with the complete capture of the territory by adult trees with the suppression and displacement of local species plants (5):

(1) shoots of the current year and shoots that have not reached reproductive age, individually or in groups; any percentage of projective cover;

(2) single or groups of shrubs and trees that have reached reproductive age, but without undergrowth; projective cover less than 1/3, or up to 33% (±8%);

(3) single or groups of shrubs and trees that have reached reproductive age, with undergrowth; projective cover up to 1/3, or more than 33% (±8%);

(4) groups of shrubs and trees of reproductive age with undergrowth, between which there are small glades with local vegetation; projective cover from 1/3 to 2/3, or 33–67% (±8%);

(5) solid thickets of shrubs and trees of reproductive age, crowns close, even undergrowth of its own species cannot grow or is extremely depressed; projective cover more than 2/3, or 67% (±8%).

The distribution map as result is given on the original publication in the Russian Journal of Biological Invasions.

P. juliflora most often found in anthropogenic habitats: in gardens, along fences, near roads, on wastelands, less often on the streets, etc. and successfully naturalizes and creates stable self-reproducing populations. It possesses a complex of specific helio-mesomorphic structural features, which allows it to successfully take root in relatively open, moderately humid and even dry or saline habitats and to compete with native species of acacia (*Acacia tortilis, A. ehrenbergii*) and *Prosopis cineraria*. Features such as high germination of seeds and significant morphological, dimensional, and temporal variability of premature individuals of *P. juliflora* identified in this study undoubtedly contribute to the successful naturalization of the species in the secondary range and its wide distribution throughout the emirates.

Observations are continuing, and as of June 2021, the situation with the invasion has not changed much: at some points the prosopis was cut down, but it sprouts again; there are new findings in the territories near the places already occupied by prosopis. Owing to the high aggressiveness of mesquite, it is necessary to develop a methodology for combating this plant in the UAE, which will stop its uncontrolled settlement in the region.

For details see: Byalt V.V., Korshunov M.V. Distribution of Invasive Species *Prosopis juliflora* (Mimosaceae) in Fujairah (UAE) // Russian Journal of Biological Invasions, 2021, Vol. 12, No. 2, pp. 157–166. https://doi.org/10.1134/S2075111721020053

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MODERN GENETIC TOOLS IDENTIFY ORIGIN OF A TRANSLOCATION AND ITS CONTEMPORARY GENE FLOW AS A TOOL FOR INVASIVE SPECIES MANAGEMENT

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Identifying the origin of an invasive species is a critical management objective, and molecular genetic techniques have greatly promoted our capacity to do so. Here we demonstrate how cutting-edge tools can identify an 'invasive' source (here a translocation) by focusing on the re-establishment of a heavily managed species (white-tailed deer; *Odocoileus virginianus*) that was virtually eliminated 100 years ago by unregulated harvest in eastern North America. It was subsequently restored by extensively restocking from less impacted northern populations. However, in so doing, historic population structure was replaced by an 'invasive-history' that acted to obscure natural patterns of gene flow. To reconstruct the past, we evaluated 35,099 single nucleotide polymorphisms (SNPs) derived via reduced-representation genomic sequencing from 1143 deer sampled statewide in Arkansas. We then summarized ancestry assignments and visualized spatial genetic transitions, then tested clinal patterns across our loci against theoretical expectations for re-colonization and restricted dispersal. Two salient results emerged: (A) Genetic signatures are clearly apparent today that identify the origin of the historic translocation; and (B) Geographic filters (major rivers; urban centers; highways) now serve to geographically deflect the contemporary distribution of deer statewide. From this, we could derive a statewide assessment of population structure in deer, as driven by historic translocations as well as ongoing processes. Our analytical framework is clearly applicable for the management of other biodiversity elements with demographic histories similarly as complex, such as the origin/ subsequent trajectory of an invasive species.

For additional details see: Chafin T.K., Zbinden Z.D., Douglas M.R., et al. Spatial population genetics in heavily managed species: Separating patterns of historical translocation from contemporary gene flow in white-tailed deer // Evolutionary Applications. 2021. Vol. 14. No. 6. P. 1673– 1689. https://doi.org/10.1111/eva.13233

DISTRIBUTION OF *HERACLEUM SOSNOWSKYI* MANDEN. IN THE KAMCHATKA KRAI

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Sosnovsky's hogweed (*Heracleum sosnowskyi* Manden.) is one of a hundred especially dangerous invasive species in Russia, one of the "transformer" species. *H. sosnowskyi* actively introduces into natural and semi-natural communities in Kamchatka, changes the appearance of ecosystems and breaks succession relations. It acts as edificator and dominant forming large-area single-species thickets, displaces and prevents the renewal of species of natural flora. It was brought to Kamchatka in the 70s of the 20th century to an agricultural station in the village of Sosnovka as a promising silage crop. Subsequently, the species settled near the hot pipelines in the villages of Paratunka and Termalny, adapted and began to spread. The species occupies vast areas on heated soils near pools, wells and pipelines of recreation centers in the valley of the river Paratunka and on the lawns in the surrounding villages. In Petropavlovsk-Kamchatsky, *H. sosnowskyi* was first recorded in 2010 in the Seroglazka district, where it naturalized near the heating pipe on the slope of a hill. Over the next years, there was a constant expansion of *H. sosnowskyi* in the city. It occurs along the roadsides, as well as along the channels of ditches and streams. By 2014, *H. sosnowskyi* settled 1 km towards the Siluet district and occupied plots in a garage cooperative bordering the road to Seroglazka district. In the neighboring area "6th kilometer" (about 2 km), there are several separate areas in the yards occupied by *H. sosnowskyi*. In 2015, it was found on the slope of a hill near st. Elizovskaya (about 3 km from the initial focus of invasion), and in the Gorizont district (at a distance of about 4 km). In 2018, the species was first recorded in Vilyuchinsk. Automobile transport plays an important role in the settlement of the hogweed. In all cases, *H. sosnowskyi* prefers well-lit and warm places.

In the fall of 2020, a resident of Esso (Central Kamchatka) reported finding *H. sosnowskyi* in the vicinity of the village. In June 2021, we examined the territory and found that the species has been growing for several years on an abandoned field with an area of about 1 hectare, 2 kilometers from the village of Esso (coordinates of the center of the site N55 ° 56'29 "E158 ° 43'25", territory Bystrinsky Municipal Formation). Plants bear fruit well, seed renewal is successful. The species actively penetrates into natural communities - into a floodplain forest of a *Populus suaveolens*. *H. sosnowskyi* dominates in the communities. The density of the herbage of *H. sosnowskyi* is high: in most cases, there are more than 450 shoots at different stages of development per 1 m^2, and a large number of pregenerative shoots. On a plot of 1 m^2, there are usually 3-4 generative shoots of *H. sosnowskyi*. One of them is most developed - up to 4 m in height and weighing up to 4 kg. It also forms the most inflorescences (more than 10), the largest inflorescences - up to 54 cm, while on the central umbrella there can be up to 100 umbrellas (more than 40 flowers on each). Thus, the potential seed productivity of the invasive species is enormous.

Distribution of *H. sosnowskyi* in the central regions of the Kamchatka Peninsula may be more successful due to climatic conditions and the presence of large areas of abandoned farmland than in the Eastern Kamchatka. It will require significant costs to combat thickets of this species. In conclusion, we can say that the *H. sosnowskyi* in Kamchatka has acquired the status of a mass species, but the elimination of the emerging foci of invasion is still possible.

INVASIVE AND ENDEMIC MIDGET MOTHS (LEPIDOPTERA: GRACILLARIIDAE) IN URBAN PHYTOCOENOSIS IN KYIV CITY (UKRAINE)

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Natural process of species range expansion and distribution affected by anthropogenic activity differ significantly. It is a known fact that many contemporary ecosystems were historically formed by spontaneous introduction of adventitious species.

Modern anthropogenic distribution of organisms happens much more intensive comparing to natural processes. Because of that, formed biocenoses are changed irreversibly. Agricultural and forestal developments of land, bringing new seed material and cultivating new plant species result in the spread of herbivore insects.

Global climate changes and "mild" winters ease their habitation and adaptation. Range expansion of host plants also plays a significant role for distribution of Gracillariidae. These invading insects often don't have enemies in the nature world, thus they can cause significant harm to ornamental plants, affect reproducibility and areal of native species and present a great threat to biodiversity.

Immense negative impact of biological invasions by these insects is not limited to ecology only, because in consequence economy is affected as well.

Insects represent a majority (80%) of pests for trees and arboreal plants in urban phytocenoses. Among them midget moths (Lepidoptera: Gracillariidae) were found to be causing the most harm.

For Paleoarctic region, there are 42 genuses and about 500 species of midget moths. They most often affect such plant families: Fagaceae Dumort., Rosaceae Juss., Fabaceae Lindl., Salicaceae Mirb., Aceraceae Dumort., Betulaceae Gray. Caterpillars usually mine foliage of herbaceous plants, though in some cases affect sprouts, tree and bush bark. As they grow older, caterpillars start to skeletonise leaves. Majority of species are mono- or oligophages, rarely polyphages, having trophic relationship to herbs of phylums Pinophyta and Magnoliophyta (class Dicotyledones). They often do damage to horticultural, ornamental and industrial crops. In some cases, midget moles are prone to rapid reproduction outbursts.

Research of Gracillariidae' fauna in urban phytocenoses in Kyiv shows that arboreal plants host 24 species, from which 21 are natives (*Caloptilia semifascia* (Haworth), *C. rufipennella* (Hùbner), *Parectopa robiniella* (Clemens), *Phyllocnistis labyrinthella* (Bjerkander), *Phyllonorycter acerifoliella* (Zeller), *Ph. agilella* (Zeller), *Ph. apparella* (Herrich-Schaffer), *Ph. blancardella* (Fabricius), *Ph. cerasicolella* (Herrich-Schaffer), *Ph. coryli* (Nicelli), *Ph. emberizaepennella* (Bouche), *Ph. faginella* (Zeller), *Ph. guercifoliella* (Zeller), *Ph. issikii* (Kumata), *Ph. platani* (Staudinger), *Ph. strigulatella* (Zeller), *Ph. salicicolella* (Sircom), *Ph. sorbi* (Frey), *Ph. tenerella* (de Joannis), *Ph. ulmifoliella* (Hùbner), *Phyllocnistis labyrinthella* (Bjerkander)) and 3 invader species – *Cameraria ohridella* Deshke & Dimic, *Phyllonorycter populifoliella* (Treitschke) and *Gracillaria syringella* (Fabricius). There were 23 species of Gracillariidae found in botanical gardens of Kyiv, 16 in public parks and only 6 across roads.

The most widespread and harmful are invader species *C. ohridella*, *Ph. populifoliella* and *G. syringella.* Great economic impact of invader species can be illustrated by our calculation: Kyiv city contains more than 2 million of chestnut trees. Population control of only one invader specie (horse-chestnut leaf miner, *C. ohridella*, originating from Balkan region) by the method of insecticide trunk injection can cost 2.5 - 6.5 million of euro per year.

There are few invader species of Gracillariidae found in Europe, which are not present in Ukraine yet. For uncontrollable population growth and direct harm of phytocompositions regular preventive measures of phytopathological monitoring should be taken.

HUMAN CONTRIBUTION TO PLANT INVASIONS: THE CASE OF NON-INDIGENOUS GOLDENRODS IN KALININGRAD REGION

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Alien goldenrods are known to have significant bio-ecological advantages over autochthonous species in disturbed local ecosystems. In this paper, I will take a closer look to the role of humans in the successful invasions of the species in general and in Kaliningrad region in particular.

The territory of the Kaliningrad region of Russia is located in the southeastern part of the Baltic Sea region. The area is characterized by a relatively high population density, high industrial concentration and intensive agriculture. The anthropogenic transformation of flora has a long history. In most of the territory, soils have been greatly changed and vegetation has been replaced by cultural forms. One of the results of intensive human economic activity is the almost complete disappearance of primeval forests. Their natural spatial distribution and structure were changed by land drainage, felling, planting of agricultural crops and plantings of introduced species. Cultural continental meadows were formed; monodominant plantings of spruce, pine and European oak were laid. Thus, most natural landscapes have turned into anthropogenic modifications, mainly agricultural (over 60% of the area) and forestry (about 20.4%). Only coastal meadows, partly – low-lying bogs and central sections of end-moraine ridges remain relatively undisturbed. Some areas have turned into a sort of natural reserves, the existence of which has a positive effect on the level of biodiversity (Dedkov, 2006).

Since the introduction of new species continues, the adventive component of the flora tends to further expand. Present-day globalization and urbanization increase the risk of invasions. Cities and adjacent areas are experiencing intensive development and have become centers of the spread of invasive species. These are the territories where many transport routes intersect, new green areas are formed and vast wastelands appear.

More evidence of human impact can be found in recent history. The first herbarium records of Kaliningrad State University (KLGU) of non-indigenous *Solidago* species date back to the late 1960s-early 1970s. The alien goldenrods identified as *S. canadensis* and *S. gigantea* were found at the landforms created by humans: in the post-war ruins and bare lands, near moats and ditches, on roadsides, along railways and tramlines. No difference between the types of habitats of two species could be stated on the basis of these data. Our recent field study has discovered the similar types of habitats of the alien goldenrods and their wide spread and abundance in the new range. Besides, the species actively occupy unused agricultural lands, which were abandoned either after the dissolution of kolkhozes (Soviet collective farms) or later.

In a nutshell, the following anthropogenic factors of goldenrod invasions should be mentioned:

heavy anthropogenic transformation of natural landscapes and disturbance of vegetation cover;

long-lasting active introduction of neophytes in the area;

development of transport network increasing the landscape fragmentation and contributing to the spread of seeds and parts of rhizomes into new areas;

uncontrolled use of the species in horticulture and apiculture;

social calamities and socio-economic transformations entailing the interruption of land use practices;

shortcomings of environmental legal regulations;

malpractices and lack of responsibility in private land use;

careless handling of fire.

PENETRATION OF NON TYPICAL SPECIES OF SEALS INTO THE EAST SIBERIAN SEA

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The East Siberian Sea is one of the most faunistically depleted Arctic seas (Geptner et al., 1976; Atlas of the Oceans, 1980), and until recently, only three species of pinnipeds were permanently found in its water area: the walrus *Odobaenus rosmarus* (Linnaeus, 1758), bearded seal *Erignathus barbatus* (Erxleben, 1777) and ringed seal *Pusa hispida* (Schreber, 1775).

Information about pinnipeds of the East Siberian Sea has been collected by us since the 1980s along with the main field works on the territory of the Nizhnekolymsky district of Yakutia on the coast of the sea and in the delta of the Kolyma River. We have also collected annual survey data from fishermen and hunters, reindeer herders, inspectors of the Nizhnekolymsky district inspection of nature protection and the Kolyma polar hydrological station, inspectors of the Kolyma branch of the Ministry of Emergencies of the Republic of Sakha (Yakutia) (GIMS), ship crews and local residents.

To date, information has accumulated on the fairly regular entry into the water area of the East Siberian Sea of the Steller's sea lion *Eumetopias jubatus* Schreber, a species of marine mammals not typical for this sea. We have published information about its penetration in 1987, 2001, 2007 into the water area of the Chukchi and East Siberian Seas, including entry of this seal into the lower reaches of the Kolyma, Bolshaya Chukochya, Konkovaya and Rauchua rivers (Boeskorov et al., 2011).

New observations in this region show the continuation of this process. So, in the last decade, two individuals of the Steller's sea lion were sighted in 2015 and one individual in 2019 in the Kolyma River delta. One seal was observed in 2020 in the lower reaches of the Bolshaya Chukochya River.

On the whole, over the past decade, the described area has seen a rapid increase in the number of pinnipeds. Basically, this refers to the population of ringed seals, the number of which has grown rapidly. To date, this species forms autumn haul-outs in the delta of the Kolyma River and the lower reaches of the rivers flowing into the Kolyma Bay of the East Siberian Sea. Here the number of seals reaches many tens and even more than a hundred individuals, which only 10-15 years ago was not noted by anyone. Earlier the bearded seal sightings were rare, this seal was not observed every year in this water area. By now, the bearded seal records have become more frequent and they are found more frequently near fishing areas in the lower reaches of rivers.

Thus expansion of migrations of pinnipeds, accompanied by the growth of their numbers in the coastal waters of the East Siberian Sea, serves as a reliable indicator of climatic changes in the Arctic seas. The last circumstance is expressed, first of all, in the improvement of the ecological conditions of marine mammals. A decrease of the area of the ice cover and its thickness, and also the seasonal period of its existence leads to the increase in temperature, the increase in mixing and the arrival of solar radiation in coastal waters (https://earth.gsfc.nasa.gov/cryo/data/current-state-sea-ice-cover). In the end all of these factors positively impact on biological productivity and on the development of the coastal ecosystem complex. The continuing warming of the climate suggests the further distribution of non typical species of marine mammals in the waters of the East Siberian Sea, one of the harshest seas in the eastern sector of the Arctic.

ALIEN SPECIES IN HOLARCTIC: STATUS, TRENDS, RESEARCH, AND PRIORITIES

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The Holarctic is the largest region of our planet with approximately a uniform set of natural zones and conditions. This creates the conditions for the successful spread of alien species within this gigantic region. All regions of the world have recently faced a great challenge of global change (GCH), including global climate alterations and the increasing impacts of human activities such as environmental degradation, habitat transformation, pollution, global transport, etc. A result of globalization of many processes has greatly increased the risk of biological invasion of alien species and destruction of native biodiversity and ecosystem functions. Like other places, the Holarctic became a donor and recipient of alien species of other parts of the World. Despite the cold and temperate climate, by the beginning of the 21st century, a large number of alien species, representing the majority of large taxonomic groups, had penetrated to and naturalized in the Holarctic. Holarctic can be attributed to one of the hottest points of the invasion process on Earth if when assessing the scale of the invasion process, both invasions of species from other regions and invasions within the Holarctic are taken into account. Analysis of the dynamics of invasions over the past 250 years and modeling trends for the 21st century show a rapid acceleration of the invasion process in the Holarctic.

Actually, the issue of the biological invasions of alien species in the modern sense is being intensively researched in the Holarctic for a relatively small time. However, we have got a rather big bulk of knowledge in this field. There were been identified six essential components of predictive risk assessment of invasions:

- determination of corridors and sources of invasion;
- determination of vectors;
- assessment of inoculation rates (propagule pressure);
- studies of invasive species biological traits;
- the presence of symbionts;
- assessment of the ecosystem vulnerability to invasions.

Specific data have been obtained on these components for many groups of invaders and aboriginal ecosystems of the Holarctic, which make it possible to predict, prevent and control the invasive process. It is extremely important that data on alien species of the Holarctic have entered a number of global and regional information systems. At this stage, it seems important to develop and unify the terminology of invasion studies.

If we talk about the priorities of work on invasions of alien species, then taking into account the large scale of the invasive process, it seems productive to concentrate attention primarily on more dangerous invaders, the so-called target species. An important priority is also the development of methods for early identification and control of invaders.

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INVASIVE POTENTIAL AND RISK ANALYSIS OF LIVING PLANT COLLECTIONS IN THE ALMATY MAIN BOTANICAL GARDEN (KAZAKHSTAN)

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The Main Botanical Garden (106 ha, founded in 1932) is situated at an altitude of 856 – 906 m a.s.l. in the upper part of piedmont plains of the Ile Alatau Mountains (the North Tien Shan). It has 11 living plant collection sites.

Among the numerous woodies, shrubby and herbaceous plants introduced over the years, more than 170 taxa have gone beyond their collections and spread throughout the botanical garden.

According to scale of invasiveness there are 4 categories of species. Among the first category of highly invasive species (ggg) there are five taxa with a North American primary geographical distribution (*Acer negundo, Asclepias syriaca, Ambrosia artemisifolia, Robinia pseudoacacia, Parthenocissus quinquefolia*).

The second category consists of invasive alien species (+++), which are characterized by a high degree of naturalization on the territory of the botanical garden. So, escapees from the collections are *Euonymus sacrosancta, E. europaea, Amorpha fruticosa, Ligustrum vulgare*, etc. Among them there are also North American species (*Amaranthus retroflexus, Conyza canadensis, Solidago gigantea, Fraxinus pennsylvanica*) which are found not only within the botanical garden.

The third category – potentially invasive species (++) that tend to further naturalization, is represented most widely, there are 77 species only in the collection of medicinal plants. There are three American species (*Mahopia aquifolium, Galinsoga parviflora, Lepidotheca suaveolens*) in the list.

The analysis of the degree of aggressiveness of alien species in the collection site of medicinal plants revealed 12 aggressive (+++) taxa (*Amaranthus cruentus, A. retroflexus, Aralia elata, Asarum europaeum, Astragalus falcatus, Chaerophyllum aromaticum, Eupatorium cannabinum, Galium album, Genista tinctoria, Hyoscyamus niger*) and 12 highly aggressive (ggg) alien taxa (*Aristolochia clematitis, Asclepias syriaca, Matricaria chamomilla, Galega officinalis, Helianthus tuberosus, Lotus corniculatus, Sanquisorba minor, Sedum acre f. alba, Solidago canadensis, Valeriana officinalis, Vinca minor, Xanthium spinosum*). They were introduced at the site in 1945-1989. Some of them did not show aggression for a long time. Thus, *Aristolochia clematitis* was introduced in 1968, it belonged to the category 4 of species capable of self-reproduction (+). However, over the past two years, it has moved into the category 1 of highly aggressive species (ggg) that have taken a dominant position in the herbaceous layer of some collection sites of the botanical garden.

Some alien species become dominant in plant communities of the botanical garden: *Robinia pseudoacacia, Acer negundo, A. platanoides, Fraxinus excelsior* – in tree layer; *Prunus spinosa, Malus domestica, Swida alba, Ligustrum vulgare* – in bush layer; *Arrhenatherum elatius, Asclepias syriaca, Conyza canadensis, Galinsoga parviflora* – in herbaceous layer, and also lianas (*Vitis vinifera, Parthenocissus quinquefolia*).

The potential threat of invasive species is manifested in the expansion of the boundaries of the growth of some plant species beyond the expositions of the botanical garden and urban plantings into natural communities. Our research in the Nature Park "Medeu", located in 15 km from Almaty city, revealed the penetration of alien tree species (*Acer platanoides, A. campestre, A. negundo, Fraxinus excelsoior, Ulmus laevis, U. pumila, Robinia psedoacacia*) into the natural communities of the core zone of the Park (1251 – 1705 m a.s.l.).

Taking into account the increasing rates of invasion and active spread of alien species, the importance of botanical gardens as a network for identifying future regional threats from introduced species is increasing.

INVASIVE SPECIES IN THE VISTULA LAGOON (BALTIC SEA)

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The Vistula Lagoon is a brackish lagoon in the southeastern part of the Baltic Sea. The features of the hydrological and hydrochemical regime of the lagoon are favorable for the invasion and naturalization of alien species. Only one potentially toxic alien species *Prorocentrum cordatum* has been noted in the phytoplankton community since 1997. This species usually develops in the autumn. The highest values of the abundance of *P. cordatum* were recorded in spring (542 thousand cells/L). In summer the abundance took the minimum values per season (80 thousand cells/L) and increased to 202 thousand cells/L in autumn. Biomass was high in autumn due to the development of large-cell forms of this species. The largest abundance of *P. cordatum* was noted in the spring months at a temperature not higher than 11 °C and a salinity of at least 5 ‰. The mass development of the invader during this period was also favored due to the high content of biogenic elements (mineral forms of nitrogen and phosphorus) in the water.

There are four invading species which develop in the zooplankton community of the Vistula Lagoon: *Acartia tonsa, Cercopagis pengoi, Evadne anonyx*, and *Moina micrura*. According to the literature data, *A. tonsa* was first found in the Vistula Lagoon in the 1930s (Nikolaev, 1951), *C. pengoi* in 1999 (Naumenko, Polunina, 2000), *E. anonyx* was found in the central part of the Vistula Lagoon in July 2012, *M. micrura* in August 2014. Only *M. micrura* and *C. pengoi* reached mass development in the lagoon. *E. anonyx* occurs as a single species during the inflow of waters from the Baltic Sea. The maximum development of *C. pengoi* was observed in July–August wherein its biomass reached 1.4–1.9 g/m^3. High rates of development of this species were noted in June 2013 and June–August 2018. *M. micrura* reached its maximum development in August 2015 and 2018, September 2017 and August 2019. Water temperature and salinity are the main factors which influence the development of invading species. The maximum abundance and biomass of *C. pengoi* and *M. micrura* were noted during the warmest summers.

There are 33 invasive species which are registered in the macrozoobenthos of the Vistula Lagoon. North American polychaete species of the genus *Marenzelleria* (in 1988, *M. neglecta* and *M. viridis*) and the Bivalvia *Rangia cuneata* (in 2010) reach mass development in the lagoon (Naumenko et al., 2014). The peak of development of *Marencellaria* spp. was noted in 1990–1995. The average biomass during this period was about 12 g/m^2. In 2002–2020 their average biomass decreased by 4 times and was about 3 g/m^2. In autumn 2010 the biomass of the *R. cuneata* was 0.02 kg/m^2. In 2011–2020 the biomass of the *R. cuneata* in the Russian part of the Lagoon varied from 0.21 to 1.84 kg/m^2 (on average 1,05 kg/m^2). The invasion of new species has led to an increase in the total biomass of benthos. At the same time the food availability of *R. cuneata* for benthophagous fish is very low because to the end of the growing season juvenile of Atlantic rangia exceed the available feed size (in autumn, juveniles long are more than 1 cm long).

DYNAMICS OF PLANKTONIC COMMUNITIES IN THE VISTULA LAGOON BEFORE AND AFTER THE INVASION OF *RANGIA CUNEATA* (G.B. SOWERBY I, 1831)

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The North American wedge clam *Rangia cuneata* (G.B. Sowerby I, 1831) was first found in the Vistula Lagoon in September 2010. In 2010–2011 *R. cuneata* colonized a fairly large area of the Lagoon (Rudinskaya and Gusev, 2012) including its Polish part. During 2011–2020 *R. cuneata* has naturalized throughout the lagoon. After invasion into the lagoon the biomass of this species varied from 0.21 to 1.84 kg/m^2 (on average 1.05 kg/m^2). The peak of the biomass of *R. cuneata* was observed in 2016 (1.84 kg/m^2). The invasion of the new species led to an increase in the total biomass of benthos but at the same time the food availability of *R. cuneata* for benthophagous fish is very low.

The aim of the work is to reveal changes in phyto- and zooplankton communities that occurred after the invasion of *R. cuneata* into the Vistula Lagoon. The material for the study was samples of phyto- and zooplankton taken in lagoon from April to November 2002–2019.

In 2002–2019 the dynamics of phytoplankton was characterized by clear evident seasonal variability: there are two biomass peaks in spring and summer. Before the invasion of the mollusk the summer maximum of phytoplankton was higher than the spring one. After the invasion of the bivalve the summer maximum smoothed out to a significant extent and the development maximum shifted to early spring. Perhaps this was due to the low filtration activity of the *R. cuneata* in early spring. Analysis of the average long-term indicators of phytoplankton biomass showed that in 2002–2010 it was 12.2 g/m^3, and in 2011−2019 biomass has decreased by half to on average of 4.8 g/m^3. Changes in the ratio of the dominant groups of algae were noted. A decrease in the biomass of green algae in spring and summer by 3–4 times and in autumn by 7 times was established. The biomass of diatoms decreased 3 times in summer and 1.7 times in autumn. A decrease in the biomass of cyanobacteria (by 4 times) was noted only in autumn. Apparently, such a change in the ratio of the main phytoplankton groups in summer during the period of maximum filtration activity of the mollusk *R. cuneata* occurred as a result of selective grazing by mollusks of more nutritious green and diatoms algae. As a result, cyanobacteria received a competitive advantage for their development.

Changes in the structure of the zooplankton community after the invasion of *R. cuneata* were found. They were most evident in summer and weaker in spring and autumn. Veligers of *R. cuneata* were found in zooplankton in summer. They could compete with other zooplankters for food especially in July–September when their abundance reached their maximum. After the invasion of *R. cuneata* the proportion of *Eurytemora affinis* species which is one of the key species in the zooplankton of the Vistula Lagoon decreased by 3−5 times in the summer time compared to the period before the invasion. A change in the ratio of the main taxonomic groups was noted in zooplankton. In 2011–2019 the proportion of rotifers in the abundance and biomass of zooplankton increased 4–10 times and the copepods decreased 3–6 times. For cladocerans the changes were not so obvious. The influence of *R. cuneata* on zooplankton was most likely expressed in the form of competition for food resources which was the strongest in summer. In addition, there are other factors influencing on zooplankton: the grazing of zooplankton by young stages of fish and species like *Cercopagis pengoi* and other.

NON-NATIVE PLANT SPECIES *PISTIA STRATIOTES* L. IN THE DNIESTER DELTA

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In recent years, biological pollution of water bodies has become a global environmental problem. Invasive non-native species are considered to be the second most important threat to biodiversity after the destruction of habitats of plants and animals. In this regard, the study of anthropogenically introduced invasions into the aquatic habitats of the Northern Black Sea region becomes especially relevant in view of climatic changes and increased anthropogenic pressures on the environment. Introduction of alien plant species into natural aquatic habitats can lead to a significant transformation of the ecosystems. One such species of cosmopolitan panthropic species with a wide ecological range is *Pistia stratiotes* L., which is included in the Global Invasive Species Database.

P. stratiotes is widespread in all tropical and subtropical regions. Apparently, its place of origin is the tropical regions of Africa. The modern geographical presence of this species is very wide. *P. stratiotes* is present in water bodies of Africa, Asia, South and Central America, as well as in several states of the United States. On the European continent *P. stratiotes* is registered in the aquatic habitats of the Netherlands, Denmark, Austria, Portugal, Italy, Spain, Czech Republic, Slovenia, France, Germany, the Russian Federation and Norway. In Ukraine, this species has been detected in the reservoirs of Kiev, Kharkov, Odessa and Izmail.

In May 2013, as a result of an outbreak of P. stratiotes invasion in the Kharkiv region near the village of Eskhar, about 100 km of the surface of the Seversky Donets River was covered with this plant, which led to an ecological disaster. In 2020, an outbreak of *P. stratiotes* was noted on the territory of the Bortnichy treatment facilities in Kiev, in particular, lake Zoloche, wherein in September about 60-70% of the water surface was invaded by the weed.

In the Dniester delta *P. stratiotes* was first discovered in August 2018 on the territory of the Lower Dniester National Natural Park and wetlands “Southern part of the Dniester estuary”, protected by the Ramsar Convention. Accumulations of *P. stratiotes* rosettes with an area of up to 20 square metersin the Dniester channel were found in the water area of the Dniester estuary, at the confluence of the Dniester and its Glubokiy Turunchuk branch, as well as in their channels. (Figure). The site of the primary invasion of *P. stratiotes* was probably one of the berths located 3 km upstream of the Dniester from the bridge near the village of Mayaki. In 2019, a small number of *P. stratiotes* rosettes, apparently due to seed germination, were found only in two streams connecting the old channel of the Dniester (Stoyachiy Turunchuk) with the Dniester. In 2020, and in the first half of 2021, this species was not recorded in the Dniester delta. High summer water temperatures in the reservoirs of the Dniester delta and relatively mild winters make this region vulnerable to the penetration and naturalization of invasive non-native plant and animal species from subtropical regions, including *P. stratiotes*.

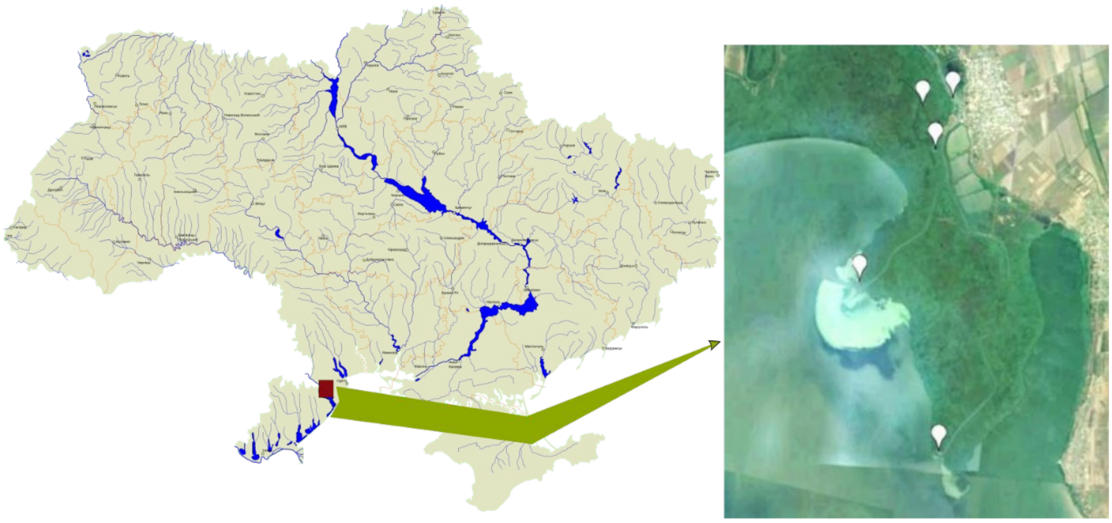

Figure. Location of discovery of *Pistia stratiotes* L. in the Dniester delta.

HOST PLANTS OF *CUSCUTA LUPULIFORMIS* KROCK. IN THE TOMSK REGION

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The parasitic weed species is common agricultural weed throughout the world, causing reductions in yield of many crops and if infestation is heavly, causes the death of host (Salgude et al., 2015). The study of the evolution of the system of consort relationships of invasive species and the assessment of the role of this factor in the further expansion of introduced species is one of the priority tasks of invasive biology.

To study the consort relationships of the dodder *Cuscuta* spp. with host plants, more and more attention is being paid in our country (Aistova, 2012) and abroad (Baráth, Csiky, 2012; Kaiser et al., 2015; Panek-Wójcicka, Piwowarczyk, 2020; Krasylenko et al., 2021).

Cuscuta lupuliformis Krock. included in "Black Book of the flora of Siberia" (2016). The study of consort relationships with host plants of *Cuscuta lupuliformis* was conducted by us in Tomsk, its surroundings and on the territory of the Tomsk Region in June-August 2020. A total of 10 populations were examined.

Among the possible host plants of the dodder, we counted 63 species of vascular plants (61 species of flowering plants) belonging to 56 genera from 30 families. 15 species are arboreal (including shrubs). 4 species are invasive for Siberia (*Acer negundo* L., *Conium maculatum* L., *Impatiens glandulifera* Royle, *Lactuca serriola* L.). In the studied populations, the number of plant species to which *Cuscuta lupuliformis* was attached with the formation of gaustoria ranges from 2 to 25. In each habitat, woody (shrubby) and herbaceous plants are necessarily present, which confirms the data that the presence of hosts of both life forms is necessary for the development of *Cuscuta lupuliformis* (Zhuk, 2000). The plants of the Asteraceae family (10 genera, 11 species), Rosaceae (6 genera, 7 species), Poaceae (4 genera, 5 species), Lamiaceae (4 genera, 4 species) and Salicaceae (2 genera, 3 species) are the most numerous in terms of the number of genera and species among the potential hosts of the dodder *Cuscuta lupuliformis* in the Tomsk Region. To establish a more accurate list of hosts, further studies (including the study of the anatomical structure of the contact zone of the parasite with the host) of these populations of the dodder *Cuscuta lupuliformis* are necessary.

LONG-DISTANCE DISPERSAL OF ORCHIDACEAE IN RUSSIA

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Orchids have one of the tiniest seeds among vascular plants. This means that the wind, their main dispersal vector, theoretically can carry them over larger distances comparing to most of the other groups of seed plants. In the course of the project dedicated to the mapping of the Orchids of Russia, we came across several records of Orchids outside their distribution range that can be interpreted as alien localities, or at least as the cases of 'long-distance dispersal' (LDD). LDD is an event, when diaspores are translocated across untypically large distances, normally far away from natural distribution range, which is executed by natural vectors such as strong storms, migrating animals, ocean currents, etc. (Nathan 2006). The features of orchids dispersal and large numbers, in which their seeds are produced, suggest that LDD is important factor in their biogeography. Large territory of Russia provides enough space for their study.

The following main problems were encountered in dealing with the localities of Orchids outside their main distribution range in Russia:

1). When presumable 'LDD' localities are very far (1000 km or more) from the main range and are documented by solitary herbarium specimen, there is some possibility that the specimen may have been mislabeled.

2). The distribution area of any plant species is a dynamic system, subjected to shrinkage and expansion. Should we treat differently the most distant and isolated localities of the species which undergo expansion, and 'true' LDDs? If yes, which are the criteria to separate them?

3). Most of the alien taxa start colonization of new territories from the ruderal environment. Orchids normally do not grow in such places, and populations may normally include only few specimens. Those factors hamper distinguishing solitary LDD events from successful naturalization.

4). Orchids are typically associated with natural and semi-natural ecosystems, and alien taxa are untypical in this family. Only ca. 20 of 25000 species of Orchids are considered to successfully colonize new land (Adamowski 1999). For Europe, the former 'DAISIE' project provided information about only 10 alien species in Europe, of them only 3 behaved as invaders. Accordingly, there is a certain tendency to over-interpret any orchid locality distant from its main distribution area as a relic one.

I tried to summarize information about the cases of LDD of Orchids in Russia, and classified them in 3 categories:

1). Possible established aliens. This group is represented by the only species, *Liparis* cf. *kumokiri*, which is discussed in detail in separate paper with molecular analysis (Efimov et al., 2021). The species is native to East Asia, but it was recently discovered in Italy, in Austria, and in three Regions of Russia, viz. in the Krasnoyarsk Region, in the Republic of Dagestan and in the Kamchatsky Krai. Close relative of *L. kumokiri*, *L. hawaiiensis*, is one of the only three Hawaiian Orchids, suggesting that the ability for colonization of new land is typical for this clade of the genus. However, the prevailing point of view is to treat all localities of *L. kumokiri* outside East Asia as relicts. A population of *Neottia nidus-avis* in Irkutsk Region may be another possible candidate in this group.

2). Confirmed cases of LDD. *Neolindleya camtschatica* in Khabarovsk Region and *Platanthera metabifolia* in Kamchatsky Krai (nearest native localities of both are in Sakhalin Region), *Platanthera chorisiana* in Khabarovsk Region and Magadan Regions (nearest native localities are in Kamchatsky Krai and Sakhalin Region), *Himantoglossum comperianum* in Krasnodarsky Krai (nearest native localities are in Crimea), *Dactylorhiza sibirica* in Sakhalin Region (native range is in Siberia).

3). Possible cases of LDD (mislabelling possible). *Platanthera chorisiana* in Moscow Region (native range is in East Asia); *Dactylorhiza incarnata* in Primorsky Krai (nearest native localities are in north Khabarovsky Krai).

4). Cases which are better classified as enlargement of distribution area. The most characteristic examples are isolated localities of *Dactylorhiza baltica* in the cities of Murmask, Arkhangel'sk and near Kem', and *Malaxis monophyllos*, with isolated localities in Murmansk Region, north Komi Republic, and Yamalo-Nenets Autonomous Okrug. For both species, distribution maps with the indication of the year for all marginal localities, are very illustrative.

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THE USE OF THE METHOD OF DONOR AREAS FROM PLANT INTRODUCTION IN THE STUDY OF THE POTENTIAL DISTRIBUTION OF INVASIVE PLANTS

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The introduction of plants originated in the times of agriculture and has a practical focus on the result — providing a person with resources for carrying out his life. A number of introduced plants (for example, *Heraculum sosnowsky* Manden., *Acer negundo* L. and others) can give invasive activity. At the same time, economically and ecologically dangerous invasive plants differ from useful introduced ones only by the presence of the last stage of adaptation – overcoming the phytocenotic barrier associated with distribution in natural communities.

The scientific basis of plant introduction was created by H. Mayr (1909), suggesting that greater success in the survival of a plant outside its natural range depends on how similar the climatic conditions of the territory to which the species is relocated with its natural range are. H. Mayr (1909) called the regions similar in climate as climatic analogues. Since the theory of H. Mayr has been criticized, V. P. Maleev (1933) suggests using a combination of approaches to assess the success of plant introduction: climatic analogs and phytogeographic ones – based on the similarity of vegetation. Continuing the thoughts of V. P. Maleev, we formed the following concept that the territory can be characterized through vegetation types, climatic characteristics, etc., while similar vegetation types will have similar climatic characteristics (Egorov, Afonin, 2018a). I. Y. Koropachinsky and co-authors (2011) for targeted plant introduction suggests the concept of a donor area, which means regions with climatic analogues and regions characterized by more extreme values of limiting factors.

The distribution of a biological species over the Earth's surface within its natural range is not accidental and is associated with environmental conditions and, first of all, with climatic ones. Thus, for the temperate and cold regions of the northern hemisphere, we identified the following limiting factors: insufficient heat supply, severe winter conditions and insufficient water supply during the growing season, as well as a number of other factors (Egorov, Afonin, 2017, 2018b, etc.). These factors, respectively, limit the distribution of invasive plants and their invasive activity.

With the development of modern GIS technologies, it has become possible to quickly and effectively conduct a spatial analysis of plants and their living conditions. Such analysis in GIS has been called ecogeographical modeling in Russian literature, or in foreign literature – environmental niche modeling, or species distribution modeling. The concept of ecogeographical analysis and modeling is consistent with the theory niches of G. E. Hutchinson (1957), and in this case can be used as a scientific basis for the development of the theory of plant introduction and in the study of the distribution of invasive species.

Ecogeographical analysis is usually carried out for one species (for example, our works: Egorov, Afonin, 2017, 2018b; etc.), and its technology is well described in foreign and russian literature (for example: Nix, 1986; Afonin, Sokolova, 2018; etc.). However, this analysis can be carried out with the allocation of donor areas for a certain territory, with further comparison of it with the ranges of specific species. The technology of modeling such territories is similar to the technology of modeling for a species, and can be used not only in plant introduction, but also in predicting the distribution of economically dangerous invasive species. The method of climatic analogues for a number of plant groups, including forage plants, does not always work, as N. I. Vavilov (1935) wrote. Therefore, when using the method of donor areas, it is important to create an ecogeographical model using data on the distribution of the species not only in its natural range, but also in its secondary, in which it has realized its ecogeographical potential. Thus, the ecogeographical analysis of the caucasian species *Heraculum sosnowskyi* in the secondary range allowed us to predict its distribution for the territory of the middle taiga of Western Siberia, but does not give a reason to expect it in the North taiga subzone of Western Siberia. At the same time, it is already registered on the Kola Peninsula in the North Taiga subzone.

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NATURALIZED WOODY PLANTS IN THE NORTH OF WESTERN SIBERIA

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Territories of the Yamal-Nenets and Khanty-Mansi Autonomous Areas in the North of Western Siberia have been experiencing intensive industrial development during the last decades; this facilitated the migration of non-native species into the local flora (Byalt et al., 2017; Pismarkina et al., 2020, etc.); including several new for northern Eurasia species (Byalt et al., 2020). However, their dispersal is limited by the severe climatic conditions. This region spreads throughout the tundra and northern taiga zones and the climate is arctic and continental.

The majority of alien species were found during 2012-2019, Therefore we can draw only preliminary conclusions about their naturalization rate and invasive activeness. Woody plants represent only a little portion of alien species. They were used in green landscaping of settlements, in private gardens and experimental plots (Kukurichkin et al., 2014; Egorov et. al., 2020). Growing of woody plants in green plantations takes long time; their ability to survive in unfavorable conditions above the snow cover allows us judge about their degree of naturalization.

Invasive plants which have adapted to local conditions are called "naturalized species" (Baranova et al., 2018). If such species are present among the alien species, they can be potentially hazardous for the local environments and the control of their dispersal is necessary.

Analysis of our results and the results of other authors revealed a certain zonal regularity characteristic for woody plants. In the settlements within the West Siberian forest-tundra, vegetative spread of woody plants (*Sorbaria sorbifolia*, *Spiraea betulifolia)* was recorded at a short distance from the place of planting. By means of introduction these species belong to ergasiophytes – species escaping from cultivation. By degree of naturalization, they belong to kolonophytes – species forming sustainable populations in the area of invasion. In the middle taiga subzone some species spread more actively. In the forested areas around the town of Surgut and around the adjacent settlements and summer cottages, we observed active dispersal of *Amelanchier spicata*, *A. florida*, *Caragana arborescens, Malus prunifolia* and some other species, which we refer to ergasiophytes and epekophytes. However, some species can be conventionally referred to agriophytes. In the tundra zone naturalized woody plants were not recorded. Above-mentioned species usually have a limited distribution within the area, connected with the places of their cultivation. However, *Rubus idaeus*, which can be referred to archaeophytes is wide spread in settlements and their surroundings and its behaviour generally confirms the found zonal regularity of naturalization: in the forest-tundra and northern taiga subzones it belongs to epekophytes (kitchen gardens, wastelands, along the roads), whereas in the middle taiga subzone – to agriophytes (grows in natural forests). Totally, we found 15 naturalized woody species, 2/3 of which belong to the *Rosaceae* family.

The study of naturalization and invasive activeness of alien woody species is important for very sensitive territories of the Far North. It allows define introduction of the potential ecological threats at the early stages and elaborate measures preventing their penetration into the natural communities.

Field work was carried out in 2012-2019 with the support of the Government of the Yamalo-Nenets Autonomous Area, Contract No. 01-15/4, 25.07.2012 and by the Russian Foundation for Basic Research, grant No. 16-44-890088. The data analysis was carried out with the support by the Department of Education and Youth Policy of the Khanty-Mansi Autonomous Region – Ugra, grant No. 10-P-1308 of 4.09.20. Determination and confirmation of herbarium vouchers and analysis of our data and literature were done as a part of the state budget tasks of the Russian Academy of Sciences, Ural Branch: Institute Botanic Garden.

STRUCTURE, COMPOSITION, AND SPATIAL DISTRIBUTION OF THE ALIEN COMPONENT OF THE FLORA OF THE SOUTHERN RUSSIAN BLACK SEA COAST

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The total number of alien species of the southern Russian Black Sea coast, located within the administrative borders of Greater Sochi, is 182, belonging to 53 families. The Amaranthaceae, Asteraceae, and Poaceae families have the most significant number of exotic species (41% of all alien species). The biomorphological structure of the most considerable number of alien species is teraphytes (87) and phanerophytes (56). The vast majority of the studied species are mesophytes (94 species). According to the ways of spreading, most of the considered exotic species are autochores (53%). Most alien species are native to the Americas (41%) and Asia (32%).

According to the results of spatial distribution modeling using MaxEnt and Worldclim data, the study area's bioclimatic conditions are most comfortable only for 74 most aggressive alien species (Fugure).

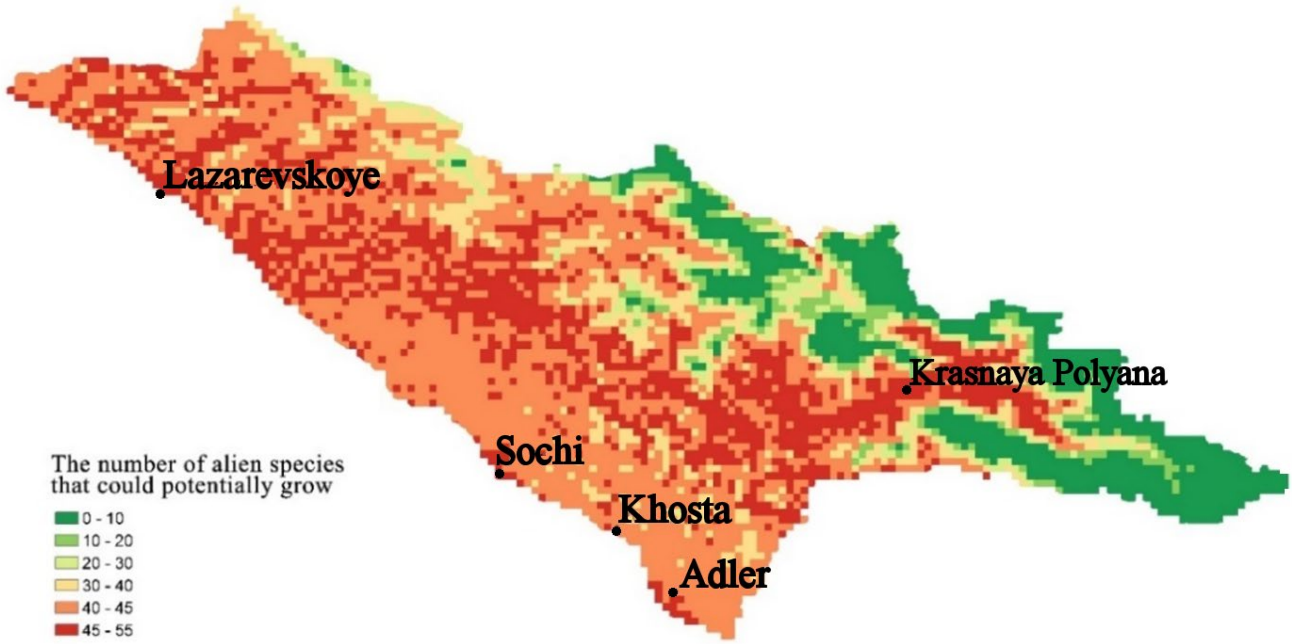

Figure. The vulnerability of ecosystems of Sochi to invasions of alien species.

In general, the climatic conditions of 2050 and 2070 will be conducive to further spreading plant species such as *Ambrosia artemisiifolia* L., *Amorpha fruticosa* L., *Andropogon virginicus* L., *Abutilon theophrasti* Medikus, *Conyza bonariensis* (L.) Cronqist, *Cyclachaena xanthiifolia* (Nutt.) Fresen, *Duchesnea indica* (Andrews) Focke, *Elaeagnus pungens* Thunb., *Euphorbia maculata* L., *Euphorbia nutans* Lag., *Ligustrum lucidum* W.T. Aiton, *Microstegium japonicum* (Miq.) Koidz., *Microstegium vimineum* (Trin.) A. Camus, *Miscanthus sinensis* Andersson, *Oenothera erythrosepala* Borbas, *Oenothera biennis* L., *Oxalis corniculata* L., *Phytolacca americana* L., *Setaria pumila* (Poir.) Roem. & Schult., *Setaria viridis* (L.) P. Beauv. *Trachycarpus fortune* (Hook.) H. Wendl.

According to predictive modeling, the most comfortable for the growth of many currently widespread alien species in 2050 will be the middle-mountain areas of the Great Sochi. Herewith the changed climatic conditions will no longer meet the biological requirements of some contemporary aggressive exotic species. The climatic conditions of the most extreme representative concentration pathway (RCP8.5) will inhibit the spread of all representatives of the current regional pool of alien plant species.

CHANGES IN THE ECOSYSTEM OF THE BELOYARSKOE RESERVOIR (MIDDLE URAL) IN THE CONDITIONS OF FORMATION OF THE POPULATION OF THE INVASIVE SPESIES *DREISSENA POLYMORPHA* (PALLAS, 1771)

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The Beloyarskoe reservoir (BR) is the largest reservoir in the Sverdlovsk Region. It created in 1959-1963. It performs long-term and intra-annual regulation of the Pyshma River (Ob’-Irtysh basin) flow. The main purpose of the reservoir is the technical water supply of the Beloyarsk NPP (BAES). It has a fishery value, is used for sports and amateur fishing, recreation. Area: 34.4 km^2, volume: 242 million m^3, length: 25 km, average depth: 7.03 m, maximum depth: 18.3 m.

Systematic studies of the ecological state of the reservoir have been performed since the 1970s. The oxygen regime in the reservoir is favorable throughout the year. The water is fresh, medium mineralized. The maximum mineralization is 406 mg /dm^3. The reservoir is polluted by household and industrial wastewater discharged into the Pyshma River above the Beloyarskoe reservoir. According to the value of the Carlson TSI_{SD} index (51-70), the reservoir is mesotrophic-eutrophic.

There is no information about the distribution and development of *D. polymorpha* (zebra mussel) in the water bodies of the Sverdlovsk region. In the BR, *D. polymorpha* individuals were first observed by us in July 2018 in the water intake channels of the BAES. Probably, the mollusks got into the reservoir a little earlier with the landing material of the fish. The length of the shells varied from 6 to 10 mm, the average number did not exceed 150 specimens/m^2, the area of the bottom cover was 0.5 % (0.5 dm^2/m^2). The prevailing conditions in the reservoir were very favorable for the development and reproduction of the invasive species. In 2019, *D. polymorpha* has spread throughout the entire water area of the reservoir. The number of mollusks in some areas reached 5240 specimens/m^2, the average for the season-114 specimens/m^2, the biomass-10.58 g/m^2. In the main mass, the size of individuals was 15-18 mm, the maximum - 28 mm. In the unusually warm winter of 2019-2020, the largest zebra mussel individuals successfully wintered in the water intake channels of the BAES. The average number of *D. polymorpha* in 2020 was 501 specimens/m^2, and the biomass was 244.6 g/m^2.

The spread of *D. polymorpha* in the reservoir was accompanied by a number of changes in the ecosystem of the reservoir. Water transparency increased from 0.5-0.6 m in 2018 to 1.5-2.2 m in 2020. This is due to a decrease in the number of phytoplankton (2012 – 78.46 million cells/l, 2018 – 87.37 million cells/l, 2019 – 12.31 million cells/l, 2020-13.7 million cells/l), especially cyanobacteria. In the structure of the number and biomass of the community, diatoms took the place of cyanobacteria. In 2020, the first mass development of *Cladophora glomerata* (Linnaeus) Kützing 1843 was observed in the shallow water zone. The total phytomass of dominant macrophytes increased from 362.1 t in 2018 to 697.4 t in 2019 and 693.5 t in 2020.

The taxonomic list of zooplankton of the Beloyarskoe reservoir, taking into account the literature, archival and own data, includes 55 taxa. In the zooplankton, veliger larvae’s were first identified in May 2020. Their maximum number was 9.3 % of the total number of the community. In 2020, the emergence of phytophilic species increased the diversity of *Cladocera*. Predatory *Copepoda* and *Rotatoria* confined to littoral habitats dominate in terms of number and biomass.

As part of the bottom fauna of the reservoir, there are about 50 species and forms of zoobenthos. The species diversity is dominated by insects (about 20 species). Oligochaetes, leeches, and mollusks occupy approximately equal shares of the total number of species. The introduction of zebra mussel led to a sharp outbreak of the number and biomass of zoobenthos (2018 - 227 specimens/m^2, 2.20 g/m^2, 2019 - 482 specimens/m^2, 15.2 g/m^2, 2020 - 877 specimens/m^2, 245.6 g/m^2). At the same time, 97 % of the total number and 92.1 % of the benthic mass accounted for the mollusks of *D. polymorpha*.

Thus, the introduction of *D. polymorpha* into the BR initiated significant changes in the structure and functioning of the reservoir ecosystem, which require further study.

EPIGENETIC FEATURES OF RAGWEED MORHOGENESIS IN THE WESTERN CAUCASUS

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Adventive plants undergo heterogeneity under new habitat conditions due to abiotic and biotic stress factors. Due to phenotypic plasticity, plants adapt to new environmental factors. The mechanism of their survival under changes in environmental conditions is still little studied. In this regard, the functional reactions of plants to global changes at the ecosystem level are currently being actively explored. It is obvious that organisms with high adaptive plasticity have the ability to survive in new environmental conditions. Long-term study of natural populations will make it possible to understand the response of plants to fluctuations in environmental factors, including climate change. In this regard, it is necessary to analyze variations at the phenotypic and genetic levels for the same species, and especially for adventive organisms, since they can have radical consequences at the ecosystem level in agrobiocenoses.

Phenotypic plasticity involves a change in the phenotype, expressed by one genotype in different habitats. It is likely that phenotypic plasticity is under genetic control and therefore is a subject to selective pressure.

Morphological features associated with phenotypic plasticity reflect genetic correlations well and allow us to consider the phenotype as an integrated function showing a change in the slope of the reaction rate between ancestral and derived populations or species.

Plant plasticity can facilitate the expression of relatively well-adapted phenotypes under new conditions, improving the characteristics of the population and leading to genetic assimilation of the trait under new conditions.

Ragweed, as an invasive plant, is a convenient object for studying phenogenetic variability due to the presence of metameres - leaves. Metameres of one plant, built on the basis of one genotype, allow us to assess the relationship between the role of the genotype and the environment of plant development.

Intraindividual phenogenetic variability can also manifest itself on the left and right sides of metameres - homologous antimeres. When examining the leaves of ragweed, we registered differences on different sides of the metameres, which served as the basis for identifying antimeric variations in the structure of ragweed. It was found that the lateral veins of the leaf branch off from the axial veins quite symmetrically. At the same time, asymmetric metameres appear on the left and right sides of the central submetamer. Protruding veins and denticles are double, positionally they are strict antimeres: symmetrically protruding beyond the edge of the leaf (e1), relatively normal phene; asymmetrically developing on the left (e2), asymmetrically developing on the right (e3).

The realization of protruding veins is the result of a structural transformation. The emerging protruding vein can vary, from small to large sizes, and this is due to the epigenetic processes of morphogenesis of ragweed. The protruding veins can be attributed to the category of a phene - a steady state of a threshold non-metric feature. The length of the leaf blade in plants with the e1 phenotype is 19% longer than e2 and 22% longer than e3. According to the preliminary processed data, it can be claimed that the isolated phenes are morphogenetic modifications.

The appearance of phenes in ragweed, in its new conditions, is associated with the transition to another subprogram of leaf morphogenesis and is caused by compensatory rearrangements, both under the influence of anthropogenic stress and environmental factors.

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ON THE DISTRIBUTION AND GENETIC POLYMORPHISM OF *MARENZELLERIA* SPP. (POLYCHAETA: SPIONIDAE) IN RUSSIAN ZONE OF THE SOUTH BALTIC SEA

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The nucleotide sequences of three mitochondrial DNA (mtDNA) regions, a fragment of the cytochrome oxidase subunit I gene (COI, 329 base pair (bp) in length), a fragment of the cytochrome *b* gene (cyt *b*, 149 bp), and a fragment of the 16S ribosomal DNA (16S rDNA, 323 bp), were studied in representatives of three *Marenzelleria* species: *M. arctia*, *M. viridis*, and *M. neglecta*. The specimens of these species were sampled in the South-Eastern part of the Baltic Sea, Russian Exclusive Economic zone (EEZ). The number of analyzed sequences for each mtDNA marker region is shown in the Table; the number of sequences taken from the Genbank (NCBI) for comparison is given in brackets.

Table. *Marenzelleria* samples characteristics

Species	Sampling area	Date / depth, m	Analysis of genetic polymorphism		
			COI	cyt *b*	16S rDNA
M. arctia	South Baltic, Russian EEZ	July, 2018/25-46	6(2)	7(1)	3(7)
M. neglecta	Vistula Lagoon, Baltic Sea	July 2018,0,5-5,0	(1)	–	9(14)
M. viridis	South Baltic, Russian EEZ	July 2018, June 2017/ 24-38	6(2)	7(1)	7(10)

Analysis of genetic distances between representatives of three *Marenzelleria* species revealed a greater similarity for *M. viridis* and *M. neglecta*. Thus, for COI sequences of these species T92-distance was 0.140, while for *M. arctia* and *M. viridis* the distance was 0.209, and for *M. arctia* and *M. neglecta* – 0.183. For 16S rDNA sequences, we revealed the same picture: genetic distance for *M. viridis* and *M. neglecta* equaled to 0.021, for *M. arctia* and *M. viridis* – 0.077, and for *M. arctia* and *M. neglecta* – 0.073. These data indicate close relationship of *M. viridis* and *M. neglecta*, and support the point of view of Sikorski & Bick (2004), who combined, in a part, these species into a new one, *M. neglecta*, basing on morphology. Results of morphological and genetic identification of *Marenzelleria* species does not always identical. For example, among seven individuals identified as *M. arctia* in accordance with morphological criteria, four worms were recognizesd as *M. viridis* according to analysis of polymorphism of mitochondrial 16S rDNA. This fact indicates the need for a more detailed study of the diagnostic criteria of these very closely related species., as well as their ecology and features of the spatial distribution in the regions of its introduction.

Analysis of the polychaetes spatial distribution based on genetic data, has shown, the area of distribution of three species are not overlapping. In the Russian South-Eastern Baltic, *M. neglecta* inhabits the Vistula Lagoon only, *M. arctia* is found closer to the Russian-Lithuanian border, and *M. viridis* is marked in the more western part of Russian EEZ.

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ALIEN AMPHIBIAN SPECIES OF RUSSIA: STATUS AND RESEARCH PERSPECTIVES IN THE ACQUIRED PART OF THE RANGE

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Changing ranges leads to transformations of structural and functional relationships in the ecosystem. The reduction in the range caused by the extinction of populations (Mack et al., 2000) will also contribute to a change in trophic connections and disruption of the circulation paths of parasites in biocenoses.

To date, the study of amphibians as alien species on the territory of the Russian Federation has achieved significant success. The marsh frog Pelophylax ridibundus (Pallas, 1771) is an amphibian species that significantly expands its range on the territory of Russia. The species is included in the list "The most dangerous invasive species in Russia (Top-100)" (Petrosyan et al., 2018). The acquired range of the marsh frog includes the Middle Urals - Sverdlovsk (Vershinin, 1983; 1990; 1997, 2007; Fominykh, 2009), Chelyabinsk (Fominykh et al., 2016) and Kurgan (Fominykh, 2010) regions; the Altai Republic and Altai Krai (Yakovlev, 1987, 1999; Yakovlev, Leukhina, 1999). The species was recorded in Novosibirsk region (Borisovich et al., 2002), as well as in Tomsk region (Vozniychuk, Kuranova, 2008), Krasnoyarsk Krai, the Republic of Khakassia (Gorodilova, Chibiryak, 2007; Gorodilova, 2010) and in Kamchatka (Lyapkov, 2014). The geographical distribution has been established, the history of formation of the "donor" populations of the marsh frog in the Middle Urals (Bolshakov and Vershinin, 2005; Vershinin, 2007; Ivanov, 2019) and in Kamchatka has been partially revealed (Lyapkov et al., 2017). The facts of the introduction of the marsh frog into the city of Gorno-Altaysk from the Osh region of Kyrgyzstan were noted. (Yakovlev, 1987). The features of the life cycle of the marsh frog in the Middle Urals (Fominykh and Lyapkov, 2011) and the state of populations in water bodies with varying degrees of anthropogenic transformation under the conditions of Kamchatka were studied (Romanova et al., 2020).

The composition of the marsh frog parasites was analyzed under the conditions of the Middle and Southern Urals (Burakova et al., 2014; Vershinin et al., 2017; our data), in particular, the population of Chelyabinsk (Zaripova and Fayzulin, 2016). Due to the forthcoming taxonomic revision of the marsh frog, the presence of "eastern" and "western" forms differing in nuclear and mitochondrial DNA markers, the status of the "marsh frog" in the invasive part of the range will require revision (Ivanov, 2019).

We also studied a unique population of the common frog (*Rana temporaria* Linnaeus, 1758), introduced to Kamchatka only 16 years ago (Lyapkov, 2016; 2018; 2019). We also showed that despite the strong limited duration of activity season (2 months shorter than in the "donor" population from Moscow region), this population not only supports, but also successfully increases its number and distributes.

Isolated populations of the green toad *Bufotes viridis* (Laurenti, 1768) in Western Siberia (Tomsk and Novosibirsk regions) were probably formed as a result of introduction (Zolotarenko, 1985; Kuzmin, 2012; Dufresnes et al., 2019). In general, the history of the formation of amphibian populations in the acquired area requires further study.

One also requires further study of the features of biocenotic relationships - nutrition, including larvae, the composition of consumers and the study of parasites of alien species of amphibians – marsh and common frogs, as well as the green toad. The data obtained will make it possible to assess the extent of distribution and the degree of influence of these on aboriginal ecosystems.

THE NATURE OF THE FILARIA NEMATODES DISTRIBUTION IN THE TOMSK REGION ANOPHELES POPULATIONS

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Transmissible dirofilariasis is a helminthiasis caused by the filarial nematodes *Dirofilaria repens* and *D. immitis* (Spirurata, Onchocercidae) that affects domestic and wild predators, sometimes humans. More than 70 species of blood-sucking mosquitoes (Diptera, Culicidae) are considered to be intermediate hosts and main vectors of dirofilariae. In the past few decades there has been a significant expansion of the parasite's areal and its movement to the northeast from endemic regions: the number of local transmission cases of the invasion in dogs and humans in the temperate zone is increasing. In Western Siberia the first case of dirofilariae local transmission in Novosibirsk was recorded in 1998 (Konyaev, 2019) and in Tomsk region autochthonous invasion was registered in 2016 (Poltoratskaya et al., 2016). Despite the north expansion of dirofilariasis became evident (Poltoratskaya et al., 2018) the composition of intermediate hosts species in the Tomsk region has been poorly studied. The effectiveness of Anopheles mosquitoes as vectors despite its close proximity to humans has not been studied at all. Obtaining information of malaria mosquitoes Tomsk populations infected by dirofilaria larvae is an important stage of understanding the nature and rate of parasite spread to the north and western Siberia as well as the peculiarities of its adaptation to local climate conditions.

From 2018 to 2020 we have been analyzed 64 samples from 36 settlements of the Tomsk region. Southernmost collection point - координаты (Kozhevnikovo village), northernmost - 60°44' (Strezhevoy city). In total 7058 female malaria mosquitoes were studied, 163 of which were infected. Infected females were found in 21 settlements out of 36 analyzed. Thus, the extent of invasion in the samples varied from 0 to 8.3 %. The intensity of invasion was from 1 to 100 or more microfilariae per female mosquito. 152 samples were identified as *D. repens* and 4 as *D. immitis*. Three female mosquitoes were infected with both species of dirofilariae.

There are four species of malaria mosquitoes on the territory of the Tomsk region: three species from the maculipennis complex (*An. messeae*, *An. beklemishevi*, *An. daciae*) and one from the claviger complex (*An. claviger*). *An. messeae* and *An. daciae* were previously noted as dirofilariae vectors in Europe (Shaikevich et al., 2019) which was confirmed in our study for West Siberia. For the first time we have discovered the ability to transfer dirofilariae by *An. beklemishevi* in Bolshaya Griva village on 58° 55'. *An. claviger* has been found in single specimens which makes it difficult to assess its importance as an intermediate host. Up to 57 degrees of the northern lattitude *An. daciae* is a dominant species, to the north all three species of the maculipennis complex were found. The infection rate (4.9 %) of the second the most widespread mosquito - *An. messeae* (24-27 %) was significantly higher than (1.6 %) of the first *An. beklemishevi* (57-61 %). The significance of *An. daciae* is lower in comparison with *An. messeae* in occurrence (12-19 %) as well as invasion (3.2 %). We observed following vector-parasite pairs: 66.9 % *An. daciae* and *D. repens*, 21.2 % *An. messeae* and *D. repens*, 9.3 % *An. beklemishevi* and *D. repens*, 1.3 % *An.daciae* and *D. repens* and *D. immitis*, 0.7 % *An. messeae* and *D. immitis*, 0.7 % *An. beklemishevi* and *D. immitis* and *D. repens*.

Invasion of dirofilariae was detected in nothermost point of our study in Strezhevoy city. The infectious stage of *D. repens* microfilariae was noted for *An. daciae* and *An. beklemishevi*.

Accordingly to our study, dirophilariae are ubiquitous on the territory of the Tomsk region, which indicates their successful adaptation to the local populations of vectors and climatic conditions. This circumstance makes the prerequisite for expansion of invasive species of parasitic nematodes even further to the north, which is also facilitated by the warming of the climate in Western Siberia observed in recent decades.

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INVASIVE SPECIES IN THE BOTTOM FAUNA OF IRICLA RESERVOIR (URAL RIVER)

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Irikla Reservoir is of floodland-valley type, made in 1960 in the upper flow of Ural River with help of filling the Irikla gorge with water. According to the adopted zoning, it is divided into 7 wider parts of the Reservoir in the mouths of the tributaries large reservoir bays are formed. Annual lowering as a result of human activity from 3 to 6 m., extremely uneven distribution of intra-annual and inter-annual drainage is characteristic, water exchange is once a year like in a lake of weak flow (Solovych, Raimova, Osadchaya, 2003; Sivochip et al., 2018; Shashoulovskaya et al., 2020).

Monitoring of macrozoobenthos which we have been carrying in Irikla Reservoir from 2009 to 2020 in shallow waters and profundal zones in five wider parts of the Reservoir and three largest reservoir bays allowed doing inventory of invasive species. The value of introduced species in the transformation of macrozoobenthos according to changing water balance and in the conditions of accelerating succession in the part of river regulated by dam is revealed. Also, spatial distribution of populations of leading invasive species is studied and their part in forage capacity of the reservoir is revealed.

In structure of fauna 9 invasive species were identified including: regional – *Gammarus lacustris,* Sars, 1863, of Ponto-Caspian fauna – *Paramysis (Mesomysis) lacustris* (Czerniavsky, 1882), *P. (M.) intermedia* (Czerniavsky, 1882), *P. (Metamysis) ulsskyi* Czerniavskiy, 1882, *Chelicorophium maeoticum* Sowinsky, 1898, *C. curvispinum* Sars, 1895, *Dreissena polymorpha* (Pallas, 1771), Baical subendemics – *Gmelinoides fasciatus* (Stebbing 1899) and *Micruropus possolskii* Sowinsky, 1915. It can be traced from the history of introducing benthic invertebrates into Irikla Reservoir (Grandilevskaya–Deksbach, Eryomenko, Shilkova, 1978) that most of the given species are introduced species, 4 of them – *P. (M.) ullskyi*, *C. maeoticum*, *C. curvispinum* and *D. polymorpha* – were first described by us for the reservoir (Filinova, 2018; 2020; Kolozin, Filinova, Meleshin, 2021) are most evidently invasive species, came by chance in the process of acclimatisation procedures during the reconstruction of fishing ichtyofauna and food supply of benthic feeding fish. According to frequency rate Baikal gammarids were leading among the invasive species, with all other Peracaridae met rarely.

Before 2019 in reservoir bays and in wider parts the basic macrozoobenthos was represented by native larvae of chironomids (mostly detritivores – tappers) and oligohaetes (detritivores - swallowers), larvae *Chironomus* gr. *plumosus* (Linnaeus, 1758) dominated in general quantitative indicators. Maximum incumbency and biomass rates were registered in profundal zones on benthic muddy sediments. Reduction of annual variability in water levels in Irikla Reservoir during the period of operation since 2009 up to present moment resulted in appearance in large bays of biotopes which are inhabited by higher aquatic flora (HAF) and favourable for Baikal gammarids. Increasing density of population of *G. fascistus* and *M. possolskii* was registered in bays, in parts from water's edge to 2.5 m isobath. In the given biotope number of Baikal invasive species made 7% of overall figure and biomass accordingly was 12 %. During the years when the water regime was optimal at benthic biotopes where filamentous green algae grow number of phytophilic omnivorous *G. fasciatus* in bays reached during a year 650 per square meter, biomass 2,4 grams per square meter. In reaches/stretches distribution of all pericaridaes was no higher than 1%. *D. polymorpha*, first registered in 2019, in 2020 have displaced Baikal gammarids from leading position in invasive group and have become widely dominant in benthic fauna. In bays they made 30 % of total number and 80 % of biomass, in reaches/stretches 18% and 20% respectively. Maximum quantitive development indicators were registered in intertidal zones of bays and reaches/stretches, as far as *D. polymorpha* have inhabited stony areas of open shallow water, decaying parts of HAF and remains of riparian vegetation which got into water.

Under changed environmental conditions significant changes have taken place in trophic structure: since 2020 Dreissena detritivores – filtrators are dominating trophic group. As a result of introduction of *D. polymorpha* overall biomass has increased at ten times. In macrozoobentos without Mollusca decrease of infauna biomass – fnnelid worms in bays in 2019 – 2020 – was offset by development of population of epifauna Baikal invaders species.

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MUD CRAB *RHITHROPANOPEUS HARRISI* (GOULD, 1841) - AS A COMPONENT OF THE HYDROFAUNA OF THE KUCHURGAN RESERVOIR-COOLER OF THE MOLDAVIAN POWER STATION

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The mud crab *Rhithropanopeus harrisi* (Gould, 1841) is an invasive species that is widespread in coastal marine and brackish water ecosystems of the European continent. On the territory of Moldova, the mud crab was first observed in the Cuciurgan reservoir-cooler of the Moldavskaya TPP in 2016, when one individual of the crab was accidentally caught. The second specimen was caught in 2017. The first 2 specimens of the crab *Rh. harrisii* caught in the Kuchurgan reservoir in 2016 and 2017 had the following dimensions: carapace length - 17 and 13.6 mm, carapace width - 22 and 18.1 mm, carapace height - 9.5 and 6.7 mm, claw length - 17 and 14.1 mm, claw width - 9 and 6.7 mm, claw height - 6 and 4.4 mm respectively (Philipenko, 2018).

In 2019-2020 56 mud crabs were caught in the reservoir. All individuals were weighed with an accuracy of 0.1g and measured according to 8 morphometric parameters with an accuracy of 0.1 mm: body length without claws, claw length, claw height, claw width, carapace width, carapace height, abdominal length and abdominal width.

The mass of crabs varied from 0.1 to 4.4g. The average morphometric parameters were: body length without claws - 14.5 mm, claw length - 21.1 mm, claw height - 7.5 mm, claw width - 4.9 mm, carapace width - 17.6 mm, carapace height - 8.3 mm, abdominal length - 10.4 mm, abdominal width - 8.5 mm. The minimum and maximum values of the morphometric parameters of the mud crab of the Kuchurgan reservoir are presented in Table.

Table. Morphometric parameters of the mud crabs of the Kuchurgan reservoir

	Body length without claws	Claw length	Claw height	Claw width	Carapace width	Carapace height	Abdominal length	Abdominal width	Body weight, g
minimum	5,6	6,2	2,2	1,3	7	3,1	4,5	3,1	0,1
maximum	19,8	32,8	13,3	10,2	25	13,8	17	14,9	4,4
average	14,5	21,1	7,5	4,9	17,6	8,3	10,4	8,5	2,1

The morphometric parameters of individuals indicate favorable habitat conditions for the crab in the Kuchurgan reservoir. The linear dimensions of the crabs make it possible to assert this. For example, maximum width of the carapace of the Dutch crab of the Kuchurgan reservoir is 25 mm. For comparison, the same maximum parameter for crabs from the Taman Bay and the Vulan River is 23.9 mm (Zalota et al., 2016). Data on the size composition of *Rh. harrisi* in the literature show that the maximum size of crabs in the Baltic waters of Poland is up to 26.0 mm; in the Gulf of Finland - 22.0 mm. Interestingly, in their home range (Gulf of Mexico, Louisiana), males over 18 mm and females over 16 mm have not been recorded (Zalota et al., 2016).

Thus, the habitat conditions of the mud crab in the Kuchurgan reservoir (thermal regime and a high degree of mineralization of 1.6-1.9%, which are within the tolerance range of this species) are favorable for this new euryhaline invasive species, as evidenced by the rather large linear dimensions his body. Based on the increase in the number of mud crab in the Kuchurgan reservoir and its linear dimensions, it can be argued that this invasive species entered the structure of the hydrobiocenosis of the reservoir. Taking into account the limits of water mineralization for the normal existence of the mud crab, it can be argued that on the territory of Moldova, the Kuchurgan reservoir will remain the only reservoir where this invasive species can create a stable population.

ADENOCAULON ADHAERESCENS AND *A. HIMALAICUM* – DIFFERENT SPECIES, ECOLOGICAL FORMS OR SYNONYMS?

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Adenocaulon adhaerescens Maxim. – is an East Asian species that is invasive in the European part of Russia. Currently, foreign botanists consider *A. adhaerescens* synonymous with *A. himalaicum* Edgew, and this information is listed in international databases (POWO, GBIF, the PlantList, Tropicos). In our opinion, it is incorrect to say that they are synonyms, as the morphological differences allow us to consider *A. adhaerescens* as at least a special ecological form of *A. himalaicum* (fewer glands on the upper leaf veins, gray rather than white pubescence on the lower leaf side).

We isolated DNA from the leaves of 27 plant samples of the genus *Adenocaulon* (Aa 1-3, 14, 15 – *A. adhaerescens* from 4 populations in Moscow; 10, 11 – from 2 populations in the Moscow oblast; 4-6, 12 – from 4 populations in the Far East; Ah 7-8, 13 – herbarium specimens of *A. himalaicum* from Japan and Nepal), and we also included in the data analysis 8 specimens from the GenBank database collected by botanists from China (Ah 16-21 – *A. himalaicum* and An 22, 23 – *A. nepalense*). Site ITS1–2 analysis showed the identity of *A. adhaerescens* individuals from different parts of the area. However, specimens of *A. adhaerescens* have significant differences with specimens of *A. himalaicum* from Nepal, China and Korea, and only two nucleotide substitutions differentiating them from *A. himalaicum* from Japan.

Further data processing in the TCS program (parsimony method) showed that all samples formed 4 haplotypes (Figure). The first haplotype (1) included all *A. adhaerescens* plants. Another large haplotype (3) included specimens of *A. himalaicum* from China, Korea and Nepal as well as *A. nepalense*. Haplotype 4 is represented by a single sample of Ah13b and is very close to haplotype 3. Haplotype 2 occupies an intermediate position and is represented by two specimens of *A. himalaicum* from Japan. Thus, interspecific differences between *A. adhaerescens* and *A. himalaicum* in the structure of the ITS1–2 nuclear site exceed the interspecific differences between *A. himalaicum* and *A. nepalense*.

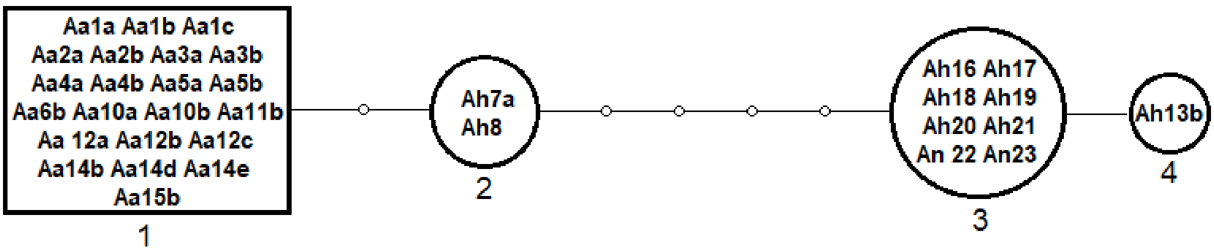

Figure. The haplotype network based on ITS1–2 data.

Chloroplast DNA analysis (non-coding intergenic spacers *rpl*32–*trn*L and *trn*H–*psb*A) confirmed the results, except for one sample of *A. himalaicum* from Korea (Ah 21), which was in the same haplotype with samples of *A. adhaerescens.* These species are related and some areas of chloroplast DNA may be the same, a situation also observed in other closely related species.

In summary, the differences between *A. adhaerescens* and *A. himalaicum* are no less than between two other different species of the genus *Adenocaulon*: *A. himalaicum* and *A. nepalense*. Thus, *A. adhaerescens* can be considered as an independent species.

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INVASION OF *CHYDORUS SPHAERICUS* SPECIES COMPLEX TO AUSTRALIA

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Cladocerans are among dominant invertebrates in the continental waters of the Planet. Gamogenetic females of the order Anomopoda form the ephippia = modified moulting exuviae which protect resting eggs from unfavorable external conditions. Ephippia are able to be transported over great distances by wind, different animals (birds, mammals) and even humans. Just anthropogenic-mediated invasions are a potential threat to native ecosystems. Cladocerans are known among such invaders. Our aim was to study the colonization of Australia by populations the *Chydorus sphaericus* groups.

We analysed 254 sequences of the cytochrome oxidase I region (*COI*) from different regions of the world. Among them, 251 sequences belong to the *C. sphaericus* complex. The Australian populations belonged to two different clades: The first clade (A1) is also widespread in Europe, Greenland, and Eastern Siberia. The second clade (A3) is also widespread from Eastern Siberia to the North and South Far East. Because Australia was separated from North America and Eurasia since the Mesozoic and the speciation in the of clade A took place in the Middle Caenozoic, we need to exclude any vicariant scenarios explaining the presence of A1 and A3 clades in Australia.

There is no other realistic explanation for the A1 clade appearance in Australia rather than anthropogenic introduction from Europe. This clade was found in reservoirs of artificial origin (reservoirs for breeding rainbow trout) in Australia. But the distribution of clade A3 correlates well with “the East Asian-Australasian Flyway” (EAAF) of bird’s migrations. Most likely, just migratory birds were the vector of this clade dispersion from the Holarctic to Australia.

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FIRST OCCURRENCE OF FRESHWATER BRYOZOAN *PECTINATELLA MAGNIFICA* (LEIDY, 1851) IN VUOKSI RIVER SYSTEM, KARELIAN PENINSULA, NW RUSSIA

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Invasion of alien species is among of key problems for aquatic habitats. In some cases, alien species inhabit new habitats very fast and successfully. However, for many alien species, a little is known about their recent distribution as well as their biology in the new environment. Nevertheless, this information is important for revealing potential interactions with indigenous organisms and for understanding the potential of alien species for further invasion. For freshwater benthic communities, invasion of an alien species quickly reaching high densities and biomass may be a crucial factor. A freshwater bryozoan *Pectinatella magnifica* (Leidy, 1851) (Bryozoa: Phylactolaemata) is one of such examples. *P. magnifica* is an autochthonous species characteristic of lentic areas, such as sluggish rivers and outflows from lakes. It was originally described from the area near Philadelphia (North America). Although it was registered in Europe a little later (in 1883, near Hamburg), many authors did not doubt that this species was accidentally introduced into Europe. For rather a long time, it was documented from Germany (the river basins of the Elbe and Oder) and Poland (Wrozlaw). However, last ten years a massive spread of *P. magnifica* (Leidy, 1851) was registered in different European regions, including Finland where it was registered in Saimaa (Vuorio, 2018), close to the border with Russia.

In July 2019 we registered numerous large colonies of P. magnifica in Vuoksi river system, close to Romashki village (60.7503 N, 29.7910 E). The project cover of different substrates, particularly coastal reed beds was nearly 95%, while only minor colonies were observed between boulders. While data on structure of benthic communities in Vuoksi river system are scarce, *P. magnifica* has never been previously registered in the river below the Saimaa lake system. So this is the first discover of P. magnifica in Russia. Also, further studies did not revealed presence of P.magnifica in the main stream of the Vuoksi river (162 km long). We suggest that recent spread of P.magnifica in Europe is correlated with the ongoing climate change, as this species is a thermophile organism.

There is little information about possible modes of dispersal in P. magnifica though two modes are most likely: (i) by transport along rivers on boats or with water animals; (ii) between water reservoirs by water birds. P. magnifica has floatblasts with big anchors which enable them to attach to different water objects (from boats to the feathers of birds). It was also shown that about one third of swallowed floatblasts of this species passed through the digestive system of Anas platyrhynchos unharmed. Since statoblasts were recorded in stomachs of many fishes, it is also likely that P. magnifica is spread by introducing young fish into rivers and ponds.

Further investigation of this species in the Vuoksi river system seem to be very useful for our understanding of the impact of invasive alien on the structure of indigenous benthic communities.

POND SLIDER *TRACHEMYS SCRIPTA ELEGANS* WIED, 1838 – INVASIVE SPECIES IN DAGESTAN

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Conservation of biological diversity is a global environmental problem of our time. Introduced species are one of the reasons for the decline in the biodiversity of natural ecosystems. They promote interspecific hybridization and transgenic transfers, suppress or displace autochthonous species, contributing to the transformation of zoocenoses. Reptiles are an essential and most vulnerable component of ecosystems. Among them, one of the threatened groups are the turtles (Testudines). In the literature, there are isolated cases of invasion or reintroduction of representatives of this group (Branch, 1991; Gibbs et al., 2008). An exception is the subspecies of the pond slider, *Trachemys scripta elegans*, which in recent decades has penetrated the fauna of countries of almost all continents (Warwick, 1991; Bringsoe, 2006; Pendelbury, 2007). Penetration of the pond slider into the natural ecosystems of Dagestan may lead to a reduction or destruction of the autochthonous populations of two species of freshwater turtles - *Mauremys caspica* and *Emys orbicularis*. In recent years, the pond slider has been sold in pet shops in Dagestan and there are cases of its release into natural reservoirs. Locals actively buy it for captivity. They are attracted by the bright color and miniature size of the turtles. As a rule, sellers misinform buyers, passing them off as a dwarf species. In captivity, turtles grow rapidly and their maintenance of large individuals becomes problematic. The owners lose interest and try to get rid of them, releasing them into ponds and all kinds of reservoirs in the vicinity of settlements. In April 2018, we found a mature pond slider in irrigation canals in the vicinity of Kaspiysk (-15 m above sea level, 42º52′17.37″ N, 47º36′41.84″ E). According to observations, it has adapted well to living in its natural environment. We also observed sexually mature turtles kept in the terrarium of the Department of Zoology and Physiology of the DSU in the period from 2017 to 2019. Three sexually mature individuals were kept here, the sizes of their carapaces were: 13, 15 and 16 cm. All turtles survived three wintering periods. The period of their activity was 4-5 months a year. They ate gammarus, sprat and fish food. During their captivity, the turtles did not breed. When the *E. orbicularis* and *T. s. elegans* were kept together, the latter behaved aggressively. The two were separated after the *T. s. elegans* bit and cornered the *E. orbicularis*. We do not yet have data on the influence of the pond slider on the autochthonous turtle species in the region. However, with the massive release of invasive species in the vicinity of large populated agglomerations, the impact on the populations of native turtle species is possible. There are reports in the media about the mass release of this turtle in other regions of the Russian Federation (for example, in the Republic of Kabardino-Balkaria, in Moscow and the Moscow region). In this connection, it is necessary to monitor water bodies in the vicinity of large settlements in the region, as well as to think over measures for collecting and keeping released turtles in captivity. In order to minimize its spread and impact, it is advisable to carry out activities to identify such cases, as well as to inform the population through the media about invasive alien species and their negative impact on natural ecosystems. It is necessary to develop recommendations for amendments to local environmental legislation for the preservation of natural ecosystems and autochthonous species.

INVASIVE VASCULAR PLANTS IN THE ISLAND ECOSYSTEMS OF THE BALTIC SEA

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Island ecosystems of the Baltic Sea are vulnerable to the introduction and rapid spread of alien species due to a constant drift of plant diaspores to the islands, mainly by means of anthropochoria, hydrochoria, and ornithochoria. Open seashores are very favorable for alien species, where they meet little competition from native species.

The study and monitoring of invasive plants in the ecosystems of the Baltic Sea have been carried out during the last 30 years. The study area comprises about 300 islands and islets of the Gulf of Finland varying in their size from 1 to 5000 ha. As a result of the research, 29 invasive vascular plant species have been recorded. The species invasiveness status (IS) was evaluated based on the level of ability of invasive species to affect natural ecosystems and on the peculiarities of their dissemination (Notov et al., 2011). One species (*Rosa rugosa*) can be evaluated as a transformer (IS 1), spreading widely along the seashores of the islands and forming single-species dense plant communities on sandy, gravely or stony shores. The species has several ways of spreading seeds (hydrochory, ornithochory, anthropochory, and vegetative reproduction by rhizomes), all of which have contributed to its naturalization and active spreading in the Baltic Sea area. Seven species (*Amelanchier spicata, Sambucus racemosa, Matricaria discoidea, Hippophaë rhamnoides, Heracleum sosnowskyi, Juncus tenuis, Aster novi-belgii*) are classified as invasive plants with IS 3, currently spreading and naturalizing mainly in disturbed habitats on the islands. 13 invasive species of the islands (*Aster × salignus, Erigeron canadensis, Elodea canadensis, Schedonorus arundinaceus*, *Epilobium adenocaulon, E. pseudorubescens, Bidens frondosa, Impatiens glandulifera, I. parviflora, Saponaria officinalis, Lepidium latifolium, Calystegia spectabilis, Lupinus polyphyllus)* have IS 2, actively spreading and becoming naturalized within disturbed, seminatural and natural habitats. Seven species (*Acer negundo, Aronia mitschurinii*, *Cotoneaster lucidus, Sorbaria sorbifolia, Galinsoga parviflora*, *G. quadriradiata, Oenothera rubricaulis, Helianthus tuberosus)* are potentially invasive species (IS 4), which are able to spread within places of introduction or behave as invasive species in adjacent regions.

Some species (*Calystegia spectabilis*, *Elodea canadensis, Hippophaë rhamnoides*) have invaded only Kotlin Island and the mainland coast, the others have spread and completely naturalized on many islands of the Baltic Sea. The most active invasive species on the islands are those of the North-American origin (e.g., *Epilobium adenocaulon*, *E. pseudorubescens*, *Erigeron canadensis*), as well as some species originated from Asia (e.g., *Rosa rugosa* and *Impatiens glandulifera*).

Among invasive species of the islands, 15 (e.g., *Aster × salignus A. novi-belgii*, *Impatiens glandulifera*, *Saponaria officinalis*, *Lupinus polyphyllus, Hippophaë rhamnoides*) are naturalized escapees of cultivation, introduced to the islands of the Gulf of Finland as ornamental or food plants.

Many invasive species have reached the islands of the Gulf of Finland only in the last 15-20 years and continue their invasion to coastal plant communities. Thus, a very aggressive North-American invasive species *Bidens frondosa*, invaded and even transformed natural plant communities in a great part of the Eastern Europe, was found for the first time in NW Russia on Kotlin Island in 2004 (Glazkova, 2005), spread rapidly through the island, and in 2006 reached the mainland coast. In 2018, it was found on a small island Verperluda and was first discovered at a considerable distance from the sea coast in St. Petersburg (Doronina et al., 2018; Belekhov, 2019). *Lepidium latifolium*, native on the seashores of Atlantic Europe, but alien in NW Russia, was found in 2005 on Kotlin Island in ruderal places (Glazkova, Tzvelev, 2006), and in 2012 it was recorded already on a small island Khanheloda in the Gulf of Finland, where it naturalized on seashore meadows (Glazkova, Doronina, 2013). In 2016-2017, *Lepidium latifolium* reached Severny Berezovy Island, Moschny Island and the Kurgalsky Peninsula, invading seashore plant communities (Glazkova, 2017, 2018).

An increase in the number of invasive and potentially invasive species on the islands of the Baltic Sea requires further study and monitoring of alien flora to prevent the negative impact on the islands' natural ecosystems.

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DISTRIBUTION OF SOME ALIEN PLANT SPECIES AT THE NORTHERN BORDER OF THE RANGE IN WESTERN SIBERIA

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The territory of the north of Western Siberia remained poorly untapped by people for a long time. The natural complexes have been preserved in an almost untouched state. Oil- and gasfields were discovered in the northern and central parts of Western Siberia in the middle of the XX century. There has been started construction of linear objects, large cities and towns. That has contributed to huge changes and emergence of new plant species of decades.

There are two ways in which new species of plants can appear and moving them north on disturbed ecotopes:

1) introduction, usually associated with recultivating industrial wastelands (quarries, drill sites, road embankments etc.);

2) independent dispersal of species with adaptive properties and potential ability to expand the geographical area.

In the first case, they are species in the composition of grass mixtures for vegetation restoration (mostly cereals) and random species whose seeds are present in some quantity in the grass mixtures as an impurity. Cereals form stable community wich limited by the area of the disturbed site. In most cases, random species are observed only in the first year of vegetation. The basis of grass mixtures used in the north of Western Siberia is most often *Festuca rubra* L. and *Bromopsis inermis* (Leyss.) Holub. Such cereal communities are widespread in forest tundra (66-66,5°N) on recultivated drilling sites. *Galium mollugo* L., *Melilotus officinalis* (L.) Pall., *Puccinellia hauptiana* Krecz. are constantly present in cereal communities. Species such as *Achillea millefolium* L., *Tanacetum vulgare* L., *Oberna behen* (L.) Ikonn., *Trifolium hybridum* L., *Chenopodium album* L. and others are found on reclaimed sites up to 67-67,5° N.

In 2019, we carried out experiments on the reclamation of sandy areas near the village of Yar-Sale (Yamal Peninsula, 67° N) with grass mixtures from *Secale cereale* L., *Hordeum vulgare* L., *Bromopsis inermis* (Leyss.) Holub and perennial grasses. All cereals of the grass mixture germinated and developed successfully during the growing season. In most cases, alien species are replaced after a while by local synanthropic species.

Along the embankment of a relatively recently built road from Urengoy to Tazovsky, *Achillea millefolium* L., *Alopecurus pratensis* L., *Galium mollugo* L., *Pimpinella saxifraga* L., *Potentilla norvegica* L., *Lathyrus pratensis* L. and other plants (more than 40 alien species) are spreading to the north.

Some alien species are introduced intentionally when used as decorative plants. *Hordeum jubatum* L., found in cities and villages near the border of the forest-tundra and northern taiga (65.5-66° N), was specially introduced and planted by local residents in the Samburg village (67° N). Then the species began to settle in the disturbed areas on its own. Pine trees (*Pinus sylvestris* L.) were planted in Yurkharovo and Novozapolyarny (66.5-67.5° N, subzone of southern tundra) near buildings. In the local absence of permafrost, pine successfully overwinters.

In most cases, the independent dispersal of invasive species occurs along railways and highways, pipelines, and power lines. In recent years, an example is the active advance in the northern direction of the steppe asian species *Taraxacum stenolobum* Stschegl. At present, along the railway embankments, the species reaches up to 66° N (Pangody). The presence of sewage ditches in settlements beyond the Arctic Circle contributes to the emergence and mass development of *Lemna turionifera* Landolt (Yar-Sale, 67° N) and *Lemna trisulca* L. (Tazovskiy, 67° N). The northernmost location of *Lemna trisulca* is a floodplain lake near Bovanenkovo village (Yamal Peninsula, 70° N).

GENETIC DIVERSITY OF THE GENES COI AND THE *CYT B* OF THE WESTERN TUBENOSE GOBY IN THE BELARUSIAN PART OF THE CENTRAL INVASION CORRIDOR

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In recent decades, the introduction, establishment, and spread of alien fish species has become increasingly significant worldwide, of which Ponto-Caspian gobies (family Gobiidae) are an example. The natural range of these species includes the littoral zones and bays of the Aegean, Marmara, Black, Caspian, and Azov seas, estuaries, and coastal lakes. In the second half of the 20th century, the range of many species of gobies expanded. The main rivers of Belarus belong to the Central European invasion corridor connecting the basins of the Black and Baltic Seas. This corridor has played an important role in the distribution expansions of non-native species, including gobies, from the Ponto-Caspian region to European water bodies. In Belarus, specimens of *Proterorhinus* were discovered in the Pripyat River in 2007 by Rizevsky et al., which were mistakenly documented as *P. marmoratus* (Pallas, 1814). However, it was clarified using molecular genetic methods that the samples in the Central European Corridor are *P. semilunaris* (Heckel, 1837). Important characteristic of alien species is genetic structure of alien populations. The study of phylogenetic, genetic diversity and evolutionary processes helps to understand and predict the dynamics of dispersal of alien species and their successful survival. Such studies have never been carried out in Belarus. At the same time, comprehensive study of the process of invasions is an important task, because Belarus is a trans boundary territory for alien species.

Samples from the Central European invasion corridor were collected in 2016–2019 using hand nets and fishing rods, immediately fixed in 96% ethanol. Samples from other invasive area and native area were took from BOLD and GenBank. Genomic DNA was isolated from caudal muscle tissue using a Blood-Animal-Plant DNA Preparation Kit (Jena Bioscience). Parts of the COI and *cyt b* genes were amplified using the primers for Gobiidae. Analysis of results was made using MEGA7, PopArt and DnaSP 6 programs.

In total, 60 samples gene COI and 62 samples gene *cyt b* of *P. semilunaris* were studied to analyze genetic variability in native and alien populations. Analysis of the data on the genetic diversity of the COI and *cyt b* genes showed same results. Samples from the Belarusian part of Central Invasion Corridor are characterized high haplotype diversity (Hd – 0.713 for COI and *cyt b* genes) and low nucleotide values (π – 0.0043; 0.0055 for COI and *cyt b* genes respectively). Nine haplotypes of the COI gene and twenty-six haplotypes of the *cyt b* gene were found during the analysis. A haplotype network was built and showed similar result. Two clusters can be distinguished. For COI gene the first cluster with the main haplotype Hap_3 includes samples from Belarus, Ukraine, the USA, and Canada. The Hap_3 haplotype is also ancestral to the haplotype Hap_2, which was found in the Simferopol reservoir and along the entire Central Invasion Corridor. The second cluster with only the haplotype Hap_1 includes samples from Czech Republic, Austria, Belarus, Ukraine, Serbia and Germany. For *cyt b* gene the first cluster with the main haplotype Hap_1 includes samples from Czech Republic, Canada, Belarus, Ukraine, Bulgaria, Austria and Serbia. The second cluster includes ancestral haplotype Hap_17 that was found in Simferopol reservoir and haplotypes that were found in Belarus, Ukraine and USA.

Four haplotypes of COI gene were found in the Central Invasive Corridor north of the Kakhovskoye reservoir: Hap_1 (the Danube River and tributaries also); Hap_2 (Simferopol Reservoir); Hap_3 (Great Lakes); Hap_4 that wasn't found anywhere else. Seven haplotypes of the *cyt b* gene were found in the study area (Hap_1 и Hap_2 that were found in the Danube River and tributaries also; Hap_17 that was found in the Simferopol Reservoir also; Hap_8, Hap_24, Hap_25, Hap_26 that were not found anywhere else.

Results from the present study showed that *P. semilunaris* from the Central European invasion corridor has high genetic diversity values. Its genetic diversity values equivalent to native populations and higher than other alien areas. In the Central European Corridor there are haplotypes from eastern part of native area and from the Southern Invasion Corridor (Danube River and tributaries). Thus there was no evidence apparent for founder effects or bottlenecks. These results suggest that the population of *P. semilunaris* in the Central European Corridor was founded by a very large number of diverse individuals.

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PALLAS′S GULL *LARUS ICHTHYAETUS* ON THE VOLGA RIVER RESERVOIRS IN SUMMER-AUTUMN PERIOD

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The Pallas′s Gull *Larus ichthyaetus* Pallas, 1773 is a fish-eating predator. It is included in the 5th category of the Red Data Book of the Russian Federation as a recovering species. The state of the world population it is estimated least concern with the tendency to increase the number.

The aim of the study is to improve our understanding of the current state of the Pallas′s Gull at the reservoirs of the Volga River in the post-breeding period. In the summer-autumn period of 2020, in the fairway (navigable) zone of the reservoirs of the Upper, Middle and Lower Volga census of the number of Pallas′s Gulls were carried out on the research vessel «Akademik Topchiev» and the values of its relative abundance were obtained. The average speed of the vessel was 14.3 km/h, the counting strip width was 200 m, the counting route length was 1819.5 km, and the total counting time was 127.4 hours. The total number of Pallas′s Gulls recorded on the route is 191 individuals.

Historically, the colonial breeding sites of the species were located in the Northern Caspian and in the Volga delta. In 2015 and 2016, breeding of the Pallas′s Gull was established at the mouth of the Kama River (in the vicinity of the Kuibyshev reservoir). By the end of the 20th century, an increase in the number of individuals in the summer was observed on the Volga reservoirs from Volgograd to Kazan. In Chuvashia on the Volga, it was recorded irregularly since 1986, in the Nizhny Novgorod region for the first time in 1996, in 2020 it was observed from the lower reaches of the Volga to the north up to the Rybinsk reservoir inclusive (Figure).

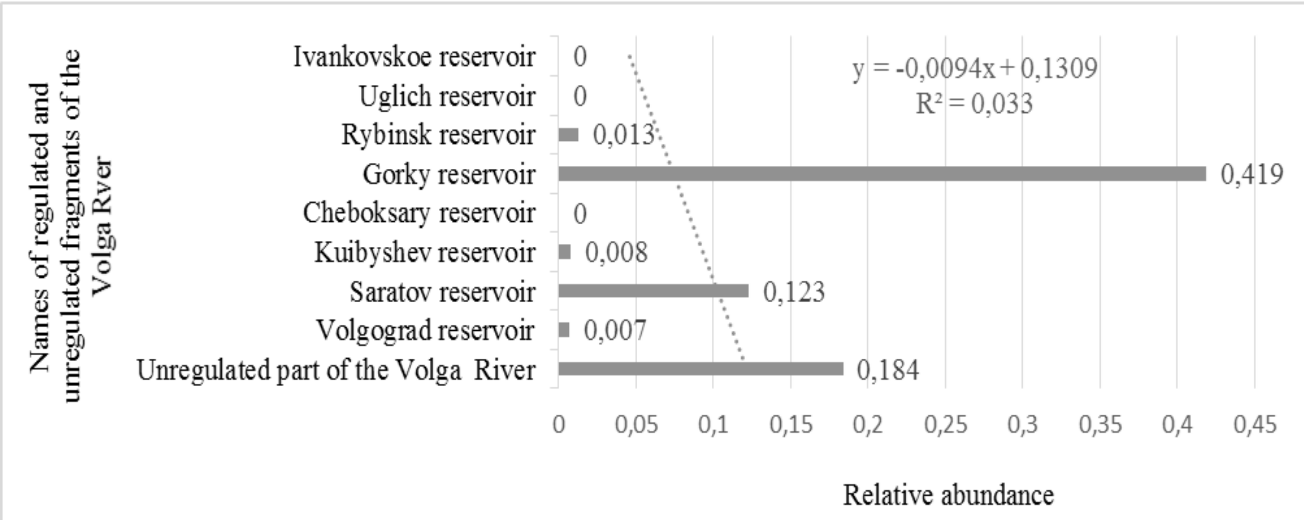

Figure. Relative abundance (individuals/km counting strip) of Pallas′s Gull (*Larus ichthyaetus*) on regulated (reservoirs) and unregulated fragments of the Volga River fairway in the summer-autumn period of 2020.

Until 2010, the most northerly regular registration of the species was limited only to the Gorky reservoir at the latitude of the city of Yuryevets, Ivanovo region. The single vagrant Pallas′s Gull was first recorded in the Rybinsk reservoir in 1952. However, 70 years later, in the autumn of 2020, this reservoir became the site of four single bird registrations at once, one of which by now turned out to be the northernmost registration of the Pallas′s Gull in the European part of Russia (58.67252 N). In the Yaroslavl Volga region on the Rybinsk reservoir, this bird species was recorded for the first time in the historical period.

Thus, Pallas′s Gull became a recent invader of the Middle and Upper Volga basin, reaching the southern taiga subzone. Historical and recent materials suggest that the Volga River valley can be considered as an intrazonal invasive corridor in the distribution of the species to the north, and as a place of regular residence of the Pallas′s Gull in the summer-autumn period.

It is necessary to control the population of the species along the entire length of the Volga artery to understand its functional significance in the ecosystem and clarify the conservation status.

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NEW SPECIES OF INVADERS OF FRESHWATER BRYOZOANS IN THE FRESHWATER COMMUNITIES OF PROTECTED NATIONAL AREAS IN EUROPEAN PART OF RUSSIA

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Spreading of species (biological invasions) has been taking place since the Neolithic times due to the removal of geographic and environmental barriers that limited the natural spread. Scientific and practical interest in the process of spreading of species (biological invasions) is determined by its evident influence on the current state of terrestrial and aquatic ecosystems. The flexibility (multivariable) of the overall strategy is manifested, among other things, through the implementation of various patterns of the seasonal dynamics of the resettlement stages. Brackish water conditions, warming and the involvement of the Finnish Bay region in a system of international shipping may enhance the spread of alien marine and freshwater species, including fouling.

The freshwater Bryozoa *Plumatella geimermassardi* Wood&Okamura, 2004 was found for the first time in the Kopora Bay of the Gulf of Finland in the Baltic Sea at the border of the reserve as fouling on artificial substrate. Alien species are being implemented on biodiversity and ecosystem functions.

To aid accurate estimates observations of the bottom populations of fouling were carried out and the freshwater bryozoan *Plumatella similirepens* Wood, 2001 was found on the southern shore of the specially protected natural area Udomlya lake as fouling on stones. Both species are the first findings in the European part and new for the freshwater bryozoan fauna of Russia. The conditions for the formation of fouling of *Plumatella similirepens* can be described in Lake Udomlya. Under the pattern we understood the totality of time ("timing") and quantitative characteristics.

The structural and functional parameters of marginal communities depend on both technological and biotic factors in the techno-ecosystems of thermal and nuclear power plants in terms of their composition, spatial structure, development in the conditions of lothic lenthic, and change in time. Consequently, knowledge can be relevant to classify the encountered bryozoans as a number of species that have a flexible survival strategy in the changing environmental conditions that are formed under the influence of increase of the power station capacity. Probably, a flexible strategy for the survival of these bryozoans is the reason for the successful development by this small family of diverse water bodies of the Earth Globe and the rapid recolonization of ecosystems disturbed as a result of techno genic transformation by separate species and it leads to environmental impacts and economic costs, for example due to biofouling.

THE OCCURRENCE OF EXPANSIVE *GONYOSTOMUM SEMEN* IN EUROPE AND NORTH AMERICA

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The eukaryotic raphidophyte *Gonyostomum semen* (Ehrenberg) Diesing 1866 is known to cause nuisance blooms in freshwater bodies and has recently expanded its distribution across Europe by colonizing new habitats. Knowledge about biotic factors determining its occurrence is still scarce, especially in lakes outside of Northern Europe, from where its expansion has started. To fill this gap, we focused on relations between *G. semen* and other planktonic organisms (including algae, cyanobacteria, rotifers and crustaceans) in 32 freshwater ecosystems in Europe and North America. Plankton community structure and water quality were studied from August to November 2017 in Europe and from June to July 2018 in North America. In all of European sites located in 8 countries high abundance of *G. semen* had been reported previously. In the United States sites the occurrence of *G. semen* had either been documented previously or occurrence was suspected based on habitat type where monitoring records were scarce.

Presence of *G. semen* were observed in phytoplankton in all sites. They represented both natural and artificial lakes and reservoirs, as well as bogs and fens. Results showed the environmental heterogeneity of *G. semen* bloom sites across Europe and the United States. *Gonyostomum semen* dominated the phytoplankton community in 18/20 sites in Europe and in 2/12 in the United States reaching from 33.1% to 99.1% and from 0.24% to 95.2% of total phytoplankton biomass, respectively. The main accompanying algae of raphidophyte in European bodies were other flagellates belonging to Chrysophyceae (*Dinobryon* spp., *Synura* spp.), Dinophyceae (*Peridinium* spp., *Ceratium hirundinella*) and Cryptophyceae (*Cryptomonas* spp.). In the case of sites from the United States, the dominant group included both the flagellates mentioned above but also Chlorophyceae, Zygnematophyceae and Cyanobacteria (*Dolichospermum* sp.).

Our results pointed also to the large differences in the zooplankton community structure in lakes of different geographical regions. Nonetheless in European lakes often was found *Ceriodaphnia quadrangula* and *Eudiaptomus gracilis*, which are common components of zooplankton in humic lakes. The lower share of *G. semen* in the USA may be a result of the domination of *Holopedium gibberum* and Calanoida copepods which may feed on this algae.

NEW AMPHIPOD SPECIES IN THE NORTHEN BLACK SEA REGION OVER THE PAST 20 YEARS

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Amphipods in the Black Sea have been identified since 1837. Until 2000, 111 of these invertebrates were known in this region [Greze, 1977, 1985]. However, since 2000, 9 previously undetected species and 1 new genus have been recorded in the northern part of the Black sea: *Apherusa chiereghinii* Giordani-Soika, 1949; *Apohyale crassipes* (Heller, 1866); *Dexamine thea* Boeck, 1861; *Echinogammarus foxi* Chellenberg, 1828; *Jassa marmorata* Holmes, 1905; *Microprotopus maculatus* Norman, 1867; *Monocorophium insidiosum* (Crawford, 1937); *Nototropis massiliensis* (Bellan-Santini, 1975); *Platorchestia platensis* (Krøyer, 1845) [Grintsov, Sezgin, 2011; Grintsov, 2003, 2010, 2016, 2018, 2019]. All the species mentioned above are known in the Mediterranean Sea [Bellan-Santini, 1982, 1993; Karaman, 1982; Krapp-Schickel, 1982; Myers, 1982, 1989]. As a result of the extensive research, other representatives of these genera (except genus *Platorchestia* Bousfield, 1982) were known in the Black Sea before 2000 and are now identified in this region [Grintsov, Sezgin, 2011]. The reasons for the lack of identification of the above species before 2000 remain unknown.

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FIRST RECORDS OF THREE INVASIVE *PENTAMERISMUS* (ACARI: TENUIPALPIDAE) SPECIES ON CONIFERS IN DONBASS

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On the territory of Donbass, the natural southern boundary of conifers growth lies in the floodplain of Seversky Donets River in the north of the region, where grow Scots pine (*Pinus sylvestris* L.) and its variety – Cretaceous pine (*P. sylvestris* var. *cretacea* Kalenicz. ex Kom.). All other conifers, including Taxaceae and Cupressaceae, are introduced species that widely used in green building. For a long time, these plants were practically not damaged by pests; however, studies carried out in recent years show the active formation of a complex of invasive phytophagous arthropods in artificial plantations of conifers.

In the period from 2017 to 2020 for the first time for Donbass on the plants of Taxaceae and Cupressaceae families in Donetsk were registered three species of invasive Tenuipalpidae mites: *Pentamerismus taxi* (Haller, 1877), *P. juniperi* (Reck, 1951) and *P. oregonensis* McGregor, 1949. These species were repeatedly noted as pests in parks on the southern coast of Crimea; in addition, in the last decade, *P. taxi* and *P. oregonensis* were found in urban plantings of Kherson and Kiev regions. The record of these species in the Donbass indicates the continuing expansion of their range in the northeastern direction.

Pentamerismus taxi is a monophagous species commonly known as a pest of yews (*Taxus* spp.). In Donbass *P. taxi* was first recorded in May 2017 on berry yew (*Taxus baccata* L.) on the territory of Donetsk Botanical Garden, and is currently widespread throughout the region. As a result of the mites feeding, yellowing and falling of the needles and cracking of the bark of the shoots are observed. Mass dying off and shedding of last year's and the year before last needles, leading to a partial loss of decorative effect, is observed from mid-May to late June. In this case, shaded and oppressed plants damaged especially strongly. *Pentamerismus juniperi* is a polyphagous species, trophically related to conifers, feeding primarily on Cupressaceae (*Juniperus*, *Biota*, *Thuja*). First recorded in 2020 on shoots of *Thuja occidentalis* L. in Donetsk. To date, the species is quite local and, due to its low number, does not cause significant damage. Further spread of *P. juniperi* and increase its density may have a negative impact on the plant sanitary of Cupressaceae in the region. *Pentamerismus oregonensis* is a polyphagous species, trophically related to conifers: Cupressaceae (*Juniperus*, *Biota*, *Chamaecyparis*, *Cupressus*, *Platycladus*, *Thuja*, etc.), Pinaceae, Taxaceae, etc. First recorded on the territory of Donetsk Botanical Garden in 2020 on the shoots of *Juniperus scopulorum* Sarg. With a high density on young and weakened plants, it causes yellowing of the needles and a decrease in the viability and decorative effect.

To date, on coniferous in Donbass has formed a complex of invasive arthropod phytophagous: 12 species was registered on Cupressaceae family, and 2 species – on Taxaceae. The record of new species of pests in artificial plantations of conifers indicates the ongoing processes of the formation of specific complexes of plant-parasites. In the conditions of the secondary range, the possibility of potential harmfulness evaluation of invasive mites is difficult due to the ongoing processes of acclimatization under new conditions. In addition, the presence of a complex of invasive species may cause the formation of a synergistic effect, which multiplies the pathogenic effect on plant communities. Based on the foregoing, the most adequate mites management strategy at this stage should be recognized as a complex of agrotechnical measures aimed at increasing the resistance and viability of plants. The use of chemical control agents is advisable only on young plants in nurseries and growing areas. For a detailed clarification of the life cycles, trophic and ecological features of new species in the conditions of Donbass, and the development of effective strategies of pest management additional research is required.

DISTRIBUTION OF *LAONOME XEPROVALA* (SABELLIDAE, POLYCHAETA) IN THE OPEN WATERS OF THE VISTULA LAGOON, BALTIC SEA, IN 2014-2020

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For the first time, the polychaete *Laonome xeprovala* Bick & Bastrop, in Bick et al., 2018 was recorded in the Vistula Lagoon in 2014. It was previously identified as *Laonome* cf. *calida* Capa, 2007. In 2014-2016. polychaetes were found in two areas in the northeastern part of the lagoon not far from the mouth of the Pregolya River in the Kaliningrad sea channel (KSC) and in the northern part of the Nasypnoj Island, where their abundance ranged from 40 to 320 ind./m^2 (Kocheshkova, 2017; Kocheshkova and Ezhova, 2018). Species was recorded in the Baltic Sea in 2012 (Kotta et al., 2015). Currently, polychaetes occur in the Baltic Sea from the Oder River to the Gulf of Finland (Pabis et al., 2017; Tamulyonis et al., 2020). In 2013, the species was recorded in the Azov Sea, where it is assumed to have entered from the Baltic Sea through the Volga-Baltic and Volga-Don channels (Syomin et al., 2014; Boltachova et al., 2017).

The lecithotrophic larvae were noted for polychaetes Laonome. They have a low ability to spread over long distances at the larval stage (Boltachova et al., 2017). As a result, the process of dispersal or colonization of new water bodies, including the Vistula Lagoon, will proceed more slowly in this species than, for example, in the bivalve *Rangia cuneata* (G.B. Sowerby I, 1831) (Gusev, Feneva, 2018).

The zoobenthos samples were collected in the open part of the Vistula Lagoon as part of a comprehensive monitoring carried out annually according to a standard grid at 9 stations in 2014–2020. Petersen bottom grab was used with for sampling a capture area of 0.025 m^2. Then they were washed through a sieve with a mesh size of 0.5 mm, disassembled in vivo on board the vessel, and fixed with 4% formalin solution. Processing of the material was carried out according to generally accepted methods (Salazkin et al., 1983; Rukovodstvo..., 1983).

L. xeprovala was not found in 2014-2015. The first find was in May 2016 at two stations 4 and 8. During 2016-2017, polychaetes were found only at these two stations. The abundance varied from 20 to 400 ind./m^2. In 2018, polychaete was found at station 7. The abundance of polychaetes varied from 110 to 3000 ind./m^2 in 2018. In 2019, *L. xeprovala* was recorded at three more stations 5, 6, and 9. As a result, since 2019, polychaetes have been recorded at six stations. The abundance of polychaetes was 20–2320 ind./m^2 n 2019-2020 (Figure).

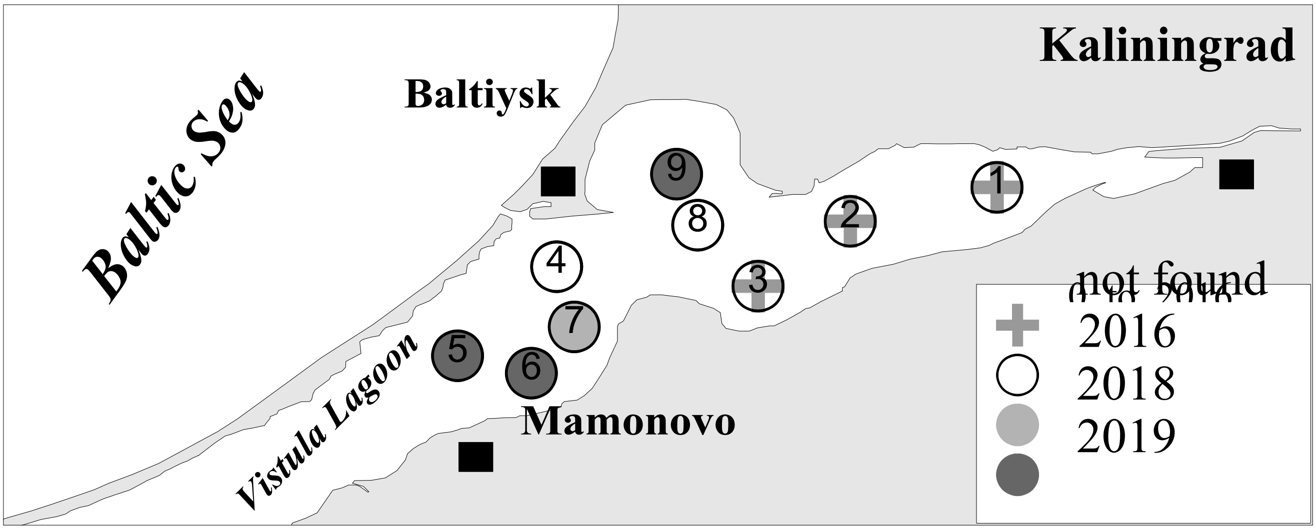

Figure. Distribution of *Laonome xeprovala* in the Vistula Lagoon in 2014-2020

Thus, *L. xeprovala* continues to inhabit the Vistula Lagoon. It is likely that in the near future it will penetrate into the northeastern part and into the southern Polish part of the Vistula Lagoon. It can be noted that *L. xeprovala* spent six years for settling at the same number of stations, for which *R. cuneata* spent only two months (Rudinskaya and Gusev, 2012).

INHIBITION OF RESTORATIVE SUCCESSION PROCESSES IN FELLED AREAS UNDER THE INFLUENCE OF LIANA *PARTHENOCISSUS QUINQUEFOLIA* (L.) PLANCH.

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The paper concentrates on the assessment of the influence of invasive species *Parthenocissus quinquefolia* (L.) Planch. on restorative processes of pine forest felled area. The object is located in the south-east of Belarus, in the southern part of the city of Gomel, and is an area with a vegetation cover destroyed in 2002 during the construction of the pipeline. Permanent plot for plant restorative succession research was set up in 2002 and was being studied during 2002–2017.

By 2009, a meadow community with domination of *Calamagrostis epigeios* (L.) Roth. was formed. Liana *Parthenocissus quinquefolia* first appeared 9 years after succession begun. In 2013, its projective cover exceeded 20%. In 2015, this species already had projective cover 60%, in 2016 – 85%, in 2017 – 90%.

Significant changes during this time occurred in the composition of ground vegetation. In the community with *Parthenocissus quinquefolia* dominance some species with projective cover of 1-5% were also noted such as *Poa pratensis L.*, *Echium vulgare L.*, *Artemisia vulgaris* L. Compared to previous years (before *Parthenocissus quinquefolia* invasion stage*)*, coverage of *Tanacetum vulgare* L., *Artemisia campestris*, *Elytrigia repens* (L.) Desv. ex Nevski, *Achillea millefolium* L. declined considerably. Such species as *Calamagrostis epigeios*, *Oenothera biennis L.*, *Berteroa incana* (L.) DC., *Veronica longifolia* L. and some others disappeared from the grass layer. The total number of species has decreased by 1.8 times. The community contains undergrowth of trees (*Acer negundo L.* and *Pinus sylvestris L.*), the number of which decreased from 1400 per ha in 2009 to 600 per ha in 2017. Almost all undergrowth consists of the invasive species *Acer negundo*.

Thus, it can be seen that invasion into the community and growth of *Parthenocissus quinquefolia* reduce the diversity and projective cover of grass species, reduce the number of undergrowth, that is, slow down and stop the natural process of secondary succession, which has negative consequences for the sustainability of landscapes and biodiversity.

The main features of the transformation of the ecological and floristic characteristics of the community under consideration in 2009–2017 are as follows. In the phytosociological spectrum before the invasion of *Parthenocissus quinquefolia*, species of the classes Artemisietea and Molinio-Arrhenatheretea (under Braun-Blanquet plant classification) absolutely prevailed and had equal shares (both of them were about 30%) of all species in the community. The influence of *Parthenocissus quinquefolia* manifested itself in a 2–5-fold decrease of share of the meadow class Molinio-Arrhenatheretea species, and an increase of share of synanthropic class Artemisietea species, that became more than 40%. At the same time, the share of other synanthropic classes, Chenopodietea and Robinietea, almost doubled, thus, in total, the share of species of synanthropic classes increased from 40.8 to 58.3%. The species of felling and burnt areas class Epilobietea completely disappeared, but the share of grass communities on the underdeveloped sandy soils class Sedo-Scleranthethea 2-fold increased.

In the ecological-cenotic spectrum, the share of adventive (1.4 times), nitrophilic (1.8 times) species increased, and the proportion of meadow-steppe species decreased (1.3 times).

Calculation of values of ecological regimes by D. Tsyganov scales showed that the main changes are manifested in an increase in soil moisture, a decrease in soil fertility, an increase in the soil nitrogen content, and an increase in illumination.

Thus, it can be concluded that the invasion and growth of *Parthenocissus quinquefolia* in felled communities leads to suppression of regenerative succession processes, an increase in the level of synanthropization and adventitization, a decrease in the diversity of vegetation, and changes in the ecological regimes of communities.

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DO INVASIVE ALIEN PLANTS IMPACT THE DIVERSITY OF VEGETATION MORE COMPARED TO NATIVE EXPANSIVE DOMINANTS?

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Invasive alien plants are known to reduce the diversity of recipient communities, but many native dominant species are presumed to have similar effects. To compare the impacts of these two groups, we selected 10 native species and nine aliens to central Europe that are dominant in plant communities. We sampled plots chosen to represent a gradient of the dominant species' covers. LMM regression models were used to relate the dominant species' covers to the community richness and diversity, and ANCOVAS to test for the differences between native versus invasive dominants' impacts. We used indirect gradient ordination analysis (DCA) to identify pairs of native and invasive dominants that grow in a similar type of vegetation. Native *Calamagrostis epigejos* and *Urtica dioica* have a strong negative impact on species richness and Shannon diversity, respectively. Invasive *Reynoutria* x*bohemica* and native *Phalaris arundinacea* impact both richness and diversity. No significant differences in impacts were detected concerning the dominant species origin (native vs alien) when all 19 dominants were included in one model. Of the 27 pairs of native–invasive dominants, defined to reflect their occurrence in the same habitat, native dominants had stronger impacts on species richness in three cases and invasive dominants in two (11.1% and 7.4%, respectively). Also, the invasive dominants had stronger impacts on Shannon diversity in four cases (14.8%). Our results suggest that both native and invasive dominants suppressing community richness and diversity are characterized by a "hybrid strategy" – they possess traits that support rapid spread and competitiveness, hence allowing such species to maintain their dominance long after a major disturbance. The results show that both native and invasive dominants can reduce the diversity of vegetation. To conserve biodiversity, measures should be adopted to mitigate not only invasive species' impacts but also that of native dominants spreading in the current landscape; this would be best achieved by promoting traditional management and land-use.

INVASIVE SPECIES OF ARTHROPOD PHYTOPHAGES IN GRODNO NEMAN RIVER REGION URBOCOENOSES (BELARUS)

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The work was carried out within the framework of the Belarus state program of scientific research (GPNI) «Nature management and ecology» for 2016–2020, subprograms «Biodiversity, bioresources, ecology» 2.05 «Changes in the background phytophagous species – woody-shrub plants pests communities in Grodno Neman River Region urbocoenoses as a result of invasive processes».

Grodno Neman River Region – historical and ethnographic region of Belarus, named after the Neman River. The region is located at the Belarus western border, characterized by specific natural and climatic conditions, and is one of the main corridors for the alien species and potential invasions penetration into natural communities. The territory of Grodno Neman River Region belongs to the West Belarusian landscape-geographical province, which extends within the Eurasian coniferous-forest (taiga) geobotanical region.

The collection of material on the territory of Grodno, Skidel, Mosty, Lida cities and Porozovo urban-type settlement carried out. In all the cities studied, test plots laid in decorative green spaces of general use, 18 plots of total. Phytophages and the caused by them damage during visual inspection of arboreal and shrub plants collected. Fragments of damaged plants were herbarized according to the appropriate methods. The material is stored at the Department of Zoology and Physiology of Man and Animals, in the Laboratory of Invertebrate Zoology Yanka Kupala Grodno State University (Belarus). The degree of harmfulness according to a special S.V. Gorlenko 4-point scale analyzed, and the biological pollution of urban ecosystems assessed.

Based on the results of studies carried out in 2016–2020 on woody and shrubby plants in urban green spaces of Grodno Neman River Region urbocoenoses revealed 42 species of phytophagous invaders (21 % of the arthropod phytophages species abundance in this area). Invasive arthropods belong to two classes – Insecta Ectognatha (83 % of species) and Arachnida (order Acariformes, family Eriophyidae). The invasive phytophagous insect species belong to five orders. The order Hemiptera includes 27 species belonging to the Aphidoidea, Coccoidea, Phylloxeroidea, Psylloidea, Fulgoroidea superfamilies. The order Lepidoptera by four species from the Gracillarioidea superfamily represented. Order Hymenoptera – two species from Tenthredinoidea (*Hinatara recta* (C.G. Thomson, 1871) and *Nematus tibialis* Newman, 1837). Orders Thysanoptera (Thripidoidea, Thripidae, *Dendrothrips ornatus* (Jablonovski, 1894) and Diptera (Sciaroidea, Cecidomyiidae, *Obolodiplosis robiniae* (Haldeman, 1847)) are represented by one species each other.

Fodder plants for invasive phytophagous species are woody and shrub plants from 24 genera, 17 families, and 16 orders. Plants of the genera *Robinia* L., 1753 and *Acer* L., 1753 provide food for six and five phytophages species, respectively. A complex of invasive phytophages (eight, six, and four species, respectively) on the introduced plants of the Fabaceae, Juglandaceae, and Rosaceae families in the Grodno Neman River Region urbocoenoses formed.

Most invasive phytophagous species originate from the regions of North America (11 species), as well as South, Western and foreign Central Europe (10 species), and Central Asia (nine species).

Thirty-four invasive phytophagous arthropods species with different patterns of damage as pests of decorative deciduous trees in urban green spaces are used. As pests of ornamental shrub plants – five invasive species of sucking phytophagous insects, and as pests of conifers of woody plants – three invasive species of sucking phytophagous insects.

According to the conducted studies data, out of 42 registered invasive species in the Grodno Neman River Region, nine species (*Aphis craccivora*, *Cameraria ohridella*, *Cholodkovskya viridana*, *Dendrothrips ornatus*, *Myzus cerasi*, *Pemphigus spyrothecae*, *Phyllonorycter issikii*, *Ph. robiniella*, *Vasates quadripedes*) an extremely high level of harmfulness have. In addition to the extremely high level of harmfulness, four species (*A. craccivora*, *C. ohridella*, *Ph. robiniella*, and *V. quadripedes*) are also characterized by a high occurrence. In accordance with the biological pollution indicators, all studied 18 urban green spaces of Grodno Neman River Region by a level of high and strong biological pollution characterized.

PENETRATION AND SPREADING OF VARIOUS FISH SPECIES INTO THE WATER BODIES OF THE REPUBLIC OF KARELIA, RUSSIA

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The sharp increase in the in the penetration rate of new fish species, observed in the past decade in Russia, is provoked by human economic activities. Long-term studies carried out in Karelia have revealed several ways of fish penetration: fish culture, self-invasion along lake-river systems and accidental invasion, which takes place when fish are carried by the ballast water of ships.

The goal of our project was to study the penetration of new fish species into Karelia's water bodies (the fluke *Platichthys flesus* and the sucker *Catostomus catostomus*); to reveal the reasons for the arrival of the rudd *Scardinius erythrophthalmus;* and to appraise the results of fish culture (the smelt *Osmerus eperlanus*, the vendace *Coregonus albula*, the pike-perch *Sander lucioperca*, the bream *Abramis brama*, the char *Salvelinus lepechini* and the grayling *Thymallus thymallus*).

Fluke was first caught in July 2000 in Petrozavodsk Bay of Lake Onega at a depth of 18 m at a distance of 1 km from the shore. It was a male of maturation stage VI, which had a length of 29 cm and a mass of 370 g. Fluke is a typically marine fish, and its accidental catch is of considerable interest, considering its geographic distribution and ecological characteristics. It must have been carried by the ballast water of ships from the sea into Lake Onega. There are species among alien, accidentally carried fish, especially brackish-water, whose successful naturalization in fresh water can really be dangerous to the stable functioning of well-established ecosystems. There are many examples in the literature (mitten crab, ruffe).

Siberian sucker was first caught (6 fish) in August 1992 in eastern Lake Ladoga at a depth of 17 m at a distance of 5–6 km from the shore. The fish varied in length from 24 to 28 cm and in mass from 327 to 550 g. Their age was 4+. The reasons for the penetration of the redside sucker into the lake are unknown, but some assumptions can be made. During fish culture part of the redside sucker bred in the GosNIORH ROPSHA ponds could have penetrated into Lake Ladoga, its new habitat. This newly-formed redside sucker population deserves special study.

Rudd is seldom encountered in Karelia's water bodies. In 2007, while doing research on Lake Kosmozero, it was first caught with a net. In 2020, rudd was revealed in Lake Syamozero (age 7+, length 32 cm, mass 340 g.). It seems to have penetrated along lake-river systems so abundant in Karelia.

In 1950 – 1980, 19 fish species were introduced to Karelia: 13 species from other regions of Russia (only the pink salmon *Oncorhynchus* gorbuscha has naturalized) and 6 species were aboriginal: 5 have naturalized and 1 grayling was not encountered).

Smelt. To improve the food supply of predatory fish living in Karelia's water bodies, attempts to introduce smelt were made. Since the 1950s, 950 million smelt larvae from Lakes Onega and Ladoga were released into Lakes Sundozero, Segozero, Seletskoye, Maslozero and Yelmozero. The smelt has naturalized in all these lakes.

In Karelia, smelt self-penetrated along lake-river systems from Lake Sundozero to Lake Pyalozero and from Lake Segozero to Lake Vygozero. Smelt has become commercially abundant in these lakes.

In 1968, smelt was first reported from Lake Syamozero. It must have penetrated accidentally. During a long monitoring period (over 50 years), the formation of its population, its biology in a new environment and its influence on aboriginal fish species were studied. It has been shown that the arrival of a new fish species, especially a predator, who contacts aboriginal species, may be dangerous to the fish population.

Pike-perch is the best example of fish introduction in Karelia. It has naturalized in 10 out of 14 lakes into which it penetrated. Large-sized vendace introduced into 5 lakes, char into 3 lakes and bream into 2 lakes have also naturalized, forming commercial populations.

The studies were funded from the Federal Budget for fulfilling State Project 0218-2019-0081.

THE COASTAL–MARINE SPECIES *EURYTEMORA AFFINIS AFFINIS* (POPPE, 1880) (COPEPODA, CALANOIDA) DISTRIBUTION IN THE LOWER NORTHERN DVINA RIVER

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The spread of invasive species is an important problem in biogeography nowadays. It is difficult to solve it due to lack of knowledge and low understanding of the mechanisms involved. There is still no clear understanding of how some species can quickly adapt to new environment and expand their areals, while others do not adapt and disappear.

Copepods of the genus *Eurytemora* have significantly dense population in coastal waters all over the world. They dominate among zooplankton communities, for example, in the Gulf of Mexico and Chesapeake Bay, at the mouth of the Columbia River, and in many European rivers, where they occupy main trophic positions. Invasive species *Eurytemora affinis affinis* (Poppe, 1880) is of a great scientific interest, because it can transfer water-borne diseases. The sequencing of the *E. affinis* microbiome revealed Some pathogenic and potentially pathogenic taxa, including *Vibrio cholerae*, *Salmonella*, *Shigella*, *Campylobacter*, *Corynebacterium diphtheriae*, *Yersinia*, *Aeromonas hydrophila*, and *Acinetobacter hausoul* were detected in the sequenced microbiome of *E. affinis*. These bacteria were absent in areas where *Eurytemora* samples were taken. Due to tidal effect in the river mouths *E. affinis* can easily migrate from coastal to inland waters. During migration they have rapid physiological evolution and their microbiomes change. These changes in the species composition of microbial community may have serious consequences in the transfer of the diseases.

The invasive species *E. affinis* in the lower reaches of the Northern Dvina River is of a great interest, as it flows through the vast territory of the Arctic zone. These studies were carried out during the growing seasons in 2012–2014 and in 2018–2019 at a permanent network of observation sites (Table).

Table. Long-term average abundance (*N*, ind./m3) of zooplankton taxonomic groups in the lower reaches of the Northern Dvina River.

Stations	$N_{Rotifera}$	$N_{Cladocera}$	$N_{Copepoda}$	$N_{Rotifera+Cladocera+Copepoda}$
No. 1, Ust-Pinega	215	332	128	675
No. 2, Novodvinsk	70	200	115	385
No. 3, Arkhangelsk near railway bridge	435	654	294	1383
No. 4, Kuznechikha duct	54	339	3681	4074
No. 5, Korabelny branch	158	305	241	704
No. 6, Maimaksa duct	50	290	1216	1556
No. 7, Nikolsky branch, Rikasikha	68	184	456	708
$M \pm m$ (min–max)	136±48 (41–435)	304±57 (125–654)	772±436 (42–3680)	1212±440 (208–4074)
m_e	69	298	267	706

Based on the data obtained there was a change of dominant groups in zooplankton over the entire period of research starting from the station in the Kuznechikha duct. Copepods dominate and have high contribution the total taxonomic abundance, Cladocerans have 50 % of a total population in the upper parts of the water area, while copepods replaced them in the lower parts (up to 90.3 % at the station in the Kuznechikha duct). Their abundance was many times larger than the total abundance of the groups before the above-mentioned station. This increase was due to the local outbreaks of *E. affinis*, which indicated a significant influence of marine waters on the freshwater ecosystem of the Northern Dvina River. Besides, in the Kuznechikha duct during summer low water there is a maximum species richness and a sharp decrease of Shannon index values close to the level noted in the autumn period. This is also explained by the formation of a monodominant community due to the intensive development of *Eurytemora*, as a result there is the evenness of the community, which isone of the important indicators affecting the Shannon index the values. The area of *Eurytemora* (single individuals are noted) reaches the closing station of the mouth area of the Northern Dvina River – within Ust-Pinega, that is at a distance of more than 100 km from the sea water area.

For details see: Imant E.N., Novoselov A.P. Dynamics of Zooplankton Composition in the Lower Northern Dvina River and Some Factors Determining Zooplankton Abundance. Russ. J. Ecol. 52, 59–69 (2021). https://doi.org/10.1134/S1067413621010045.

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FEATURES OF THE DISTRIBUTION OF THE INVASIVE FISH ROTAN *PERCCOTTUS GLENII*, IN THE SOUTH OF WESTERN SIBERIA

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The fish rotan, *Perccottus glenii* Dybowski, 1877 (Odontobutidae), is recognized as one of the TOP-100 most dangerous invasive species in Russia. In Western Siberia, the rapid dispersal of this fish species is continuing. Specific patterns of its distribution in the region represent a special interest.

The data for this research were collected during the fishery inventory of water bodies carried out by the Novosibirsk branch of VNIRO in the forest-steppe and southern taiga of Western Siberia in 2013–2017. In total, 45 forest-steppe lakes as well as 57 floodplain and non-floodplain lakes, ponds, quarries, and artificial reservoirs of the southern taiga were examined.

In forest-steppe, the rotan has occupied 20% of lakes. These lakes are characterized by significantly lower water salinity than those where this fish species is absent. In our study, the maximal value of salinity in a lake with population of rotan was 1521 mg/l.

In southern taiga, the rotan was recorded in 54% of ponds and quarries. Regarding connections with river systems, this invader was found in 47% of floodplain lakes and only 21% of non-floodplain lakes. Water bodies with rotan are characterized by significantly shallower depths (both average and maximum) compared with rotan-free ones. Hydrological connection between certain water bodies and watercourses is an important factor determining colonization success. Indeed, ponds and lakes with connections to rivers are colonized by rotan twice as often (51% of cases) than isolated ones (25%). In addition, water bodies with rotan are characterized by a shorter linear distance to the nearest human settlement, which may indirectly suggest the importance of the role of human activity in the secondary (local) dispersal of the studied invasive fish.

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INVASIVE PLANTS ON THE PART OF THE KERZHENSKY NATURE RESERVE COVERED BY FOREST FIRES IN 2010

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Kerzhensky Nature Reserve, located mainly within the sandy Zavolzhie plain in the center of European Russia, is subject to periodic catastrophic forest fires, recurring every 35-40 years. An important feature of the reserve is the presence on its territory of several locations where small villages were previously situated, as well as narrow-gauge railway lines, the remains of which were dismantled in the first years after reserve's foundation. The recent big forest fire in 2010 affected about half of the reserve's territory, where, since 2011, both stationary and route studies of the vegetation cover post-pyrogenic restoration have been carried out. From the very first years of research, the monitoring of invasive species distribution became an important aspect of it, which is due to the greater vulnerability of phytocenoses after fires and the high activity of some invasive species on the adjacent territory.

From 2011 to 2020 on the fires covered part of the reserve, totally 15 species with invasive potential were noted. One of them – *Lupinus polyphyllus* Lindl. – was recorded only in 2011 at the site of the former settlement. Three more species (*Saponaria officinalis* L., *Armoracia rusticana* Gaertn., B. Mey. et Scherb., *Caragana arborescens* Lam.) have resumed in places of the previous cultivation on the territory of former settlements and do not spread out from those known places.

Four species – *Acer negundo* L., *Bidens frondosa* L., *Aronia mitschurinii* A. Skvorts. et Maytulina and *Amelanchier spicata* (Lam.) C. Koch – were found in single locations throughout the observation period, but, undoubtedly, are at the beginning of their dispersal across the territory. *Acer negundo* and *Amelanchier spicata* have been found on the territory of former settlements, but both species bear fruit and seed renewal is noted. A single *Aronia mitschurinii* bush does not give self-seeding. *Bidens frondosa* has been registered on the reserve's territory only in the last seven years of observations. However, it undoubtedly actively spreads over wet biotopes. On the fire-affected part of the reserve *Bidens frondosa* was noted in 2019, but its very place of growth, the floodplain of a river, was not affected by fire.

The remaining seven species were regularly recorded in various locations. Four of them were found as single plants. *Epilobium adenocaulon* Hausskn. and *E. pseudorubescens* A. Skvorts. were recorded in some years in different habitats, including on permanent sample plots, but did not show tendencies towards dispersal, often disappearing for several seasons. *Juncus tenuis* Willd. was noted only along the roads, mainly in the vicinity of cordons and in places of former settlements. The number of the species is small and the facts of settling off the roads have not been registered. *Erigeron annuus* (L.) Pers. was recorded in various locations near the former village of Sazonikha, but mainly along the roads.

The most active in the areas covered by fires were *Padus pensylvanica* (L. fil.) Sokolov, *Erigeron canadensis* L. and *Solidago canadensis* L. *Padus pensylvanica* is represented by single plants on the sides of roads and extensive thickets at the site of the village of Sazonikha. The frequency of species registration along the roads has slightly increased in recent years; successful fruiting and subsequent dispersal by birds have been noted. The presence of a large population of the species, combined with the described trends and known examples of its invasive activity, is of great concern.

Solidago canadensis was recorded annually at many points, more often by single plants, mainly along roadsides and wet biotopes. Often over time (usually 3-4 years), the species was displaced from the composition of the communities. The species began to be regularly observed in the reserve on the eve of fires, since 2008, and annually increased its presence.

In the first three years after the fires, *Erigeron canadensis* was one of the dominants of the herb-dwarf shrub layer in the communities of dry biotopes and was found singularly in all others. In the fifth year, there was a significant reduction in its number and its drop out from the composition of many communities. In 2015, 2018 and 2020 the density / occurrence of the species was estimated in the number of individuals per 100 m of the route / 10 000 m^2, which was reflected in a series of maps. Their analysis shows the landscape confinement of the density of occurrences of the species and their reduction from 2015 to 2018 with a slight increase in 2020, which is mainly associated with the appearance of areas with disturbances (mainly zoogenic) of the soil cover.

MORPHOLOGICAL CHARACTERISTIC OF INVASIVE POPULATIONS OF *PHRAGMITES ALTISSIMUS* MABILLE (POACEAE)

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The highest reed (*Phragmites altissimus* Mabille) is not recognized by all authors as an independent species and is considered as a subspecies of the southern reed (*P. australis* (Cav.) Steud.). In the forest zone of Russia, the highest reed is an invasive plant (Tzvelev, 2011). In the zone of invasion, it forms monodominant communities, in which it is an edificator. The aim of the research was to identify the features of the morphological structure of invasive populations of *P. altissimus*.

We studied the quantitative characteristics of the diagnostic features of the highest reed from the primary area and the zone of invasion. In total, 52 shoots collected at 35 points in the area of the primary range of the species (Astrakhan, Volgograd, Rostov, Saratov, Tyumen, Sakhalin regions, Krasnodar, Primorsky, Khabarovsk territories, the Republic of Kalmykia, Ukraine, Armenia, Israel) and 43 shoots from 21 points in the secondary area of the highest reed (Vologda, Moscow, Ryazan, Oryol, Samara, Tver, Tula, Tomsk, Tyumen, Yaroslavl regions, the Republic of Udmurtia and Chuvashia) were studied. In this work, we used materials collected by the author (TOB), as well as samples stored in herbariums IBIW, TK, UDU, VLA. The received data was processed in the PAST v. 4.02 (Hammer et al., 2001).

We found that the highest reed in the secondary range does not have statistically significant differences in terms of morphological structure from plants of this species from the primary range (Table). Significant differences were revealed only for such parameters as the length and width of the leaf blade. In plants from the secondary range, these indicators turned out to be higher than in plants from the primary range. This may be due to the involvement in the analysis of hybrid plants growing in the overlapping area of *P. altissimus* and a closely related species *P. australis*, and having intermediate structural features.

Table. Indicators of the morphological structure of the shoots of *Phragmites altissimus* from the primary range and the zone of invasion

Stat. parameters	Morphological parameters													
	H, cm		n		D, mm		d, mm		L, cm		a, mm		b, cm	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
N	18	18	13	9	20	13	45	25	42	20	127	118	90	46
min	186	225	15	17	5	8	1.5	2.5	16	24	19	15	27.5	37
max	550	450.9	25	18	18	12	7	6.5	58.5	38.5	58	61	72	83
M	296.0	305.7	19.2	17. 7	9.4	9.3	4.1	4.1	31.9	31.3	**33.9**	**38.6**	**46.3**	**57.7**
m	25.1	16.1	0.9	0.2	0.8	0.4	0.2	0.2	1.4	0.9	0.7	0.8	1.0	1.6
σ	106.7	68.4	3.3	0.5	3. 7	1.3	1.4	0.9	8.8	4.1	8.1	8.3	9.5	10.7
CV	36.0	22.4	17.0	2.8	39.0	14.5	34.9	21.1	27.7	13.1	23.9	21.6	20.6	18.6

Note: H – shoot height, n – number of nodes, D – diameter of the shoot at the base, d – diameter of the shoot under the inflorescence, L – inflorescence length, a – leaf width, b – leaf length, N – number of measurements, min – minimum value, max – maximum value, M – mean, m – standard error, σ – standard deviation, CV – the coefficient of variation; 1 – shoots from the primary range, 2 – shoots from the invasion zone. Values with statistically significant differences at $p < 0.05$ are highlighted in bold.

Thus, *P. altissimus* retains its species-specific characters in the area of its secondary range, in the forest zone of Russia. This allows us to consider it as an independent species, currently expanding its range in a northern direction and capable of forming its own phytocenoses.

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UNIVERSAL SET OF PRIMERS FOR DNA IDENTIFICATION OF ALIEN FISH SPECIES

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Reliable species identification is critical for detection and monitoring of biological invasions. In this study, we propose four sets of primers for efficient amplification of several loci, including the mitochondrial cytochrome oxidase-*c* (*COI*) subunit I gene which is a basis for DNA barcoding. This set of primers gives a shorter product which can be used in high-throughput sequencing systems for the metabarcoding purposes. Another mitochondrial locus encoding the large ribosomal subunit (*16S*) may be useful to study the population structure and as an additional source of information in the metabarcoding of communities. We propose to use a set of primers for the nuclear locus of the small ribosomal subunit (*18S*) as a positive control and to verify the results of the barcoding. Our proposed sets of primers demonstrate a high amplification efficiency and a high specificity both for freshwater alien and indigenous fishes. The proposed research design makes it possible to carry out extremely cheap studies on the assessment of biological diversity using the genetic analysis without using of expensive equipment, and with the technique for conducting laboratory work and processing of the results available to any researcher. The presentation also represents original data on the genetic polymorphism of all mass alien fish species in the Volga-Kama region. High efficiency of DNA identification based on our primers is shown as compared to traditional monitoring of biological invasions.

For details see: Karabanov D.P., Bekker E.I., Pavlov D.D., Borovikova E.A., Kodukhova Y.V., Kotov A.A. Universal Set of Primers for DNA Identification of Alien Fish Species in Central Russia (Volga-Kama Region) // Preprints. 2021. e2021070151 (https://dx.doi.org/10.20944/preprints202107.0151.v1).

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SPACE-TEMPORAL DISTRIBUTION OF THE ROUND GOBY *NEOGOBIUS MELANOSTOMUS* LARVAE IN THE SE BALTIC COASTAL ZONE DUE TO THE POSSIBLE CONSEQUENCES FOR NATIVE SPECIES GOBIIDAE

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According to the results of ichthyoplankton surveys in the Kalinigrad sector of the South-Eastern Baltic there are 17 of fish larval species in the ichthyoplankton assemblage. The sand goby *Pomatoschistus minutus* is a dominant native species in the coastal zone by the large abundance, wide size of distribution area and the long seasonal duration. Larvae of a non-indigenous round goby *Neogobius melanostomus* were found for the first time at night time in July 2004, a fourteen years later the first catching the adult round goby in the Polish costal waters (Skóra, Stolarski, 1993). Unlike the native goby progeny the larvae of the round goby have no a swimming bladder and can raise to upper water layers in a diurnal dark time only (Hensler, Jude, 2007). After 2004 these larvae were found also during a night catching (from 22 to 02 hours) in July 2015, 2017 and 2019. The maximal abundance of the larval round goby amounted to 14 sp/ m^2; the total quantity of larvae caught was 30 specimens. The length was from 6.2 to 8.2mm. Taking into account a relatively short time of spreading that species in the Baltic Sea (Olenin et al, 2017) it could be supposed that a night vertical migration of the round goby larvae jointly with a northern surface current promoted its dissemination along the Baltic coast.

The bathymetric distribution of the round goby larvae coincided with native sand goby larvae in depths from 10 to 20m only. The last species larvae occurred in a wide depth range from 1 to 50m, sometimes with changing their predomination from depth 10-15m to depth 25-30m. The length of larval sand goby was from 2 to 12mm with modal size 3-5mm. There was a noticeable decrease of abundance of the larval sand goby: from 18.4 sp/ m^2 in average for 2000-2004 to 5.1 sp/ m^2 in average for 2007-2019. Based on difference in the depth distribution and length sizes of those species larvae it could be supposed an improbable forage competition between their larvae. The sporadic water inflows from an intermediate cold water layer could be one of reasons for shortening of the distributional space and decreasing of larval sand goby abundance (Karasiova et al., 2002). The possible consequences could be a diminution of the sand goby spawning habitat and its shift to smaller depths. It is supposed that there are differences in the vulnerability of different gobiid species biotopes according to unfavorable environmental conditions.

ALIEN SPECIES OF FISH IN THE BLACK SEA

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The problem of bioinvasions in the Black Sea is very acute. The reasons for this are the following factors. The Black Sea is a relatively young body of water, the processes of ecosystem formation in which are not completed. The reservoir has unique hydrological and hydrochemical characteristics and has a connection with various water basins, including through human activity. And, finally, its ecological capacity contributes to the relatively rapid restructuring of communities under the influence of anthropogenic factors, which has been observed recently.

In the past several decades, a significant number of alien species have been observed in the ichthyofauna of the Black Sea, many of which have been successfully naturalized. The basis of naturalized species (10) is made up of small cryptobenthic fish, mainly goby families. They lead a secretive lifestyle, so it is rather problematic to establish a more or less exact time of their introduction. Most of the alien species belong to the East Atlantic or Mediterranean ichthyofaunal complexes. One of the latest finds of this group of fish was the discovery of the Monrovia surgeonfish *Acanthurus monroviae* in 2018.

Five species are Indo-pacific or Pacific endemic. The main vector for the penetration of allochthonous species into the Black Sea is the natural process of mediterranization. However, the penetration of alien species from remote areas of the World Ocean is associated exclusively with human activity. These are artificial (*Planiliza haematocheila*) and accidental (*Tridentiger trigonocephalus*) introduction, unintentional drift with ballast water or release from the aquarium (*Heniochus acuminatus*) and independent penetration of «lessepsian migrants» (*Sphyraena pinguis*), which were opened by the Suez Canal. In this regard, the finds of another Pacific species from the Sebastidae family - Korean rockfish *Sebastes schlegelii* - are very interesting in the Black Sea off the coast of the Crimea and the Caucasus. The species apparently formed a small population in the Black Sea.

Despite the organization of regular ichthyological and hydrobiological studies, issues related to the study of the degree of naturalization of most alien species, the characteristics of their biology in new conditions, distribution and distribution, quantitative estimates of their populations, interspecific relationships and, in general, the impact on native biocenoses and bioresource potential the marine sector has not been fully explored.

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NEW INSIGHT INTO THE TAXONOMIC RESOLUTION OF THE GENUS *BYTHOTREPHE*S LEYDIG (CRUSTACEA: CLADOCERA) BASED ON MOLECULAR DATA FROM CENTRAL EUROPE

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The spiny waterflea (*Bythotrephes* genus) is considered as one of the most invasive zooplankton species since it conquers North American lakes in the '70s, while in Europe it is considered as a glacial relict. Also, the taxonomic status of the genus *Bythotrephes* has been debated since the second half of the XIX century. The most widespread view of recent decades has been that *Bythotrephes* is a monotypic genus, represented by only a single morphologically highly variable species, *B. longimanus*. The recent detailed morphological revision of this genus clearly distinguishes at least seven species. However, the preliminary genetic data rather suggest monotypic genus. Nevertheless, the records of *Bythotrephes* are scattered and incomplete, especially in Europe where most species or forms occur. Therefore, we performed morphological and genetic analyses of *Bythotrephes* populations in 20 lakes in Central Europe.

Based on the morphology we have identified two species, *B. brevimanus* and *B. lilljeborgi*, as well as the hybrid forms where the range of both species overlap. For the genetic analysis, we have used newly obtained 113 sequences of mtDNA COI gene of the 535-bp length *Bythotrephes* from Central Europe and sequences downloaded from GenBank. There were no significant differences between all analyzed sequences of the COI gene, which supports the hypothesis on the monotypic genus of *Bythotrephes*, with only one highly polymorphic species. However, we are realized that COI is a tricky gene – sometimes it has no resolution to discriminate two apparent species. Therefore, further analysis of nuclear genes which are more related to morphological character could be more informative for *Bythotrephes* genus. Nevertheless, our findings give new insight into the taxonomic resolution of the genus *Bythotrephes* which is recently debated.

We have identified 30 new haplotypes of mtDNA COI, and only one was the same as the haplotype found in North America and Finland. Furthermore, this haplotype was the source variant from which most other haplotypes were derived. Our results also pointed those central Baltic countries (Germany, Poland) could be a more accurate source of the invasion of North America, than the northeast Baltic region.

FISH-INVADERS IN THE WATER AREA OF THE MIDDLE IRTYSH ICHTHYOLOGICAL REGION

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Field studies of the ichthyofauna were carried out in 1981-2021 according to generally accepted methods. The Middle Irtysh ichthyological region of the West Siberian region is located in the zone of southern taiga, forest-steppe and steppe, almost entirely within the administrative boundaries of the Omsk region. On the territory of the ichthyological region within the Omsk region there are about 16 thousand lakes, incl. 245 saline, with a total area of 2.3 thousand km^2, over 500 rivers and small rivers with a total length of 3 thousand km. The ratio of the area of lakes to the total area of the territory in the region is 2%, with significant fluctuations in natural zones. Area stratification has been developed relatively recently. Due to changes in the hydrological conditions of the Irtysh River in its middle reaches, traditional spawning grounds in the previously flooded floodplain are mostly not functioning. Acclimatization work contributed to a change in the species composition of aquatic organisms. Information about the modern ichthyofauna on the territory of the Omsk region is scattered.

To date, on the territory of the Omsk region, the habitation of two species of Roundworm and 35 species of Bony fish has been reliably established, of which 13 species are the most massive, common representatives of the aboriginal fauna. The silver carp is represented by two forms: *Carassius auratus gibelio f.diploides* (Lieder, 1959) with normal fertilization (diploid, bisexual, autochthonous in Western Siberia) and *C.a.g. f.triploides* (Cherfas, 1965) gynogenetic (triploid in a number of chromosomes, unisexual (hermaphroditic in the female type), "Amur crucian", introduced in Western Siberia), at the turn of the XX-XXI centuries, displaced the autochthonous bisexual form from most reservoirs of the Omsk Omsk region.

An increase in the species diversity of ichthyofauna in the reservoirs of the Middle Irtysh ichthyological region began in the middle of the 20th century and was associated with acclimatization work on a number of species. Check-in in the Irtysh River bream *Abramis brama*, Amur crucian carp, spontaneous introduction of the common pike perch *Stizostedion lucioperca* from the Ust-Kamenogorsk and Bukhtarma reservoirs (the first individuals were caught in the Irtysh River in 1962), which have a rapid growth due to trophic plasticity and quantitative changes commercial and amateur catches. The fish of these species replaced the previously dominant species – the common ide *Leuciscus idus* and the common perch *Perca fluviatilis*. The cultivated form of common carp / carp *Cyprinus carpio* (cultivated breeds: hybrid, Sarboyan, mirror, naked) has been introduced intentionally since the middle of the twentieth century and has become widespread in the Irtysh River and lakes of the Omsk region, changing the phenotypic appearance of the wild carp. Three more species exist only in aquaculture, supported by reintroduction in fish farms: cupid white *Ctenopharyngodon idella*, silver carp variegated and white *Aristichthys nobilis* et *Hypophthalmichthys molitrix*.

Species such as verkhovka *Leucaspius delineatus*, Chekanovsky's minnow *Phoxinus czekanowski*, alburnus *Alburnus bleak*, amur chebachok *Pseudorasbora parva*, Nikolsky loach *Misgurnus nikolskiy* for the Omsk region are occasional infestations in the river and with various success rates. At the end of the 20th century, the settlement of the Amur sleeper *Perccottus glehnii* began, which by now has spread throughout the entire water area of the Middle Irtysh ichthyological region.

The role of invasive species in aquacenoses and fishery is different.

INVASANTS IN THE AVIFAUNA OF THE MIDDLE IRTYSH REGION

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Consideration of avifauna representatives as invasive species is difficult for a number of reasons. This is mainly due to the fact that birds of many species do not have clearly defined boundaries of ranges, which constantly change in accordance with short (several years), medium (several decades) and long (several hundred years) cycles of natural and climatic phenomena in limited or large territories. Therefore, it is possible to judge the constancy or inconstancy of the habitat of birds in the region-wide (or bordering on the area) territories only on the basis of many decades of observations, which make it possible to identify the cyclical changes in the areas. In addition, many migratory birds can find themselves outside the established range under the influence of weather and climatic conditions, especially in spring, before the start of the reproductive period, being carried by air currents to territories that are new to them. Settling young (more often immature) individuals of many species, especially medium- and large-sized ones, also often find themselves outside the range in search of free areas. Therefore, the consideration of any species of birds as an invasive in the territory outside the range should be determined only as part of the avifauna in comparison with ecologically close species, in the maximum possible retrospective, using weather and climatic indicators, using multifactor models and other modern methods of mathematical research. On this basis, only those species of avifauna whose nesting areas are located outside the studied region, but which successfully nested at least once in the territory of the studied region with the regular (over a number of years) presence of non-breeding individuals, were classified as invasive species of the Omsk Region.

The territory of the Middle Irtysh region (150.07 thousand km^2) almost completely coincides with the territory of the Omsk region (141.14 thousand km^2). To date, 352 species of birds have been reliably established on the territory of the Middle Irtysh region, excluding laboratory and exotic animals. Of these, 8 are domesticated. The rest of the species are wild free-living.

On the territory of the Middle Irtysh region, wild birds of 234 species regularly nest; the modern nesting of birds of another 13 species has not been reliably established, although they used to nest earlier. On migration, mainly in autumn, there are 30 species of birds. Birds of 5 species fly to the territory of the Middle Irtysh region for wintering. Birds of 62 species (not reliably nesting) are found on the territory of the Middle Irtysh region mainly only as vagrants.

The author's ornithological studies in the period 1975-2021 and bibliographic information from the early 1870s to the present allow us to assert that the invasion of avifauna species is realized in several stages. The first stage with substages is the appearance and habitation (first random, then regular) of non-breeding individuals outside the nesting area; the second stage with substages is nesting (first single irregular, then non-single regular, then mass regular) of individuals outside the historically established nesting area, with its expansion and inclusion of the invasion territory into the nesting area.

The complete process of invasion, culminating in the naturalization of the species with regular reproduction on the territory of the Middle Irtysh region in the interval of the last 100 years, has passed only a few species: the little grebe *Podiceps ruficollis*, the common pelican *Pelecanus crispus*, the great cormorant *Phalacrocorax carbo*, the great white heron *Egretta alba*, the red-nosed duck *Netta rufina*, white-eyed diving *Aythya nyroca*, bearded partridge *Perdix dauurica*, golden bee-eater *Merops apiaster*, blue-tailed *Tarsiger cyanurus*, black thrush *Turdus merula*. Along with endangered species that are decreasing in numbers and range, most of the invasive species are listed in the Red Data Book of the Omsk Region [2005, 2015] and subsequent additions to it on the basis that they are few in number, widespread in the region in a limited area, and subject to protection.

MULTIDECADAL VARIABILITY OF THE ANABIOTIC PARAMETERS IN THE CASPIAN SEA

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NCEP/NCAR reanalysis data for the period of 1948-2017 were used to study the multidecadal variability of the hydrometeorological parameters (thermal, dynamic and humidity) in the Caspian Sea region. Polynomial approximations of the time series of the annual mean values indicated the non-linear nature and periodicity of the long-term variability of considered parameters. Three temporal intervals of duration 10-25 years with multi-directional trends of parameters changes are detected, which is considered as a manifestation of multidecadal variability. The North-Eastern wind regime prevails over the sea basin, with the major portion of heat advection into the region provided by zonal (Eastern) transport. Phases of air warming/cooling coincide with a weakening/strengthening of the Eastern wind transport. The time lag between the shift of dynamic and thermal (as well as humidity) regimes is about 6-8 years suggesting a leading role of climatic variations of the large-scale atmospheric forcing in the regional variability of thermal and humidity parameters. Specific humidity is positively correlated with air temperature and decreases/increases during periods of cooling/warming. In contrast, relative humidity and precipitation rate variations are negatively correlated with air temperature trends. Intensification of Eastern transport and associated cooling over the Caspian Sea coincide with a situation when the North Atlantic Oscillation (NAO) index decreases to negative values, and the East Atlantic-West Russian pattern (EAWR) index is significantly positive. On the contrary, weakening of the Eastern transport and warming occur during a period of sharp strengthening of the NAO, coinciding with strongly negative values of the EAWR index.

DYNAMICS OF FISH DIVERSITY IN SOME SMALL WATER BODIES IN THE BALKHASH BASIN (CENTRAL ASIA)

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Fish fauna of water bodies in the Balkhash basin was significantly changed during second half of XX-th century. Diversity and abundance of indigenous fishes were drastically reduces as a result of alien fish introduction and human impact increasing. Now the main part of the water bodies suffers from fast increasing of human population in the basin. Deficient of water and changes in hydrological and hydro chemical regimen of the water bodies were reported. Therefore, investigation of changes in fish diversity was the aim of our researches.

Fish samples were collected in 1998-2020. Observations of fish fauna were conducted at 14 stations, such as artificial reservoirs Almaty Pond farm, Chilik pond farm, "inactive" or abandoned ponds of the Kazakh production and acclimatization station (KazPAS), Almaty Lake, ponds of the Kapchagai spawning and growing farm, and rivers Kaskelen, Turgen, Sholak-Kargaly, Chilik, Lavar, Zharsu, Terenkara, Bolshaya Almatinka, Malaya Almatinka. The fish were caught with a fine-meshed dragnet 15 m long with a 3 mm mesh, a rectangular landing net 500 x 700 mm with a 3 mm mesh and hooked tackles. In fish farms, fish were collected, immediately after the water was released in the ponds.

Based on the results of long-term data, we found 7 native and 16 alien species of fish. Moreover, all alien species can be classified according to the principle of economic value into "commercially valuable alien fish species" and "non-commercial alien fish species".

Of the native species, we noted: naked osman *Gymnodiptychus dybowskii* (Kessler, 1874), Balkhash marinka *Schizothorax argentatus* Kessler, 1874, spotted thicklip loach *Triplophysa strauchii* (Kessler, 1874), gray loach *Triplophysa dorsalis* (Kessler, 1872), plain thicklip loach *Triplophysa labiata* (Kessler, 1874), Seven River's minnow *Phoxinus brachyurus* Berg, 1912, Balkhash perch *Perca schrenkii* Kessler, 1874.

Commercially valuable alien species reared in the pond are represented by the herbivorous fish complex silver carp *Hypophthalmichthys molitrix* (Valenciennes 1844), grass carp *Ctenopharyngodon idella* (Valenciennes 1844), bighead carp *Hypophthalmichthys nobilis* (Richardson 1845).

The studied fish farms also contain a small-sized, slow-growing, low-value species - the crucian carp Goldfish *Carassius auratus* (Linnaeus, 1758), the pike-perch *Sander lucioperca* (Linnaeus, 1758), and in recent years, snakehead *Channa argus* (Cantor 1842). The snakehead entered the Balkhash basin at the end of the last century. Despite the damage it inflicts on aquaculture facilities, special control measures are not carried out or rather weak trash traps are installed in the ponds. Tilapia, several sturgeons like bester, Siberian sturgeon *Acipenser baerii* Brandt, 1869, Mississippi paddlefish *Polyodon spathula* (Walbaum, 1792) were raised from new aquaculture facilities in the Chilik pond farm. These objects were grown there on an experimental basis by employees of Kazakh Fisheries and Production Center.

Non-commercial "weedy" alien species of fish are found in almost all the studied pond farms and partially in the foothill part of the rivers there is a single pseudo-collection. According to the research results, we found 7 species: topmouth gudgeon *Pseudorasbora parva* (Temminck et Schlegel, 1846), Amur goby *Rhinogobius brunneus* (Temminck & Schlegel, 1845), eleotris *Micropercops cinctus* (Dabry de Thiersant, 1872), ocellated mustard *Rhodeus ocellatus* (Kner, 1866), Chinese false gudgeon *Abbottina rivularis* (Basilewsky, 1855), sawbelly *Hemiculter leucisculus* (Basilewski, 1835), Japanese rice fish *Oryzias latipes* (Temminck et Schlegel, 1846).

Over the past 20 years, all pond farms have repeatedly changed owners and fish farming technology. 3 out of 4 farms are in a depressed state (they have reduced or stopped the production of marketable fish). As a result, there was a decrease in the distribution of all commercially valuable alien fish species. The anthropogenic load on the rivers increased due to the increase in water consumption, regulation of channels, and growing pollution with household waste.

Non-commercial alien species in the order of distribution are arranged as follows: topmouth gudgeon> goby> eleotris and medaka> bitterness> abbottina>sawbelly. The abundance of these species experienced strong fluctuations in different years.

THE ROLE OF BIOTIC FACTORS IN LIMITATION THE INVASIVE ACTIVITY OF *LUPINUS POLYPHYLLUS* LINDL. (*FABACEAE*)

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The preservation of biological diversity is complicated by the negative influence of invasive plant species infiltrating aboriginal ecosystems (Mazza et.al., 2014). A representative of *Fabaceae* - *Lupinus polyphyllus* Lindl. is characterized by high invasiveness and is ranked among top-100 most dangerous species in Russia (Morozova, Vinogradova, 2018). New pathogens and pests commonly infesting *Lupinus polyphyllus* are creating additional danger for biodiversity. Measures proposed to it are incomplete when it comes to limitation of the invasive activity of *L. polyphyllus* (Tkacheva, 2010). This problem could be solved by introduction of biological control in the areas where the adventive species are concentrated. However, the relevant data suggesting whether this is applicable in case of *L. polyphyllus* were not found in available literature. The algorithm of biological control implementation includes screening of harmful organisms in native and secondary habitats of the plant and designation of possible targets objects.

Thus, the primal objective of our research was to analyze the species composition and adaptability levels of fungic and viral pathogens (and vectors of the latter) in local populations of *L. polyphyllus* in Moscow region.

Nine fungal pathogens were found as a result of systematic monitoring and complex phytosanitary expertise of *L. polyphyllus* population: *Phyllosticta lupinocola* Roth., *Helminthosporium rhopaloides* Fries., *Pleiochaeta setosa* Kirchn., *Sclerotinia sclerotium* (Lib.) De Bary, *Botrytis cinerea* Fr., *Erysiphe communis* Grev. *f. lupine* Roum., *Uromyces lupinicola* Bubak., *U. renovates* Syd., *Fusarium oxysporum* Schl. The danger levels, infection development and buildup speed, rate of occurrence differed depending on the type and species of the pathogen. Such pathogens as *Pleiochaeta setosa* Kirchn., *Botrytis cinerea* Fr., and of *Erysiphe communis* Grev. *f. lupini* Roum. dominanted in the analyzed population. *Uromyces lupinicola* Bubak. was also registered inrare cases. Other abovementioned pathogens only begin to adapt in *Lupinus polyphyllus* pathosystems.

We identified a wide range of pathological symptoms – mosaic, banding, yellows, narrow-leaved, necrosis characteristic of the manifestation of viral infections in the tested local populations of *L. polyphyllus*. As a result of enzyme-linked immunosorbent asay of *L. polyphyllus* genotypes five viruses were diagnosed – Tobacco mosaic Tobamovirus, Cucumber mosaic Cucumovirus, Bean yellow mosaic Potyvirus, Bean common mosaic Potyvirus, Pea enation mosaic Umbravirus. These are polyhostal pathogens with a wide spectrum of infesting plants and differing in virulence and circulation patterns within ecosystems. One of the major factors defining adaptation of viruses to *Lupinus polyphyllus* are vectors, especially representatives of *Aphididae. Aphis fabae* Scop., *A. craccivora* Koch., *Macrosiphum pisum* Raltz., *M. euphorbiae* Thom., *Myzodes persicae* Sulz. were among the most widespread species (50-70%) found in the collected materials. The aphid fauna consisted of sewen species associated with wood plants and several ones typical for herbaceous plants (excluding *Fabaceae*). Moreover, controlled of aphid infection of the plant showed, that even non-specific vectors *Acyrthosiphon caragana* Shol. and *Rhopalosiphum padi* Kalt. can feed from *L. polyphyllus* long enough to transfer a non-persistent virus (Bean yellow mosaic Potyvirus). Thus, the infection of *L. polyphyllus* may be caused by various sources and not only through specific vectors, but also via migrating stages aphid different species.

Taking into account the analysis of both specific and non-specific trophic links of aphid vectors, it is possible to predict the adaptability of new viral pathogens to *L. polyphyllus*, which will in its turn help to find the most virulent variants eligible for biocontrol.

IS IT INVASION COMPLEX OR INVASION OF MICROCENOSES? THE ANSWER LIES IN THE GALLERIES OF ALIEN BARK BEETLES *POLYGRAPHUS PROXIMUS* BLANDF. AND *IPS AMITINUS* EICH.

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Unbarked wood and packaging materials are the main vectors of alien forest pests (Brockerhoff et al., 2006; Piel et al., 2008) including bark beetles (Coleoptera: Curculionidae, Scolytinae). Under natural conditions, they act as a primary element in the process of destruction of weakened or dying trees. Several dozen representatives of this group of so-called "aggressive species" are able to settle on viable trees and cause significant harm forming outbreaks (Harvey et al., 2013; Raffa et al., 2015). As a result of their vital activity, excavating galleries in the tissues of the host plant, they create a specific environment for a diverse complex of organisms: bacteria, fungi and various invertebrates (Whitney, 1982; Biederman et al., 2019). This community of organisms, united by a wide range of consortium ties, corresponds to the concept of a microcenosis or even a microecosystem of a dead tree (Dajor, 1972; Odum, 1983).

In the last decade, the rapid death of Siberian coniferous forests was caused by the formation of foci of aggressive alien bark beetles species: *Polygraphus proximus* Blandf of Far Eastern origin (Baranchikov and Krivets, 2010) and *Ips amitinus* (Eichh.) with a primary range in the mountains of Central Europe (Kerchev et al., 2019). Although the vectors of invasion of these two species are oppositely directed, the pathway of invasion is most likely associated with the transportation of wood materials along the Trans-Siberian Railway. The depleted genetic diversity of the populations of *P. proximus* (Kononov et al., 2016; Bykov et al., 2020) and *I. amitinus* (Kerchev et al., 2020 unpublished), based on the analysis of the first subunit of mitochondrial cytochrome oxidase (COI), demonstrates the "bottleneck effect" characteristic of invasive species.

Previous ecological studies were devoted to the mechanisms of invasion and were aimed at establishing interactions of these bark beetles with other groups of organisms only in binary systems, for example: with phytopathogenic (Ohtaka et al., 2006; Pashenova et al., 2012, Pashenova et al., 2018) or entomopathogenic fungi (Kerchev et al., 2017), bacterial symbionts (Bykov et al., 2020), entomophilous nematodes (Kerchev, Ryss, 2017), phoretic mites (Khaustov et al., 2017; Khaustov, Kerchev, 2020), entomophages (Kerchev, Negrobov, 2012; Krivets, Kerchev 2016; Krivosheina et al., 2018; Krivosheina, Kerchev 2020).

Comparison of the species composition of invertebrates and metagenomic analysis of the microbiome in the primary and secondary habitats showed that each of the studied groups has at least one representative of an alien fauna or microbiota that has probably entered the new habitat together with alien bark beetles. The significant diversity of relationships within this community puts them on a higher level than the phenomenon of complex invasion (D'Antonio, 1990). Due to the presence of obligate or facultative relationships, many components of these communities continue to actively spread together with *P. proximus* and *I. amitinus* in the secondary range.

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RUSSIAN REGIONS DIFFERING IN THE DEGREE OF THE MOST DANGEROUS INVASIVE SPECIES IMPACT ON ECOSYSTEMS

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The results of mapping the regions of Russia, on the territory of which alien species can compete with native species and/or are able to displace them, participate in hybridization processes, significantly affect the structures, functions of terrestrial and aquatic ecosystems, causing significant damage to biodiversity are presented. We determined the number of invasive species inhabiting the areas inside units of administrative-territorial Russian division such as republic, krai, autonomous okrug or oblast', using the range maps of the 100 most dangerous invasive species (The Most dangerous ..., 2018). Three types of maps were created: 1. for aquatic ecosystems, using ranges of species, the entire life cycle of which is associated with aquatic ecosystems (40 species); 2. for terrestrial ecosystems using ranges of species, the life cycle of which is fully or partially (for example, Asian tiger mosquito – *Aedes albopictus* or American beaver – *Castor canadensis*) is associated with terrestrial ecosystems (60 species); 3. for all ecosystems including 100 most dangerous invasive species.

The largest number of aquatic invasive species is noted in the Black Sea region. From 14 to 23 species or 35-58% of the total number of the most dangerous aquatic species are found here. The second most important place (9-13 species or 22-33%) is the western Caspian region, the Baltic regions of Russia (Leningrad and Kaliningrad oblast's), the Central Volga region. These regions belong to the zones of high potential danger of the impact of invasive species on aquatic ecosystems.

The largest number of terrestrial invasive species (from 38 to 46 species or 63-97% of the total number of terrestrial invasive species) is noted in many regions of the European part of Russia (west of the Northwestern Federal Okrug, almost the entire Central Federal Okrug, south of the Volga Federal Okrug, north and the south of the Southern Federal Okrug). The second most important place (29-37 species or 48-62%) is the adjacent regions of the above-mentioned federal okrugs, the north of the North Caucasian Federal Okrug, Crimea, the Kaliningrad Region and the south of the Far Eastern Federal Okrug. These regions together are located on the Russian territory in two spots - a vast and powerful one in the European part and a smaller in area and thickness one in the south of the Far East. They can be attributed to areas of high potential danger of the impact of invasive species on terrestrial ecosystems.

Of the 100 most dangerous invasive species, the largest number (50-64 species) is found in the western regions of the Southern Federal Okrug, including the Crimea, and in the Leningrad oblast'. The second most important place (37-49 species) is the north and northeast of the Southern Federal Okrug, almost the entire Central Federal Okrug, a significant part of the Volga Federal Okrug, and the western part of the Northwestern Federal Okrug. In total, these regions lie in the west, center, and south of the European part of Russia. They can be classified as areas of high potential danger of the impact of the most dangerous invasive species on the ecosystems of Russia.

The constructed maps and the regions highlighted on them, differing in the potential danger of the impact of invasive species on ecosystems. These studies are important both for the development of the theory of biological invasions and for application in practice to minimize the consequences of the of alien species introduction.

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ALIEN SPECIES IN MAGADAN REGION AND IN THE HERBARIUM DATABASES

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The Herbarium of IBPN FEB RAS (MAG) is the third in the Far East of Russia by the number of stored samples. The team of Department of Botany keeps traditions and develops new directions in the knowledge of the regional flora.

General information about botanical collections is updated annually on the IBPN website (http://www.ibpn.ru/kollektsii, http://www.ibpn.ru/en/collections), and also in the Index Herbariorum http://sweetgum.nybg.org/ih/. In 2016, the herbarium was registered as UNU (unique scientific installation) "Herbarium (MAG)", link to the site "Modern research infrastructure of the Russian Federation" is http://www.ckp-rf.ru/usu/445676/

The checklist of vascular plants of the Magadan region (magflora) exists in electronic form, as a database (Excel), since 2000. It was compiled from literary sources and was further replenished according to the data of the own research of the employees of the botany laboratory. Until 1992, the Magadan Region included the Chukotka Autonomous Okrug, our database is territorially limited to the Magadan Region (excluding Chukotka). The Latin and Russian names of the species, distribution in 6 floristic regions (according to A.P. Khokhryakov, 1985) are given, and introduced species are especially noted. The most complete summary of synanthropic species (Lysenko, 2012) was supplemented by recent findings (Mochalova and Khoreva, 2016; Khoreva, 2018).

Currently, more than 1500 (302) species of vascular plants are known in the regional flora (in brackets - alien species), including 1200 (272) species in the Okhotsky floristic region, 660 (23) in Gizhiginsky, 818 (50) in the Okhotsk-Kolymsky watershed, 642 (29) in the Gizhiginsko-Omolonsky watershed, Kolymsky – 1088 (181), Omolonsky – 649 (12). The territory of the Okhotsky and Kolymsky floristic regions is the most economically developed, the federal highway "Kolyma" passes here, besides, the flora here is the most studied. The list is posted in publications of the laboratory of botany on the Institute's website and is available for download: http://www.ibpn.ru/mainmenu-34/mainmenu-39/nmainmenu-50

The revision of the list of imported species of the Magadan region was undertaken in 2018-2019 to prepare the paper "Invasive plants in flora of the Russian Far East: the checklist and comments" (Vinogradova et al., 2020). The paper presents a checklist of 116 species invading the natural phytocenoses of the Far Eastern Federal District of Russia (FEFD), including 52 species occurring in Magadan region. The most of the last ones are not invasive for our extremely north territory and even rare. The next step was the preparation of the Black Book of the Russian Far East flora.

For this project, in 2020, we completed barcoding and an electronic catalog of specimen labels for 52 species (all deposited samples, not only from Magadan region), a total of 1100 records. The label database contains the following columns: Barcode, Genus number, Scientific name in the collection, Taxonomy by the Catalog of Life, Region, Administrative district, Coordinates, Locality, Ecology, Date, Collected by, Identified by, Notes.

Since December 2019, barcoding of the collection has begun, this is the first necessary step for the subsequent digitization of samples (color scale, ruler, 600 dpi), georeferencing and integration into Russian and international biodiversity databases. This work was partially done for aquatic plants, the digital herbarium of the Magadan flora appeared on the portal of the digital herbarium of Moscow State University: https://plant.depo.msu.ru/module/collectionpublic?openparams=[open-id=157050739]

In 2021, we continue to barcode and supplement the electronic catalog of herbarium labels for all 300 alien species for the region. To date, the database contains 126 species, 2255 records. This work will be continued in the future, we hope it will be complemented by high-quality scanning of samples.

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USE OF MODERN DIAGNOSTIC METHODS FOR IDENTIFICATION OF THE PLUMBALL VIRUS IN THE SOUTHWEST REGION OF UKRAINE

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In recent years, viral diseases of fruit crops have become the object of intensive study in many countries of the world, due to their wide distribution and high harmfulness. One of the most dangerous viruses of stone fruit crops is the plum shark virus, it infects almost all types of stone fruit and is the most harmful on plums, apricots and peaches. The plum sharka virus has the status of a quarantine virus throughout the world, and in Ukraine in the "List of quarantine pests", it is classified as a limited spread in the country. The total area of plum sharka virus infection on the territory of Ukraine is 4025.18 hectares. In the Odessa region, 50.0 hectares are under quarantine.

During 2016-2020, route surveys of stone fruit plantations were carried out to identify plum balls. Sampling was carried out in accordance with the International Standards for Phytosanitary Evaluation. To diagnose the presence of a pathogen, an enzyme-linked immunosorbent assay (ELISA) was used, to identify its strains, a polymerase chain reaction (PCR) with reverse transcription.

The first signs of the disease were observed on the leaves in mid-May. These were blurry light green spots of various sizes, which were located along the veins and along the edges of the leaf blade. The spots were clearly visible in the world. In the center of the spots, leaf tissues retained their normal green color. Symptoms of the disease were observed throughout the growing season, but with an increase in temperature to 25-28 ° C, they were somewhat masked.

Plum sharka virus on stone fruit plantations was found in Ovidiopolsky (Khlebodarskoe) and Belyaevsky (Doslidnoe and Mirnoe) districts of Odessa region on a total area of 9.5 hectares. Virus strains were identified in the samples taken:

1. Khlebodarskoe, Ovidiopol region, cherries (area 2.5 hectares) - PPV-M;
2. Doslidnoe of Belyaevsky district on the drain (area 2 hectares) - PPV-D;
3. Mirnoe of Belyaevsky region of peach (area 5 hectares) - PPV-D.

Today, in conducting primary phytosanitary control, almost all countries use serological methods in combination with molecular ones. During serological testing by the ELISA method among the selected samples of affected plants of plum, cherry plum, peach, almond, apricot, cherry and sweet cherry, the most infected were peach - 45.6%, and plum - 42.1% of the total number of positive samples, cherry - 8.3%, cherry plum - 2.8%, nectarine - 1.2%.

Subsequently, all positive samples were verified using the molecular RT-PCR method. Modification of RT-PCR using 2 pairs of primers: 1. P1 / PD and 2. P1 / PM for diagnostics of M and D strains of plum sharka virus made it possible to determine mixed infection of PPV-D and PPV-M in some peach samples. It was found that the most common strain in the studied region is the D strain, the M strain is found much less frequently. Of all types of plantations, isolates of strain M were found only in fruit-bearing cherry orchards, strain PPV-D is most common on peach and plum. It is noted that the plantings of these particular crops are most widespread in the territory of the Odessa region. Disease diagnosis is the key to protecting stone fruit orchards from vectors.

INTERACTION OF THE NATURAL COURSE OF FLOROGENESIS AND CONTROL ACTIONS ON THE INVASIVE COMPONENT OF FLORA WITHIN THE PROTECTED TERRITORY OF THE KULIKOVO FIELD MUSEUM-RESERVE (RUSSIA, TULA REGION)

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The study area belongs to the Don basin, which occupies the southeastern forest-steppe part of the Tula region. Most of the steppe plots were plowed up here in the middle of the 18th century. The high population density and the pressure of economic activity contributed to the radical transformation of the landscapes and vegetation cover of the Kulikov Field. Currently, active work is being carried out on the territory of the museum-reserve to restore the steppe landscapes. The total area of the study area is 165 km².

Studies on the identification and dynamics of the distribution of adventive, including invasive plant species were carried out twice: in 2012 and in 2021. The main goal of the study is to identify the direction of florogenetic processes depending on the following factors: temporary, cenotic, anthropogenic, climatic, protective. The factor of the mechanism of formation of the secondary area was also taken into account as a vector of the realization of the species biological potential.

Research results. In 2012, 99 adventive plant species were identified on the territory of the Kulikov Field. In 2021 - 127 species. Almost all species of the adventive flora of the study area belong to two groups, distinguished by the mechanism of their formation of a secondary area. These are group 6: multiple drift, extended in time, from the secondary area and group 8: multiple drift, extended in time, from the primary and secondary areas. This indicates the relative ecological purity of the territory, that is, only species "established" in the region, long known as adventive, penetrate here.

Analysis of the composition dynamics of the studied flora over 9 years led us to the following conclusions:

1. There are 3 species reacting to the cenotic factor on a time trend of about 10 years. For example, the restoration of steppe cenoses, along with protective measures, leads to a decrease in the population of *Solidago canadensis*
2. There are 16 species reacting to the anthropogenic factor on a time trend of about 10 years. A local increase in anthropogenically developed territories leads to an increase in the proportion of species deliberately planted and escaped from culture.
3. There are 28 species reacting to the climatic factor on a time trend of about 10 years. This is a fairly large group of plants of a more southern ecology, increasing their presence in the flora due to climatic factors.
4. There are 2 species reacting to the factor of application of protection measures on a temporary trend of about 10 years. These are *Heracleum sosnowskyi* and *Solidago canadensis.*
5. There are 15 species reacting to a change in the vector of formation of the secondary area on a time trend of about 10 years. This is associated with rapid expansion, or vice versa, with the termination of the diasporas flow from the primary or secondary areas.
6. There are 63 stable species that have not shown changes in the dynamics and distribution mechanisms. The species of this group may be at the stage of latent florogenetic changes.

Taken together, the studied phlorogenetic processes, complex and often multidirectional, lead to the dynamics of the flora in terms of the time factor, which we actually observe in the study area.

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EXPLORING THE INVASION PROCESSES IN LEAF MINING MOTHS (LEPIDOPTERA: GRACILLARIIDAE) IN RUSSIA USING MOLECULAR GENETIC TOOLS

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The gracillariid micromoths (Lepidoptera: Gracillariidae) are highly diverse group of leaf-mining insects trophically associated with a great number of woody and herbaceous plants across the world. Among them, there is a number of agricultural, ornamental and forest pests affecting their host plants in the invaded ecosystems. In the last few decades, some leaf-mining gracillariids expanded their relatively small primary ranges and became known as invasive pests on vast territories.

Here we use two invasive micromoths, the lime leaf miner *Phyllonorycter issikii* (Kumata, 1963) and horse-chestnut leaf miner *Cameraria ohridella* Deschka & Dimić, 1986, as the model species to understand the peculiarities of invasion processes in gracillariids in Russia. We utilize the modern molecular genetic tools, in particular DNA barcoding (based on sequencing of the gene COI mtDNA), to determine the source of invasion, define invasive haplotypes and clarify the invasion histories. We also explore the archival data, in particular old herbarium collections, to determine past distributions of the invasive gracillariids.

In the last three decades, the lime leaf miner, a species from East Asia also known by its primary distribution in the Russian Far East, has spread across the whole Russia and is presently found nearly everywhere, both in natural and man-made ecosystems, where its host plant limes, *Tilia* spp. (Malvaceae) are grown. The extensive survey of 250-year-old herbaria accounting for about 16 thousand pressed specimens of lime leaves deposited in 20 museums and botanical gardens in Eurasia allowed retrieving essential data illuminating the invasion history of *Ph. issikii* in Russia. We confirmed long existence of this species in East Asia, including the Russian Far East, and found reliable evidences of the relatively recent occurrence of the moth in the European part of Russia and Western Siberia. We specified that the primary invasion foci occurred in geographically distant locations in the European part of Russia in about the same time in the 1980–1990s, suggesting multiple introductions of the species from East Asia to the west of Russia. Curiously, in the primary range in the Russian Far East, we documented the earliest leaf mines in herbarized lime specimens dated back to 1859, which is 103 years earlier the description of *Ph. issikii* from Japan (1963). By studying the phylogeography in modern range of *Ph. issikii* in Russia, we revealed high genetic diversity in the invasive populations confirming the complexity of the pest invasion.

The horse-chestnut leaf miner, the species of a presumably Balkan origin, has spread across most Europe becoming one of the major pests of the horse chestnut, *Aesculus hippocastanum* L. (Sapindaceae), a commonly planted ornamental tree. Since its first documentation in Moscow in 2005, it has been recorded in a number of regions in the European part of Russia continuing expanding its range and providing impressive outbreaks in urban areas that results in premature leaf fall. The pest is of a special concern in the resort regions in the Southern Russia, where the horse chestnut is widely used for landscaping, and where, due to the pest outbreaks, the trees intensively shed their foliage during high touristic season. Our preliminary phylogeographic data obtained for a few regions in the European part of Russia has so far identified a single invasive haplotype, largely distributed across the invaded European countries, including Ukraine and Belarus bordering with Russia, suggesting progressive and rapid secondary range expansion of *C. ohridella* in Russia. It is highly likely that the insect will penetrate into all the regions in the European part of Russia where its host plant is present.

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THE ENCOUNTERS WITH THE EUROPEAN MINK *MUSTELA LUTREOLA* (MAMMALIA, CARNIVORA, MUSTELIDAE) ON KUNASHIR ISLAND IN 2014-2021

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As the area and number of the European mink (*Mustela lutreola* L., 1761) reduced catastrophically, experts suggested various options for saving it. Experiments on the reintroduction of this species within the range known to it, but already inhabited by its competitor, the American mink (*Neovison vison*), turned out to be unsuccessful, and it was proposed to introduce the endangered species to the large islands of the Kuril ridge, where there were no minks (Ternovsky, Ternovskaya, 1994). In 1981, 1984 and 1985 on the island of Kunashir, 134 individuals of European minks were released: in the northern part (the Tyatina river and on an unnamed stream, between the Tyatina and Nochka rivers, called Banniy by the D.V. Ternovsky) and 20 km to the south (the Filatova river and its tributary - riv. Bolysheva). In 1990 and 1991 these rivers were examined, traces of the life activity of the mink were found, but the abundance of this species was low (Schwarz and Vaysfeld, 1993). According to polls by I.L. Tumanov (2009), no mink was recorded in the northern part of the island after 1994, and to the south (up to the Golovnino village on the southern coast), single animals were encountered at the beginning of the 21st century. But even these data, according to I.L. Tumanova (2009), "do not allow us to be completely sure that the European mink on the Kuril Islands has indeed survived to the present day" (p. 386).

Beginning in 2014, the staff of the State nature reserve Kurilsky carried out the work to register traces of European mink in the reserve area and the adjacent territory of Kunashir Island. For this, special pedestrian surveys of the banks of rivers, streams and lakes were carried out. In total, about 250 km have been covered. Most often, traces of minks were found in the snow, less often on sandy ground. Additionally, mink tracks were recorded during winter route counts (1062.1 km). In Kunashir, rivers do not freeze in winter, and one can see short tracks leaving the water and returning to it, left on the obstacles to the stream, on rocks or shallows. In the upper reaches of the Lesnaya river, on March 20, 2021, the mink, emerging from the water, ran about 3 km on land, moving away from the watercourse by 500-600 m. Having made a circle, it again descended to the river

In places where the animal was most likely to meet, camera traps were set up. We managed to get good shots of the mink with a white wool ring around its lips characteristic for the European mink.

From 2014 to 2021, the European mink was registered on 19 watercourses in different parts of the Kunashir Island. Most often minks were recorded in the central and southern parts of the island: on the Pervukhina, Luchevoy, Asin streams, on the tributary of the river Lesnaya and on the lake Peschanoye. The southernmost findings are located on lakes to the south of the Belozerskaya river mouth. The north of the island is less examined. Traces of minks there, including in the places of release, from 2014 to 2019 were not found, and the northernmost finding during this period was on the river Vilka. But on February 29, 2020, fresh traces of European mink were found in the upper reaches of the river Tyatina and on the channel of this river.

River estuaries in the northern part of Kunashir Island, such as Saratovskaya and Tyatina, have a wide floodplain that is flooded during severe floods. This may be the reason that the European mink did not take root here. A.A. Kisleiko watched as, after the downpours, the rapid current of the Filatova river carried away a mink cub the size of a rat. This confirms the detrimental effect of summer floods, which are typical for the island, on young growth.

Thus, it can be argued that 40 years after the first introduction of European mink on the Kunashir Island, it has been preserved here. And although further research is required to assess the current abundance of European mink on the island, the absence of competition from the American mink suggests that the predator, whose range and abundance in Europe is catastrophically decreasing, will exist on Kunashir, and the deliberate introduction of the endangered one can be considered successful.

CONTROL OF THE NUMBER OF WHEAT TRIPS *HAPLOTHRIPS TRITICI* KURD. MODERN INSECTICIDES ON WINTER WHEAT CROPS IN UKRAINE

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The the purpose of the research was to develop an effective system of protection of winter wheat from wheat thrips *Haplothrips tritici* Kurd., to determine the technical efficiency of Karate Zeon 050CS, mc.c insecticides, Match 050 ES, k.e., Talstar, 10% KE, Mospilan, VP, Inasuma, VG, Enzio 247 SK KS, in the conditions of the Southern steppe of Ukraine.

We also studied the duration of individual phases of development of wheat thrips by year, depending on the HTC (hydrothermal coefficient). Studies have revealed the main patterns of development of the population of wheat thrips and showed the possibility of controlling its numbers with modern insecticides.

Weather conditions during the study period were characterized by some features. A comparison of the specific weather conditions of 2017-2019 with the long-term averages shows that climate change has been observed in recent years due to global warming. Thus, the average annual air temperature over the years of research exceeded the average long-term indicators by 1.0-1.5°C. The amount of annual precipitation in two of the three years of research (2017, 2019) was less than the average long-term indicators by 7-36 mm. The average humidity for all years of research fluctuated at the level of long-term averages. Calculation of the sum of average daily air temperatures more than 10° C per year showed that in all years of research there is an increase in this indicator by 279.0-653.5°C. The indicator of the hydrothermal coefficient for the years of research decreased accordingly in comparison with the average long-term level by 0.04-0.27. These features of weather conditions influenced the dynamics of the pest population.

In the studies of 2017-2019, we compared the number of wheat thrips larvae in the control (untreated areas) by years depending on the sum of average daily temperatures for the period when they were above 10°C and the amount of precipitation for the same period. The ratio of these parameters, known as the hydrothermal coefficient (HTC), was used to determine its effect on the fertility of wheat thrips. We also studied the duration of individual phases of development of wheat thrips over the years, depending on the HTC. The results showed that there is an inverse relationship between these indicators: the lower the HTC, the longer the duration of the individual phases of pest development. In 2018, when the lowest HTC of 0.43 was observed, the number of wheat thrips larvae in the control plots was the highest - 255 ind. An increase in the HTC in 2019 to a value of 0.57 led to a decrease in the number of larvae - 246 individuals. The HTC index in 2017 was 0.66, which reduced the number of larvae to 195 individuals.

Results.

1. The abundance of wheat thrips largely depends on the temperature and precipitation of the year of study. The more the sum of the average daily air temperatures exceeds 10 ° C and the less the amount of precipitation during this period, the higher the number of adults and larvae of the pest in natural conditions.

2. The use of insecticides Karate Zeon 050CS, Match 050 EC, Talstar, 10% EC, Mospilan, WP, Inazuma WG in the studied application rates (0.3 l / ha, 0.2 l / ha, 0,1 l / ha, 0.075 l / ha and 0.24 l / ha, respectively, on winter wheat crops against wheat thrips in the phase "beginning of earing" (BBCN 51) effectively controls the number of adults of this pest when it reaches the threshold number and contributes to a further decrease in the number of larvae.

3. The use of insecticide Enzio 247 SK, KS in the consumption rates of 0.05 l / ha, 0.1 l / ha, 0.15 l / ha and 0.2 l / ha on winter wheat crops against wheat thrips ensures the technical effectiveness of this drug on levels of 90.2%, 94.5%, 95.9% and 96.4%, respectively. It is advisable to apply the consumption rates of the drug in proportion to the number of adults and larvae of thrips per 1 ear of wheat, while focusing on the established ETH.

THE COMPARATIVE STUDY OF ANTIOXIDANT DEFENSE SYSTEM AND THE PROSCES LIPID PEROXIDE OXIDATION IN TWO INVADERS SPECIES *DREISSENA POLYMORPHA* (PALLAS, 1771) AND *DREISSENA BUGENSIS* (ANDRUSOV, 1897) DEPENDING ON THE SEASON

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The Ponto-Caspian *Dreissena polymorpha* (Pallas, 1771) and *Dreissena bugensis* (Andrusov, 1897) are among the most successful invaders. The high adaptation potential of Dreissenids contributes to its fast range expansion across North America and Europe in recent decades (Farr, Payne, 2010; Karatayev et al., 2018; Mathai et al, 2021). Furthermore, these mussels compete, and quagga displaces zebra mussel The antioxidant defense systems are an important foundation for the ecological plasticity of animals and play a crucial role in the adaptation of organisms on the physiological and biochemical levels. For this reason, the comparative study of antioxidant defense system and the lipid peroxide oxidation of these two species of dreissenids is relevant.

The aim of the study – the comparative study of antioxidant defense system and the proces lipid peroxide oxidation in two competing species of mollusks *D. polymorpha* and *D. bugensis* in depend on season.

The individuals of *D. polymorpha* and *D. bugensis* were collected from April to November in Volga Reach of the Rybinsk reservoir (58°04'09" N, 38°17'17" E) which is in the European part of Russia. Immediately after capture, the mollusks were placed in liquid nitrogen at t = -195°C.

The activities of antioxidant enzymes such as catalase (CAT) (Aebi 1984), glutathione reductase (GR) (Carlberg, Mannervik, 1985), glutathione S-transferase (GST) (Richardson et al., 2008) and the content of low-molecular antioxidant such as reduced glutathione (GSH) (Habig et al. 1974), as well as the content of products of lipid peroxidation (LPO) - malondialdehyde (MDA) were evaluated by spectrophotometric method (Stalnaya, Garishvili, 1977).

Significant differences in parameters enzymes of the antioxidant defense system and LPO in dreissenids were found. *D. bugensis* has in two time higher the activity of enzymes of antioxidant defense CAT (245.3±21.80 nmol/min. mg prot) GST (11.20±2.14 nmol/min. mg prot) and the concentration MDA (4.09±0.90 nmole/mg prot.).

The reaction of the antioxidant defense system depending on the season was not different in quagga mussels and zedra mussels. Thus, the activity of CAT and GST increased from May to June, but in November decreased and had a minimum value. The content of GSH was maximum in May.

Although season changes in LPO were different. *D. polymorpha* had a high level of MDA in spring and in summer, *D. bugensi* in autumn.

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FINDING OF LONGTAIL DWARF GOBY *KNIPOWITSCHIA LONGECAUDATA* (ACTINOPTERYGII: GOBIIDAE) IN THE UNREGULATED SECTION OF THE VOLGA RIVER

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The organization of processes of regular monitoring of the appearance of alien fish species is the basis for creating a successful system for the control and prevention of biological invasions. Biological invasions' monitoring pays particular attention to invasive species able to induce dramatic changes in the native communities or cause significant economic impact. At the same time, there is a large number of "hidden" invaders, whose findings are sporadic, and the number is small. The identification of such alien species of aquatic organisms is extremely important for predicting further dynamics of their abundance and for the inventory of biological diversity in the region. Fish belonging to fam. Gobiidae provide several examples of such "invisible" invaders in the basin of the Volga. Of the initially rare single finds of gobies in the 1970s – 1980s, several species have now successfully occupied most of the European rivers, and have become a common, albeit usually small, component of the fish community.

A new find of longtail dwarf goby (Figure) *Knipowitschia longecaudata* (Kessler, 1877) (Actinopterygii: Gobiidae) was made in the upper reaches of the unregulated section of the Volga River, in the Krasnoarmeisky district of Volgograd (48°29′N, 44°44′E). The report contains data on the morphological and genetic variability of *K. longecaudata* from the Volga and from the native range (the Manych River). Low genetic differentiation between the sympatric species *K. longecaudata* and *K. caucasica* is shown, which requires special attention when identifying these species. It is assumed that the donor region for the penetration of this species into the Volga could be reservoirs of the Don River, and the transit corridor is the Volga-Don Canal. There is a high probability of further dispersal of longtail dwarf goby in the reservoirs of the Lower and Middle Volga.

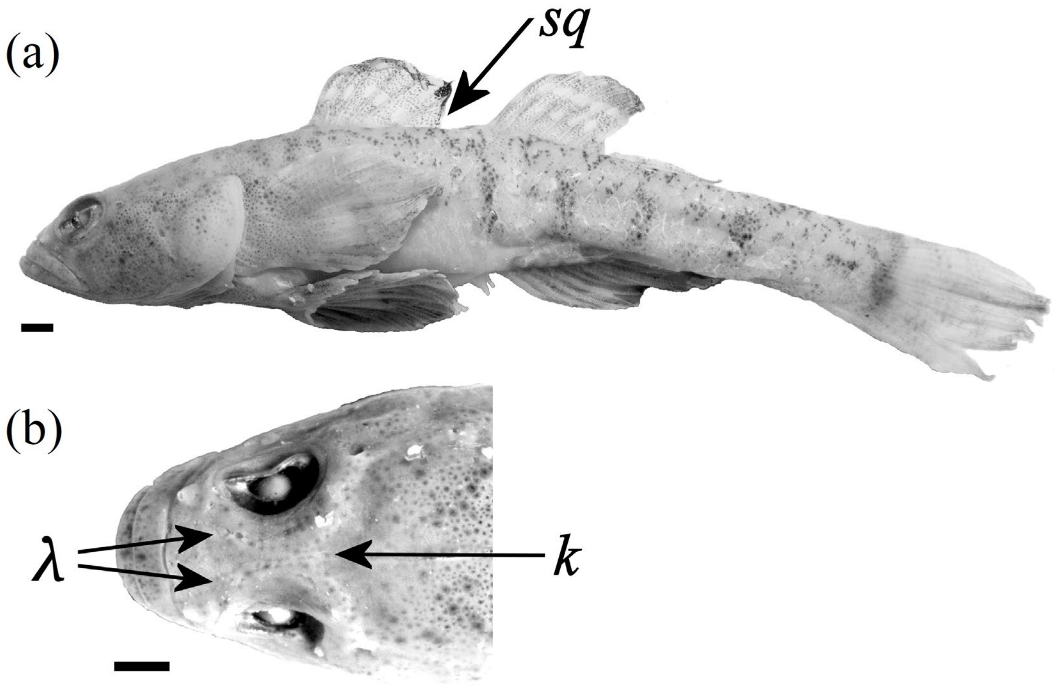

Figure. Exterior view of *Knipowitschia longecaudata*, Volga River, September 8, 2017, Krasnoarmeisky district, Volgograd: (a) – general view of fish; (b) – enlarged part of the fish head from the dorsal side; *k* – head pores, *λ* – paired pores of the anterior ocular-scapular canal of the seismosensory system of the head, sq – the spot where the scale cover ends on the dorsal side from the caudal fin side. The scale is 1 mm.

For details see: Kodukhova Y.V., Karabanov D.P. Finding of longtail dwarf goby *Knipowitschia longecaudata* (Actinopterygii: Gobiidae) in the upstream part of unregulated section of the Volga River // Inland Water Biology. 2021. Vol. 14. No. 5. P. 620–625. https://doi.org/10.1134/S1995082921050072

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A TROPICAL BIODIVERSITY HOTSPOT IN SIBERIA: ALIEN FRESHWATER MOLLUSCS IN AN ARTIFICIALLY HEATED CHANNEL OF A THERMAL POWER PLANT

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Artificially heated waters often serve as suitable habitats for invasive freshwater species. Power plants are one of the primary sources of thermal pollution of water bodies at the global scale. Heated water, most often, is discharged from a power plant through a special channel. This channel empties into a dammed reservoir, gradually cooling the water. Such kind of channels and adjacent reservoir area represents a warm freshwater environment suitable for animal and plant invasions. The cooling channel of the Belovo Thermal Power Plant (TPP) in the Kemerovo Region, Western Siberia, could be considered a typical example of such artificially heated environments. Summer water temperature in the channel varies from 24 to 36°C, and in the winter it ranges from 5.4 to 10.1°C. These temperatures are suitable for a variety of subtropical freshwater species. We collected freshwater molluscs samples from this area in September 2019. Tissue samples of molluscs were fixed with 96% ethanol. Five species of gastropods and two species of bivalves were identified from the channel using morphological analysis and DNA sequencing. Bivalves in the channel are represented by two invasive species, i.e., *Sinanodonta woodiana* (Lea, 1834) and *S. lauta* (Martens, 1877) (Unionidae). In the channel, these species occur as a sympatric mussel bed with a density up to 148 individuals per m^2. In addition, both species were found in the Belovo Reservoir itself and below the dam on the Inya River, where the thermal pollution greatly decreases (or absent). It was shown that *Sinanodonta woodiana* and *S. lauta* were accidentally introduced to the Belovo Reservoir at the larval stage with host fish stock(s) that were transported for aquaculture purposes. The fish hatchery cages are situated in the reservoir right ahead of the channel discharge (Kondakov et. al. 2020). In addition, five species of gastropods were found in the cooling channel: *Ampullaceana lagotis* (Schrank, 1803), *Radix auricularia* (Linnaeus, 1758) (Lymnaeidae), *Physella acuta* (Draparnaud, 1805) (Physidae), *Planorbella* cf. *duryi* (Wetherby, 1879) (Planorbidae), and *Pomacea canaliculata* (Lamarck, 1822) (Ampullariidae). The three latter taxa, i.e. *Physella acuta*, *Planorbella* cf. *duryi*, and *Pomacea canaliculata*, are invasive species. Based on the results of genetic analysis, *Physella acuta* from the Belovo Reservoir belongs to the European lineage of this species, which is often found in the artificially heated water bodies (our unpublished data). In its turn, *Pomacea canaliculata*, the Golden Apple Snail, was found in Siberia in the Belovo Reservoir exclusively (Yanygina et al. 2010; Vinarski et al. 2015). Its appearance in the cooling channel could be linked to accidental introduction(s) by aquarists, often breeding various Ampullariidae species. Numerous pink-colored clutches of Golden Apple Snail were observed on stones near the water surface throughout the channel, and in thermally heated places of the reservoir as well. Our DNA-based analysis showed that the samples of *Planorbella* cf. *duryi* from the channel belong to two genetic lineages. The first one was previously recorded from the Middle East (Iran), Africa (Zimbabwe), the New World (USA, Canada, and Mexico), and New Zealand (BOLD IDS data). Conversely, members of the second lineage were recorded from Germany and France. The appearance of the invasive *Planorbella* cf. *duryi* in Siberia should also be linked to aquarist's activities. Earlier, empty shells of *Planorbella* spp. were recorded from several localities of Siberia and the Middle Urals, including the Belovo Reservoir (Yanygina and Vinarski 2010; Vinarski et al. 2015). The species-level identification of invasive *Planorbella* from Russia needs further research. In addition to the invasive species, *Ampullaceana lagotis* and *Radix auricularia*, which are native to Siberia, were found in the cooling channel. It was shown previously that these species successfully invade geothermal springs with a higher mineralization such as Pymvashor Geothermal Valley (*Ampullaceana lagotis*), and Lake Baikal and Kamchatka hot springs (*Radix auricularia*). Their presence in the cooling channel confirms that they have mechanisms of resistance to higher water temperatures. This finding reveals that these species could be used as model objects for the study of freshwater animal adaptations to warm temperature regimes at the genetic level.

Finally, we show that the cooling channel of the Belovo TPP is a suitable habitat for a bunch of tropical invasive molluscs and that this "thermal island" may serve as a springboard for rapid expansion of alien species throughout Siberia in a future.

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GENETIC STRUCTURE OF EURASIAN BEAVER IN SPACE OF CASPIN-BALTIC WATERSHED

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The focus of our study is Eurasian beavers inhabiting the territory of Tver and Pskov regions. From a hydrographic point of view, the territory of collection of the material belongs to the Caspian-Baltic watershed of the East European Plain. In this area, the disappearance of Eurasian beavers’ dates back to the second half of the XVII - the first half of the XVIII. After the successful reintroduction of the species, which began in 1936 and ended in 1970, the number of *Castor fiber* in this part of the range has recovered, showing an upward trend.

The aim the study was reveal genetic structure of Eurasian beavers inhabiting Caspian-Baltic watershed in European part of Russia forming after multiply reintroduction.

In total we genotyped 134 individuals on the base of the mitochondrial DNA fragment (D-loop, 467 bp) and 11 microsatellite markers.

The beaver population in the study region is characterized by a relatively high genetic polymorphism, against the background of other reintroduced populations. The mean number of pairwise differences between haplotypes was 6.06 ± 2.92, haplotype diversity (H) was 0.72 ± 0.03 and nucleotide diversity (π) – 0.012 ± 0.006. Among examined samples heterozygosity where: He = 0.483 ± 0.051; Ho = 0.412 ± 0.016. allelic richness Ar = 2.48.

In accordance with the well-known history of the formation of local settlements and the results obtained, the central part and northeast of the Tver region populated by direct descendants of *C.f. orienoeuropaeus*, reintroduced from the autochthonous population of the Voronezh Reserve. In the west of the Tver region. a population group formed by hybrid animals belonging to the subspecies *C.f. belorussicus* × *C.f. orienoeuropaeus*. Western regions of the Tver region they are experiencing an influx of hybrid beavers from the Pskov region, whose population was formed after multiple releases of animals belonging to different subspecies. In the northeastern part of the region, a population group of reintroduced *C.f. orienoeuropaeus* not hybridizing with other subspecies.

Subsequent multiple reintroductions from various autochthonous populations of Voronezh and Belarus have greatly complicated the phylogeographic structure of the modern population of Eurasian beaver in European part of Russia. However, intrapopulation groups that retain intraspecific purity are still revealed on a relatively small fragment of the range. In our study, this is the northeastern part of the Tver region, where only autochthonous beavers were released from the Voronezh Reserve, there were no other sources for reintroduction here. Further intrapopulation trends for reintroduced Eurasian beavers are likely to be the smoothing of spatial genetic structure with the loss of features character for autochthonous subspecies. Multiple reintroductions eighty years after the beginning of the first translocations resulted in a unified but spatially still structured metapopulation of heterotic animals with good viability and potential for further expansion. According to current population counts, indicating its increasing as well as predictive estimates of promising demographic parameters, existing in the European part of Russia beavers are in a climax state, which confirms the deep integration of the reintroduced species into ecosystems.

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INVASIVE ALGAE IN CONTINENTAL FRESHWATERS: ECOLOGY AND MODERN DISTRIBUTION

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Such human economic activities as hydro engineering, water transport, construction of canals, intentional introduction, etc. significantly influence the intensity of modern spread of aquatic organisms outside their "historical ranges". Anthropogenic transformation of hydrographic networks and terrains contributes to the destruction of natural barriers. The migration of animals and the movement of air currents also contribute to the spread of microalgae. Rebuilding the structure of aboriginal communities, "immigrants" create conditions for changing the structural and functional characteristics of all subsequent trophic links and the characteristics of the phenophases of individual taxa. Rivers, especially those flowing in the meridional direction, and the influence of the modern climate are of great importance in the distribution of invasive species.

To date, over 50 species of phytoplankton recorded in the continental water bodies of Eurasia and North America are considered alien. The majority of these species are cyanobacteria and diatoms. The main direction of their distribution is from south to north. The spread of brackish and marine organisms into fresh water bodies is accelerated in areas with spatio-temporal salinity gradients. The Volga River is the largest transmeridional Ponto-Volga-Baltic "invasion corridor" in Europe. Currently, the Volga is a cascade of reservoirs located in three geographical zones: forest, steppe and semi-desert. Reservoirs differ in age, morphometry, hydrophysical, hydrochemical parameters and water trophy. Geographic zoning determines a decrease in the color of water and the amount of suspended matter and an increase in mineralization and transparency of water in the direction from north to south, from the Upper to the Lower Volga. Until 2017, there were 17 alien species of planktonic algae in the reservoirs of the Volga basin. These are mainly diatoms and one species of dinoflagellates. Except for the latter, all species are brackish water or marine.

Only two out of all these species usually dominate the planktonic algal communities of reservoirs: *Skeletonema subsalsum* (Cleve-Euler) Bethge and *Actinocyclus normanii* (W. Gregory ex Greville) Hust. Initially, their abundance and biomass progressively increased. Then, against the background of the subsequent decrease and stabilization of their abundance, their ranges gradually expanded. Antiphase was established in the long-term dynamics of their biomasses in the Rybinsk Reservoir. Among the dominant species of the Cheboksary Reservoir, *Thalassiosira incerta* Makar was also noted for the first time in 2001. Local mass development of this species was observed in 2011 in the high-trophic waters of the lower reaches of the Oka River. Two stages of the active spread of invasive species in the Volga plankton are distinguished. The first period (1960th) corresponds to the completion of the main hydro construction and the subsequent change in the hydrological and hydrochemical regime of the river. The second period (1980th) is associated with the beginning of global climate change. These changes contributed to an increase in the Volga discharge, a rise in the level of the Caspian Sea, an increase in temperature and water salinity in reservoirs. Both periods coincided in time with the high-water phase of cyclical fluctuations in the total moisture content, when the total species richness of phytoplankton decreased. The main reasons for the introduction of alien species of phytoplankton into the Volga reservoirs include an increase in temperature, salinity and trophy of waters. In the summer of 2020, the flagellate green alga *Phacotus minusculus* Bourrelly, an inhabitant of eutrophic Black Sea coastal wetlands and salty rivers of South America with a high content of ammonium nitrogen (1–2 mg/L), was first recorded in the phytoplankton of the Kuibyshev Reservoir. In the Saratov Reservoir, a new species for the Volga dinoflagellates *Unruhdinium penardii* var. *robustum (*Qi Zhang, G.X.Liu & Z.Y.Hu) Gottschling 2017, was described as a taxon new to science from rivers and lakes in China. During 2017–2019 the macroalga, *Vaucheria compacta* (Collins) Collins ex W.R. Taylor (Xanthophyceae), a North Atlantic estuarine species, was found in tailraces of the Volga River dams, which are characterized by daily fluctuations in the water level. The records from the Volga River were unexpected since the new localities are confined to hinterland area of endoreic Caspian Sea basin up to 800–1600 km from the main range of the species. Presently, invasions of macroalgae in inland waters are known only for a few species.

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MORPHO-PHYSIOLOGICAL FEATURES OF EURUPEAN SMELT IN THE HABITAT OF A SUBARCTIC MOUNTAIN LAKE

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An important feature of the behavior of the European smelt in modern conditions is the active development of new habitats in the subordinate lake-river systems of the lake basin. Imandra due to the processes of self-settlement.

The basic forms of freshwater populations of the European smelt should probably be considered lake-river smelt of cold-water and deep lakes (such as Ladoga and Onega), which differ in relatively long life expectancy, large size, and relatively late maturation. This is also typical for the Imandra smelt. The body length of the fish in the catches of 2011 – 2018 ranged from 92 to 255 mm. The basis of the population (70%) was fish aged 5-7 years. Sexual maturation in males and females began at the age of three, with linear dimensions of 90 mm. The life expectancy reached 11 years. The number of females is five times higher than that of males.

A distinctive feature of the lake Bolshoy Vudyavr is its geographical location - 312.7 m above sea level, the lake is the highest reservoir in this area, where the smelt lives. The study of its characteristics is of undoubted interest. The first reliable information about the appearance of smelt in the lake belong to 2013, before that it was absent in the catches of 2006-2008. It entered the reservoir along the Bolshaya Belaya River from lake Imandra. Most likely, these were mature fish who successfully spawned, which is confirmed by the presence of two-year-old fish in the catches of 2014. It should be noted that at this age, with an average length of 102 mm, they already had gonads of the II-III and III stages of maturity. In 2015, the number of age groups increased (1+, 2+, 3+ and 5+), three-year-olds dominated. A sample analysis of the smelt age from the 2018 catches showed a decrease in the proportion of younger fish. In 2019, four and five-year-olds dominated. The maximum life expectancy of smelt in this lake did not exceed 6 years. The body length for the entire observation period ranged from 95 to 170 mm. The environmental conditions of the recipient reservoir turned out to be less favorable than in the donor reservoir, which contributed to a change in the growth rate, the time of puberty and a reduction in the life cycle of fish.

Active distribution of smelt within the subordinate lake-river systems of the Niva River basin and the lake Imandra is obviously caused by a significant increase in its number in the reservoir and the need to develop new habitats favorable for existence.

Whether the smelt will be able to survive and reproduce in the harsher conditions of the lake Bolshoy Vudyavr requires further observations.

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ALIEN SPECIES IN THE FLORA OF POLISTOVSKY NATIONAL NATURE RESERVE (RUSSIA, PSKOV REGION)

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Floristic investigation in the territory of Polistovsky Reserve and its protective zone has been carried out since 2003 on a regular basis. The first inventory of flora was performed in 2003–2006. (Reshetnikova et al., 2006). In 2020, the second edition of the annotated checklist of vascular plants was issued (Korolkova et al., 2020). The majority of invasive plant species (The most dangerous invasive …, 2018) were identified during the first inventory. Generally, these species are stable in the territory of the Reserve; however, some species give cause for concern. Listed below are the invasive plant species of the Reserve and its protective zone (in increasing order of plant community invasion activity).

Elodea canadensis Michx. Was collected only once by VG Sergienko, in the watercourse near Chiletz village in 1998 (in the protective zone). Despite extensive surveys, were failed to find it anywhere.

Fraxinus pennsylvanica Marshall. It occurs in the protective zone of the Reserve, in the plantation on the site of the former villages Nesvino and Ratcha. No dissemination is observed.

Amelanchier spicata (Lam.) C. Koch. Was recorded in the protective zone, in the plantation near Usadba vollage, but has not disseminated in the territory of the Reserve. In the Rdeysky Nature Reserve (shares borders with Polistovsky Reserve), it spreads across coniferous swamps with alder.

Oenothera biennis L. Only in the protective zone: was found for the first time in 2003 on the side of the causeway to the north from Gogolevo village.

Solidago gigantea Aiton. Was recorded in 2018, at the border between the Reserve and the protective zone, in the meadow on the site of the former village Maloye Gorodishe.

Lupinus polyphyllus Lindl. Only in the protective zone: was found in 2019 on the roadside near Ivanisovo village in a small number; further spread across the protected area is possible.

Erigeron canadensis L. On the bench lands of Polisto lake, on the peat-sand substrates, in the burnt areas, in the meadows on the sites of former fields in a small number, and on the roadsides. In the Reserve, it is found only near the Polisto lake opposite to Ruchii village (sometimes abundant), and in burnt areas to the east from Ukhoshino village. In the protective zone it is rare, found in a small number.

Impatiens glandifera Royle. Was found in meadows on the sites of the former fields, in the mixed forests, and on the roadsides. Was first recorded in 2003 the southern part of the Reserve, and had settled extensively since then. Currently, it is spreading actively across the southern part of the Reserve and its protective zone along the roadsides.

WHAT SPECIES OF THE GENUS *BYTHOTREPHES* (CRUSTACEA: CLADOCERA: ONYCHOPODA) HAS INVADED THE LAKES OF NORTH AMERICA?

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The representatives of the invasive genus *Bythotrephes* Leydig, 1860 were first detected, being mostly recorded as a part of fish gut content, in the zooplanktonic communities of the North American Laurentian Great Lakes in early to mid-1980s. However, according to lake sediment studies they might have been introduced in the lake communities earlier. Subsequent to colonization of the Great Lakes, *Bythotrephes* widely invaded the neighboring inland waters of the United States and Canada and continues to expand its distribution.

The appearance of *Bythotrephes* in North America caused an explosion of interest in these crustaceans. Their impact on inland water communities is great, resulting in reduced zooplankton richness and abundance, primarily associated with predation on cladocerans. For this reason, these predators were characterized as "a plague of waterfleas" due to which the microcrustacean biomass can reduce 40–60 % and secondary production declines by about 67 %. Economic losses from the introduction of this alien species can also be very high, reaching tens of millions of dollars per lake. Many scientific publications are devoted to the description of its biology and therefore, the North American *Bythotrephes* could be fairly called "the world's best studied invasive zooplankter".

It is paradoxical that, despite being deeply investigated ecologically, the taxonomic status of the North American *Bythotrephes* remained poorly understood. The researchers noted the considerable intra- and interpopulational morphological variability of *Bythotrephes* and identified them variously as either different species, *B. longimanus* and *B. cederströmii,* or different morphotypes of one species. The latter opinion has prevailed being supported by genetic studies, and accepted "*B. longimanus*", which is both morphologically and genetically variable and widely distributed, as the only species of the genus. This was mainly due to inadequate investigation of highly morphologically variable and poorly studied representatives of *B. cederströmii* or yet undescribed interspecific hybrid forms which were incorrectly collectively considered as members of the variable species, "*B. longimanus*". The existence of hybrids of *Bythotrephes* confused researchers who attempted to resolve the taxonomic structure of the genus using either morphological or genetic methods. Studies of morphologically highly variable hybrids or amalgam of forms, including specimens of different undistinguished species and hybrids, have inevitably resulted in the incorrect conclusion that only one variable species of the genus existed.

The investigation of individuals of the genus from 15 Canadian lakes has allowed identifying all of them as *B. cederströmii* Schödler, 1877, based on the detailed taxonomic redescription of the Eurasian representatives of the species. Thus, the recent name used for the North American *Bythotrephes*, *B. longimanus,* must be rejected. The available documented data, figures and photographs, on *Bythotrephes* from other North American lakes, made it possible to recognize their identity with this species as well. The possible introduction of interspecific hybrids of the genus *Bythotrephes* in the North American lakes has not been confirmed.

KEY SOURCES OF INVASIVE FLORA IN FUJAIRAH, UNITED ARAB EMIRATES (UAE)

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We conducted a study of the Fujairah Emirate (United Arab Emirates) on the main habitats of the world's flora species known for their invasiveness. The study took place since 2017 and ongoing. First of all, such places as: planting of landscape gardening, orchards and vegetable gardens (especially on farms), livestock farms, landfills, plant nurseries were examined. The seaport – a territory of potential distribution of invasive flora, closed for outside visits. Nevertheless, around the territory of the seaport no intrusive species, in addition to those common in this area, were not noticed.

The main limiting factor for the introduction and naturalization of invasive species in the territory of the Fujairah emirate is the extremely unfavorable arid climate, as well as the mountainous terrain of almost the entire emirate.

Our studies have shown that the main sources of invasive species are: private planting in areas adjacent to houses (yards); planting of municipal landscape gardening; planting on the territory of hotels; landfills and houshold dumpsters. Plants for landscaping and private gardens purchased from plant nurseries, in which various types of ornamental plants are bred, and imported from other countries: Pakistan, India, Spain, China and others. The most abundant finds were in plant nurseries.

We have noticed that the main limiting factor for the spread of invasive flora is the presence of permanent water sources. Due to the expansion of local settlements, along with infrastructure, landscaping and private gardens, there are more available places for the life of alien flora, which includes species known as invasive in other areas and found by us in the territory of the Emirate of Fujairah, such as: *Prosopis juliflora, Washingtonia filifera, Washingtonia robusta, Phoenix dactylifera, Chloris virgata* Swartz, *Albizia lebbeck, Leucaena leucocephala, Parkinsonia aculeata, Azadirachta indica, Amaranthus* spp., *Cyperus rotundus, Lantana camara, Jatropha gossypiifolia, Parthenium hysterophorus, Catharanthus roseus, Millingtonia hortensis, Opuntia stricta, Opuntia ficus-indica , Opuntia monacantha, Ipomoea cairica, Pithecellobium dulce, Asystasia micrantha, Merremia dissecta, Ficus benghalensis, Ficus religiosa, Ficus microcarpa, Ficus benjamina, Eucalyptus camaldulensis, Solanum nigrum, Conocarpus lancifolius, Terminalia catappa* and others.

Analysis of the origin of invasive species shows that most of them penetrate into the UAE and Fujairah in connection with human activities. Trees and shrub species appeared here after their introduction by cultivation (garden, park and forest reclamation plantings). Horticultural crops appeared here, apparently, in the 19th – 20th centuries, and reclamation plantings - in the middle of the 20th century. Many species were brought into the country from the West. Europe, North. America, Africa, etc. for landscaping settlements, protecting roads from sanding, fixing dunes, ravines, etc. The planting of woody plants has been massive over the years, especially in the afforestation of open sands, such as in the vicinity of Dubai and Sharjah. As a result, many of them were able to penetrate into native plant communities and now pose a threat to the local flora, significantly changing the landscape (*Prosopis juliflora*, etc.). Herbaceous species could have entered the UAE in other ways, through a drift with grain, hay, building materials, planting material, along roads, or run wild from culture.

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CHROMOSOME NUMBERS IN INVASIVE SPECIES OF THE GENUS *SENECIO* L. (ASTERACEAE) IN NATURAL AND SECONDARY DISTRIBUTION RANGES

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The genus *Senecio* L. (Asteraceae) includes 1,500–2,000 species distributed in temperate, subtropical, and tropical regions of Eurasia, Africa, America, and Australia. There are 9 species growing in European Russia. There are 7 species growing on the territory of the Far Eastern Federal District (FEFD), 3 species of them are alien ones, 2 of them have been naturalized: *S. viscosus* L. and *S. vulgaris* L. The natural distribution range of *S. vulgaris* covers the whole Europe and Mediterranean. The natural range of *S. viscosus* includes Western and Central Europe, the Caucasus, and the northwest of European Russia.

S. vulgaris was first discovered on FEFD in the Tunkinskaya Valley (Buryatia), by N.S. Turchaninov [*Therma Tunkinensei. 1829. Turcz., LE*]. Half a century later, in 1880, it was collected by F.M. Avgustinovich in the vicinity of Vladivostok. This species, introduced at initial stages of development of the region, nowadays grows in all 11 subjects of the FEFD and occupied all habitats similar to those in its natural distribution range: railway embankments, wastelands, disturbed meadows, tillages and laylands, vegetable gardens, ditches, forest clearings, sea coasts, colliery waste, oak forests, shrub thickets, and lawns. The period of formation of its secondary distribution range in FEFD is about 200 years.

Rail transport was the pathway of invasion of *S. viscosus* into the FEFD. The species was firstly discovered in the vicinity of Vladivostok [*Sedanka station (17 km from Vladivostok), railway track, on the embankment, often, obviously alien, 20 VII 1948, D.P. Vorobiev, VLA*]. At present time the species is distributed in 6 of 11 administrative subjects of FEFD; in five of them (excluding Sakhalin) the first finds are associated with the embankment of Trans-Siberian Railway. The species "escapes" from railways to other habitats: the sea coast, meadows, rocky mountain taluses, colliery waste, and weedy sites. The period of formation of its secondary distribution range in the FEFD is 73 years.

The aims of our study were to compare the chromosomes numbers for *S. vulgaris* between populations of natural and secondary distribution ranges and to determine chromosome numbers for *S. viscosus* in its secondary distribution range.

Achene of *S. vulgaris* were collected in 2 populations of the natural distribution range (N) and 2 populations of the secondary distribution range (S): 1N) Kostroma Region, Sharya district, railway station Sharya, on the platform, N 58.366446, E 45.516054; 2N) Kirov city, on the railroad bed, N 58.596650, E 49.660070; 3S) Amur Region, Blagoveshchensk, 208 Krasnoarmeyskaya Str., near the fence of a garage cooperative, N 50.161930, E 127.295265; 4S) Primorsky Territory, Vladivostok, Korabelnaya embankment, on a railway track, N 43.064523, E 131.533758. Achenes of *S. viscosus* were collected in 3 populations of the secondary distribution range: 1) Tver Region, Toropetsky district, near Maslovo village, in a parking lot, N 56.260798, E 31.494906; 2) Amur Region, Bureysky district, vicinity of Talakan village, rocky bank of Bureya river, among pebbles, N 50.154702, E 130.172900; 3) Primorsky Territory, Vladivostok, Korabelnaya embankment, on a railway track, N 43.064523, E 131.533758.

The chromosome numbers were determined by the method of Yu.A. Smirnov.

All analyzed plants of *S. viscosus* and *S. vulgaris* are tetraploid: 2n = 40. At this research stage, we did not find any differences in the *S. vulgaris* chromosome number between the population of natural and secondary distribution range. For the first time, chromosome numbers were determined in *S. vulgaris* populations from Kostroma, Kirov, and Amur Regions and in *S. viscosus* populations from Tver and Amur Regions.

Our results confirm the data of other authors who determined the chromosome numbers of the studied species in the European part of their distribution ranges. However, for the FEFD, other data are also given in the literature. Thus, for *S. vulgaris* a variable ploidy was found: 2n = 38, 40. In *S. viscosus* not only tetraploids but also diploids 2n = 20 were found. Further studies of chromosome numbers of species from other habitats and regions of the secondary distribution range are required.

INVASIONS OF THE CLADOCERA (CRUSTACEA): A SHORT REVIEW WITH FRUSTRATING CONCLUSION

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Biological invasions are among the main recent challenges for humanity. Alien species are, unfortunately, common and widely distributed in fresh waters now. It is well-known that some cladocerans (Crustacea: Cladocera) formed stable populations in non-indigenous territories after their occasional human-mediated introduction. Moreover, appearance of some alien cladocerans in new regions (e.g. *Daphnia lumholtzi* Sars to North and South America, *Cercopagis pengoi* (Ostroumov) to North American Great Lakes) was destructive for the ecosystems and had a strong negative economic effects. Also recent studies have revealed some cases of "cryptic invasions" of cladoceran non-indigenous taxa or haplotypes which have a less prominent effect and are frequently missed by hydrobiologists during routine studies, even monitoring conducting over many years. Resting eggs of the cladocera are well-protected against a harmful environment well-adapted to easy dispersion by different vectors (wind, current, water birds). Recently a new page is opened in their biogeography as any geographical barriers for their dispersion lost their significance due to intensive human activity.

In this presentation, we are going to make a review of known cases of biological invasions of the Cladocera in different continents. Most of them concern the Holarctic water bodies what is a reflection of (1) its intensive study and (2) more intensive transportation between developed countries. Last decade we are performing an intensive program of global phylogeographic studies of different cladoceran taxa, and we need to say that the non-indigenous taxa and haplotypes are found in each such study without any exclusions. Unfortunately, recently we need to move from the fixation of certain cases to an ascertaining of a global faunal mixing in continental water bodies.

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ECOLOGICAL AND PHYSIOLOGICAL ESTIMATION OF THE INVASIVE SPECIES OF AMPHIBIANS (*PELOPHYLAX RIDIBUNDES* PALLAS, 1771) INTRODUCED INTO WATER BODIES OF THE MIDDLE URALS

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Conservation of biological diversity is currently important for the Ural region with extreme natural and anthropogenic habitat conditions. The invading species significantly influence the fauna of the recipient regions and contribute to the microevolutionary processes of terrestrial and aquatic ecosystems. Marked expansion of lake frog into the cooling reservoirs of the Verkhniy Tagil and Reft Power Plants of the Middle Urals. Lake frog occupies natural waterbodies in the area of Nizhniy Tagil and of the river Pyshma basin, occurs in the area the upper reaches of the river Neyva, in the floodplans of the rivers Iset and Sysert and those of the river Pyshma basin. Expansion of lake frog continues to other aquatic systems in the Middle Urals [Ivanova, Berzin, 2019]. Ecological and physiological assessment of the lake frog *Pelophylax ridibundus*, which formed stable populations in the aquatic ecosystems of the Middle Urals, is given for the first time. The results of studies of hematological and biochemical parameters of the blood of the lake frog are presented. Studies of the hematological parameters of the homeostasis of the lake frog showed a predominance of agranulocytes (73-77%), which provide effective immune surveillance and specific reactivity of the body. Lake frogs are characterized by a higher adaptive immunity compared to the non-specific protective system of the blood. There were no statistically significant gender and seasonal differences in the integral index (the ratio of heterophiles to lymphocytes: ISL = 0.30-0.36). Activation of immune processes in spring is accompanied by redistribution of blood leukocytes in the direction of strengthening the neutrophil response in males ($p = 0.02$) and mobilization of the mononuclear system in females ($p = 0.01$). Seasonal variability of carbohydrate and lipid metabolism is noted. The amino acid pool of blood plasma of amphibian is represented by 25 free amino acids (AA) and their derivatives. Some researchers consider the amino acid composition of adult aquatic vertebrates to be unchanged [Guisande et al., 2000]. However, our data results shown that ontogenetic and season changes affects the amino acids pool of *P. ridibundus.* Lake frogs have a full range of functionally significant 10 essential amino acids: threonine, valine, isoleucine, leucine, phenylalanine, methionine, lysine, tryptophan, histidine, arginine. A significant role of the essential amino acids (NAA) is marked in the processes of detoxification and elimination of toxic heavy metals in tissues of amphibians. Analysis (Ade-4-PCA) confirmed the presence of significant gender and seasonal differences in the content of essential and gluccogenic amino acids in the blood plasma of amphibians. It is shown that the percentage of NAA (52.0-52.9%) significantly increases in females and males in the summer period in comparison with the spring period (42.2-48.7%) ($p = 0.0001$). The dominant components of the amino acid pool of animal blood are formed by glycogenic AA: alanine, serine, threonine, lysine, leucine, valine, glycine, aspartic acid, glutamic acid, arginine, histidine, methionine and proline. The contribution of these amino acids was 62-64% in males and 58-62% in females. These amino acids are also involved in the synthesis of collagen and elastin. The high content of essential (48-52%) and glycogenic amino acids in the blood of amphibians indicates their relevance in the processes of protein synthesis and muscle building, maintaining immunity and participating in detoxification. Studies of inherited ecological and physiological features of the *P. ridibundus* expand the understanding of the mechanisms of adaptation and naturalization of invasive animal species in the natural and anthropogenic conditions. The presented homeostatic parameters can be used both in the assessment of the physiological state of hydrobionts in natural populations, and in the system of monitoring and environmental measures for aquatic ecosystems.

GEOINFORMATION SYSTEMS IN MONITORING OF INVASIVE SPECIES IN THE ANTHILLS OF *FORMICA* ANTS

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Bugs (*Coleoptera*) tend to occupy anthills of wood ants (genus *Formica*) as reservoirs of nourishing resources and localities for winter hibernation. Species using the anthills for mentioned purposes are called myrmecophylic insects and are mostly represented by the families *Staphyllinidae*, *Scydmaenidae*, less – by the family *Scarabaeidae*. Some representatives of these taxonomic groups are not originally coming from the regions where they are discovered and can be considered as invaders. Their localization and population dynamics have to be regularly monitored to predict dramatic successions in the examined phytocenoses.

For this reason, the aim of the current research is to demonstrate the possibility of the environmental monitoring of potentially invaded anthills using geographic information systems on the example of *Formica* anthills on the Lower Volga territory (Volgograd and Saratov regions). Determination of main hotbeds (anthills inhabited by alien Coleoptera species) can help in further environmental prediction of their behavior and potential consequences for invaded phytocenoses.

Materials for the given research were taken from the sources of previous field explorations organized mostly by scientists of the Saratov State Agricultural University in 2015-2019. In details, the data about 15 anthills in 5 localities was analyzed and put on a digital map constructed on the base of ArcGIS Online platform. ArcGIS is a cartographic service which permits not only to create a map with point, linear or polygonal feature layers but also to analyze the dispersal patterns of the mapped elements. Method used in the current research is called «hot points clustering» and is purposed on determination of the invaded localities, the most aggressive invader species and the species of ants tending to provide their anthills to myrmecophylic *Coleoptera*.

According to the results, 10 of 15 examined anthills are invaded by *Staphyllinidae* (*Zyras humeralis, Z. conrragrosus, Nothotecta flavipes, Leptacinus formicetorum, Oxypoda formiceticola* and *Stenus aterrimus*) potentially brought to the researched territory from the Caucasus, 4 – by *Scydmaenidae* (*Euconnus claviger*, *E. maeklinii* and *Stenichnus scutellaris*). A single anthill in Saratov region was inhabited by *Protaetia metallica* (family *Scarabaeidae*). Almost all the analyzed *Coleoptera* species are cosmopolitans and can migrate while occasional anthropogenic transmission.

The majority of invaded anthills are constructed by the red wood ant *Formica rufa* (8 of 15 samples). 3 anthills belong to the small wood ant *F. polyctena*, 3 – to the meadow ant *F. pratensis* and a single anthill is formed by the steppe nimble ant *F. cunicularia*. These species are typical for the southern deciduous forest subzone and the forest-steppe zone of the Lower Volga. Their areas are associated with open steppe compartments and succeeding edges of forests.

Considering the map, it is possible to observe that the dispersal structure of invaded anthills is heterogenic. They form 3 evident clusters in Khvalynskiy and Kumysnaya Polyana national parks of the Saratov region and in Gorodnishenskiy district of the Volgograd region. The dominant species in this clusters is a carabid *Euplectus signatus* (family *Staphyllinidae*). This heterogeneity can be explained by constantly changing forest phytocenoses in the Lower Volga natural reserves – anthills are discovered in few localities with a higher forest density and age of forest-forming tree species.

Besides that, it is necessary to emphasize the fact that the samples have been taken in various seasons. Myrmecophylic insects tend to use anthills as places of hibernation. For this reason, the number of insects found in early spring and late autumn differs from the summer results, what puts in doubt the real invasive role of the examined species. This fact requires confirmation or disavowal during the regular monitoring of the mentioned phytocenoses.

In conclusion, geographic information systems demonstrate their efficiency in biomonitoring and bioindication including evaluation of invasions` consequences in biocenoses. Digital mapping is a way to provide clear visualized data about the current ecological situation in case of its periodical update and extension of explored territories.

RESULTS OF MONITORING OF INVASIVE SPECIES IN THE WATER PROTECTION ZONES OF RIVERS IN MOSCOW AND MOSCOW REGION

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Monitoring of invasive species in the water protection zones of the rivers of Moscow and the Moscow region was a part of the work on monitoring water protection zones, the bottom and banks of water bodies of the indicated constituent entities of the Russian Federation by order of the authorized executive authorities in 2012-2021.

The survey of water protection zones was started in 2012 in Moscow. Since 2018, similar work has been made in the Moscow Region. In Moscow, the monitoring is done annually in 25 rivers. In the Moscow region the monitoring surveys cover 154 rivers.

Some of alien species are not only invaders occupying the ecological niches of the aborigines, but also pose a threat to both the recovery of ecosystems under a human impact.

From an ecological point of view, invasive species are mainly weeds. So they contaminate disturbed habitats only. Invasive species are able to spread over vast territories due to the lack of competition from native species, as well as, due to formation of "heat islands" in the large settlements, where the native vegetation is mainly depressed.

Rivers attract humans, which result in significant transformation of nearby landscapes. This radically affects the plant communities. In addition, the rivers themselves form unstable biotopes due to its channel natural processes, that contribute to a change in the natural river banks and valley. Thus, the valleys, and, first of all, the floodplains of the rivers are largely inhabited by species that, to one degree or another, are weeds (they do not grow in climax, stable communities, but appear at different stages of successions). As our long-term studies show, invasive species actively contaminate not only native plant communities damaged by humans, but also penetrate into river floodplains, where biotopes are often unstable, so the competition from aborigines is either weakened or completely absent.

Distribution of five invasive species were monitored in the framework of the present study: Sosnovsky's and Mantegazzi hogweeds, American maple, American goldenrods (Canadian and giant), Bohemian (and also Japanese, Sakhalin) knotweed, Ornamental Jewelweed. These species occupy habitats impacted by humans and even intact river floodplains, and thus, significantly affect the natural dynamics of the vegetation cover, slowing the pioneer ecosystem development course of turfing and strengthening of the banks. All referred alien species grow very quickly, and create strong shading, which does not allow the aboriginal community to develop under their canopy and recover in case of damage.

When populations or individual invasive plants are found in water protection zone, the special protocols are filled out. All information on areas occupied by the above mentioned invasive species are uploaded into a GIS project, so the dynamics of the alien species distribution can be assessed.

Information on human activities is entered into separate forms, incl. landfills, areas with damaged soil and vegetation cover, construction sites, arable lands, etc. to evaluate the correlation between the invasion species distribution, and direct human impact on landscapes.

Examining data obtained in different years, we assessed the dynamics of anthropogenic activity and the spread of invasive species. It was shown that during the specified period of time on the territory of Moscow, the areas occupied by the indicated invasive species within the water protection zones of rivers significantly increased after the joining of the new territory to the Moscow in 2013, and after beginning of large-scale construction in 2014. The finds are mainly confined to damaged sites of river banks, as well as to sites of the most active river bed processes. As a rule, there is a tendency towards an increase in the number of findings from river source to river mouth.

It was found, that in recent years on the territory of the Moscow region, the Sosnovsky's hogweed populations has been treated by herbicides or similar substances, which is extremely dangerous, since it leads to long-term soil pollution, the destruction of competing aboriginal plants. As a result, the invasive species, which are most resistant to this kind of impact, recover first. On the previously treated plots, the appearance of Sosnovsky’s hogweed plants was observed, while the indigenous vegetation that grew near hogweed populations did not recover, so the Sosnovsky's hogweed population squares increased.

PATHWAYS OF NATURAL DISTRIBUTION OF SOSNOWSKY HOGWEED IN WINTER

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Sosnowsky's hogweed (*Heracleum sosnowskyi* Manden.) is a dangerous invasive plant that has taken over vast areas in Russia. Sosnowsky's hogweed is a monocarpic plant. It reproduces with the help of seeds, and one plant, depending on its size, produces, according to different authors, from 15000 to 20000 seeds. It is known that seeds can remain viable in soil and germinate for 10-12 years. Its spread over the territory of some regions has acquired the scale of an ecological catastrophe and even required the intervention of government bodies.

The question arose of how the seeds could have ended up far from rivers (not brought by water), highways and railways, or agricultural land contaminated with hogweed. There is still no reliable information that the seeds are eaten and spread by birds.

Observations were carried out in the period from January to March in Moscow oblast, the objects of observation were the dead plants of Sosnowsky's hogweed, on the umbrellas of which the seeds were preserved at the time of observation. In addition to observations in nature, 2 experiments were performed. In the first case, batches of single seeds were scattered from a height of 2-2. 5 m at different wind strengths. In the second case, the speed and range of movement of broken umbrellas with seeds were observed. The viability of the seeds was determined under laboratory conditions.

To assess the effect of wind speed on the distance of movement of single seeds, one-way analysis of variance (ANOVA) was carried out using a model of type I; that is, at a given wind speed from 0 to 15 m/s, we compared the average values of the proportions of seeds that settled at the distance of 0–0.5 m, 0.5–1, …, 4.5–5 m from the maternal plant. If ANOVA analysis showed that there were statistically significant differences, then Tukey's Post Hoc HSD test was used to determine which intervals differed from each other. In order to reveal the influence of the type and nature of the movement of umbrellas on their distance in winter, we used two-way analysis of variance. Moreover, the first factor has three levels (1—straight ahead; 2—along a broken line; 3—return (along a circle)), and the second factor has two levels (1—with stops; 2—continuation of movement, including in the opposite direction).

To compare the potential for germination of seeds of Sosnowsky's hogweed sown in different months of winter, we used the chi-square test to compare the proportion of germinated seeds (Zar, 2010). Statistical analysis of the experimental data was performed using the integrated Biosystem office package (Petrosyan, 2014).

It was found that viable seeds are preserved on some umbrellas of this alien plant in winter. Falling of single seeds during the winter period is not much different from falling of seeds in the summer–autumn period. Because of its relatively large weight, the majority of seeds usually fall off and germinate near the maternal individual at a distance of 0–1 m from the parent plant. It was shown that seeds under the influence of various factors, in particular, under the influence of strong gusts of wind, can move up to 5 m from the mother plant. It was revealed that the seeds are also able to move together with broken umbrellas over distances many times greater than the distances of the natural scattering of single seeds. Experimental observations on the movement of umbrellas at a distance of 40 ± 9 m for 15 min suggest that the range of movement of umbrellas can be hundreds of meters on a flat surface of icy roads. It is noted that the largest number of seeds remains on plants that have been mowed an insufficient number of times. Seeds on such plants ripen later and do not have time to fall down before the onset of winter.

The high germination of seeds left on the umbrellas allowed us to conclude that measures to control Sosnowsky's hogweed should include the destruction of dead plants with seeds until a stable snow cover is formed.

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THE TAXONOMIC STATUS OF NATIVE POPULATIONS OF *CORBICULA* CLAMS (BIVALVIA: CYRENIDAE) OF THE FAR EAST OF RUSSIA

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Corbicula clams have invaded all continents except Antarctica. This genus is one of the most successful invaders of aquatic ecosystems (Gomes et al. 2016); itconsists of estuarine or freshwater clams native to Asia, Africa and Australia (Hedtke et al., 2008). The reliable data on the Far Eastern Russian endemic species of *Corbicula* are relatively poor. At present time as many as eight nominal species of *Corbicula* clams are listed in the fauna of the Russian Far East: *C. japonica* Prime, 1867; *C. finitima* Lindholm, 1927; *C. lindholmi* Kursalova et Starobogatov, 1971; *C. amurensis* Bogatov et Starobogatov, 1994; *C. nevelskoyi* Bogatov et Starobogatov, 1994; *C. sirotskii* Bogatov et Starobogatov, 1994; *C. producta* Martens, 1905; *Corbicula elatior* Martens, 1905 (Zatravkin, Bogatov, 1987; Glaubrecht et al., 2007; Vinarski, Kantor, 2016). Unfortunately, the validity of most Far Eastern species has not been confirmed by molecular genetic data and they are still characterized only conchologically (Glaubrecht et al., 2007).

Our study presents a taxonomic review of *Corbicula* species from the Russian Far East (Primorsky Krai). The primary material was collected from several localities of the Russian Far East, including the type localities of some nominal species – Artemovka River (type locality of *C. finitima)*, Kiparisovka River (type locality of *C. lindholmi*) (Zatravkin, Bogatov, 1987; Vinarski, Kantor, 2016), Razdolnaya River, Kievka, and Partizanskaya Rivers.

The molecular genetic analysis included amplification and sequencing of mitochondrial (COI) and nuclear (28S rRNA) markers. The method of DNA isolation, primer combinations, PCR conditions, sequencing, primary sequence processing, and phylogenetic analysis are described in our previous papers (Bolotov et al., 2015; Bespalaya et al., 2018).

According to our data, the mitochondrial COI gene of *Corbicula* clams from investigated localities, contains representatives of a single genetic lineage. The COI haplotype network reveals that these haplotypes belong to the estuarine species *C. japonica.* Two nominal endemic species of Far East of Russia, *C. finitima*, and *C. lindholmi*, appeared to be the junior synonyms of the estuarine species *C. japonica*. The taxonomic status of the rest of nominal species of *Corbicula* of the Primorsky Krai deserves a further study.

The Russian Science Foundation was supported the fieldwork in the Primorye and Khabarovsk Territory and morphological studies (project No. 19-14-00066), and the molecular analyses of mollusks was supported by project No. 21-14-00092.

CHARACTERS OF THE GENERATIVE ORGANS AND THE CONTENT OF BIOLOGICALLY ACTIVE SUBSTANCES IN INVASIVE SPECIES OF *REYNOUTRIA* HOUTT. (POLYGONACEAE)

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There are three species of *Reynoutria* Hook (= *Fallopia* Adans.) of the Polygonaceae family, that have been naturalized in Europe: *R.sachalinensis* (F. Schmidt) Nakai, *R.japonica* Houtt., and their cultigenic hybrid *R.* × *bohemica* Chrtek & Chrtková, which has been appeared in the secondary distribution range of the parental species. *R. sachalinensis* has been observed in 29 European countries. In the 18 of them it is considered to be invasive. *R. japonica* is listed as an invasive species in 12 European countries. *R.* × *bohemica* in 10 countries (CABI, 2021). *R.* × *bohemica* has been included in Top-100 the most dangerous invasive species in Russia. The natural range of *R. sachalinensis* is in the Far East. The species has naturalized in Central Russia.

The purpose of the work is to study the structure of flowers and to determine the content of biologically active substances in leaves: of *R.* × *bohemica* and *R. sachalinensis* in Moscow region. The total flavonoids, ascorbic acid, and organic acids have been determined. Some deviations from a typical structure have been observed in flowers of *R.* × *bohemica*, in contrast to flowers of *R. sachalinensis*. Eleven atypical flower structures were detected, 80% of *R.* × *bohemica* specimens possessed atypical flowers. The intraclonal variability has been observed in the number of sepals and the structure of androceum. The Interclonal variability has been noted by the ratio of stamen and pistil length. Three types of individuals were found in *R.* × *bohemica*: a) with male sterility, b) with bisexual flowers, and c) partially fertile. *R.* × *bohemica* does not fruit in Moscow region. It spreads out vegetatively. The phytochemical analysis of leaves has revealed no evident difference in the content of the studied biologically active substances of *R. sachalinensis* and those of *R.* × *bohemica* (Figures 1-3).

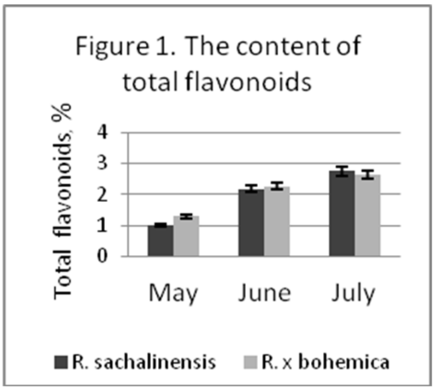

Figure 1. The content of total flavonoids

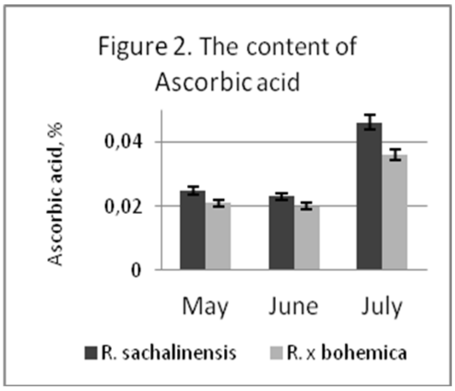

Figure 2. The content of Ascorbic acid

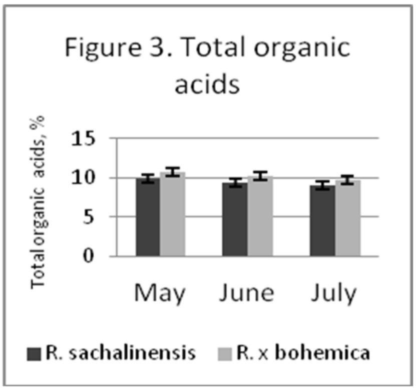

Figure 3. Total organic acids

The sum of flavonoids and the content of ascorbic acid in July is higher, than in May. The amount of bioflavanoids in the leaves of invasive species of *Reynoutria* is similar to that in the pharmacopoeial taxa of the closely related genus *Persicaria* Mill. (Polygonaceae), which are used as a hemostatic agent. The plant material of *Reynoutria* species can be useful as a source of bioflavanoids for medicinal purposes.

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INVASIVE SPECIES OF ALGAE IN THE PHYTOPLANKTON OF SOME LEFT-BANK TRIBUTARIES OF THE VOLGA RIVER

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For more than half a century, many scientists have noted the penetration of species of living organisms into new regions and ecosystems. Since the late 70s of the XX century. in the watercourses of the Volga basin, an intensification of invasive processes was noticed, what is facilitated by climate warming, anthropogenic disturbances of natural ecosystems and the global transformation of the main elements of runoff formation in the catchment of the Volga River. Long-term studies (from the late 1960s to the present) made it possible to trace the main stages of the appearance and naturalization of invasive algae species and their productivity. Among more than 15 invasive algae species in the Volga River basin, 5 were found in the left-bank tributaries of the Cheboksary reservoir.

The aim of this work is to trace the main stages of penetration (introduction) and development of invasive algae species on the basis of long-term studies of the phytoplankton composition and structure.

The material for the work is represented by both archival materials (phytoplankton samples collected in the 60s - 90s, permanent diatom preparations) and modern collections of the authors (2000 - 2019) from two large Left Bank tributaries of the Cheboksary reservoir (Vetluga and Kerzhenets rivers). The examined watercourses flowing along the low-lying Left Bank of the Volga rever, are typically flat, characterized by swampy and forested catchment.

Among the discovered species, representatives of 3 divisions were noticed, most of which belong to the phylum *Bacillariophyta* (*Thalassiosira incerta* Makar., *Skeletonema subsalsum* (A. Cl.). Bethge, *Plagiotropis lepidoptera* (Greg.) Kuntze). Species from the phyla *Miozoa* (*Unruhdinium kevei* (Grigorszky & F. Vasas) Gottschling) and *Ochrophyta* (*Goniostomum semen* (Ehrenberg) Diesing) were also found. Information about the appearance of *Goniostomum semen* in the Kerzhenets river date back to the mid-1980s, where the mass development of this species was remarked (up to 6.0 g/m^3). Nowadays, this species is constantly recorded as part of summer cenoses, but no significant development indicators have been identified. The gradual penetration and development of *Skeletonema subsalsum* into the reservoirs of the Volga River have been recorded since the late 1950s. In Vetluga River, this species whose biomass reached 8% of the total (0.05 g/m3) was discovered in the summer season of 2016. In recent years, only few cells of *S. subsalsum* have been found in plankton samples. As a result of diatom analysis, the presence of *Thalassiosira incerta* was registered in the Kerzhenets river. *T. incerta* has been present in the Volga reservoirs since the late 1960s as an invader from the Caspian Sea. Currently, this species is a constant component of phytoplankton in a number of large tributaries of the Volga River. In the Kerzhenets river, no significant indicators of the development of *T. incerta* were noticed. Information about the appearance and naturalization of *Unruhdinium kevei* in the Kerzhenets river dates back to 2006, when few cells were found in the composition of summer plankton. In recent years (2014, 2016, 2018 and 2019), an increase in the participation of dinophytes algae in the formation of algocenoses (up to 1.86 g/m^3 - 69% of the total biomass) has been noticed in the Kerzhenets river, including *U. kevei*, whose biomass reached 0.67 g/m^3. The temporal range of *U. kevei*`s occurrence covers the period from early spring to early autumn. The development of this species demonstrated a remarkable positive correlation with water temperature ($R_s = 0.68$, $p \leq 0.05$) and negative correlation with its level ($R_s = -0.61$, $p \leq 0.05$). In the Vetluga River, the maximum rates of *U. kevei*`s development was recorded in the summer period of 2016 (0.74 g/m$^3$ - 26%). In the researched watercourses, the appearance and vegetation of a benthic algocenoses` representative, *Plagiotropis lepidoptera*, was recorded, where it was found during the entire vegetation period, mainly at maximum water warming ($R_s = 0.51$, $p \leq 0.05$). In the Vetluga River, this species was part of the dominant river complexes, along with other diatoms in the second half of the summer season. The maximum abundance and biomass were estimated as 20 thousand cells per liter (4.7%) and 0.43 g/m^3 (34.3%). Only single samples of *P. lepidoptera* were discovered in the Kerzhenets river. According to the literature sources, the species is often found in marine, brackish and highly mineralized algocenoses and is currently considered as an invader of the Caspian Sea.

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ACTIVITY AND PHYTOCOENOTIC CONNECTIONS OF ALIEN PLANTS IN PSAMMOPHYTIC HABITATS IN SOUTH-WEST RUSSIA

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Psammophytic vegetation forms in natural, anthropogenic and semi-natural habitats with automorphic mobile and fixed sandy substrates. Sand as a substrate has a number of features: low heat capacity, high thermal conductivity, poor mineral nutrients, high water permeability and low water retention capacity. As a rule, such "extreme" habitats are characterized by low competition, which makes them an arena for intensive invasion of alien explerent plant species.

In 2018–2021 the authors carried out floristic and phytosociological studies on the territory of the South-West Russia within the Bryansk, Kaluga and Smolensk regions. Based on the results of these studies, an electronic database was created, including more than 250 relevés of psammophytic communities. Their classification was developed on the basis of J. Braun-Blanquet's approach and 15 syntaxa (associations, variants, non-rank communities) were established. In the described communities, alien species of vascular plants were identified that take part in the formation of psammophytic vegetation: *Amelanchier spicata, Anisantha tectorum, Armeria maritima, Eragrostis albensis, Echinochloa crus-gali, Erigeron annuus, E. canadensis, Festuca arundinacea, F. polesica, F. pseudovina, Fraxinus pennsylvanica, Hippophae rhamnoides, Lupinus polyphyllus, Oenothera biennis, Oe. rubricaulis.*

The analysis of phytosociological data made it possible to assess the activity and phytocoenotic connections of the listed plant species by comparing their constancy and the statistical phi-coefficient of fidelity, reflecting the phytocoenotic confinement of the species to the selected vegetation units. The most active species are those recorded in the coenoflora of 11–15 syntaxa; moderately active – 5–10, inactive – 1–5. The highest phytocoenotic activity is characteristic for *Oenothera biennis* (12); medium – *Erigeron canadensis* (9), *E. annuus* (7); other species can be considered inactive. High fidelity to individual syntaxa was demonstrated by *Oenothera biennis* (pioneer communities dominated by *Koeleria glauca* – phi-coefficient value – 24), *Elytrigia repens* – 26); *Erigeron canadensis* (pioneer communities dominated by *Corynephorus canescens* – 15), as well as typical for monodominant grass communities: *Anisantha tectorum* (80), *Eragrostis albensis* (55), *Echinochloa crus-gali* (69), *Festuca polesica* (74).

Of particular interest is a group of communities in which species with an undefined genesis in the study area act as edificators. Thus, phytocoenoses dominated by *Armeria maritima* are locally found in the Bryansk region, in isolation from the main more westerly native area, which made it possible to consider this species alien. The origin of *Festuca polesica* coenopopulations in the Bryansk and Kaluga regions is also unknown, where its communities are formed mainly on railway embankments and surrounding territories. An uncertain understanding of the distribution of these species in Eastern Europe does not allow to identify their communities with Central and Western European analogues.

Psammophytic habitats serve as habitats for alien trees and shrubs. In particular, in settlements on damp sands, massive seed reproduction of the introduced species *Fraxinus pennsylvanica* was noted. Its reproductive potential can be assessed as high; however, for germination, the species requires abundant moisture, which is typical mainly for alluvial sands in floodplain ecosystems. *F. pennsylvanica* is infested in pioneer psammophytic communities dominated by *Koeleria glauca*, but without high constancy and abundance.

Communities dominated by *Hippophae rhamnoides* have become an integral part of the vegetation of coastal sands, overgrown sand pits and sandy road embankments in recent decades. Unlike the previous species, thickets of *H. rhamnoides* are created more often by vegetative reproduction.

ALIEN SPECIES OF INVERTEBRATES IN LAKE LADOGA: DYNAMICS OF THE INVASION PROCESS AND NEW RISKS

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It is an indisputable fact that invasive species have become one of the main components of the ecosystem of the largest European Lake Ladoga. Alien species play the most significant ecosystem role in the littoral zone, the most dynamic and productive part of the lake. At the same time, over time, one should expect only an intensification of the biological pollution of the reservoir and, consequently, an increase in the role of invasive species in the processes taking place in the ecosystem of the lake. This happens for several reasons, the most important of which are the effect of the anthropogenic factor and climatic changes, leading to an increase in water temperature, especially in the coastal zone of the lake. Previously, it was the low temperature and mineralization that were the main factors preventing the invasion of alien species into the lake. Invasive amphipods, despite their relatively recent penetration into Ladoga, are currently of greatest importance in benthic communities of the littoral zone. The Baikal species *Gmelinoides fasciatus* (Stebbing) is the most widespread in the lake. *Micruropus possolskii* Sowinsky is much less common, which was probably associated with the later appearance of this species in Lake Ladoga in its northwestern part (near the city of Priozersk). Studies of recent years (2017 - 2020) have shown that the second Baikal invader *M. possolskii* actively spreads in the lake and already colonized shallow areas in the southwestern and southern parts of the lake. It has also already penetrated from coastal biotopes into the central part of Petrokrepost Bay, where its quantitative indicators are quite high. The habitat of the Ponto-Caspian species *Pontogammarus robustoides* (Sars) and *Chelicorophium curvispinum* (Sars) is still limited by the boundaries of the Volkhov Bay. Further dispersal of the Ponto-Caspian amphipods is hindered by the low mineralization of the waters in the lake. The dominant role of *G. fasciatus* is observed only in those habitats where other species of invasive amphipods have not yet penetrated. A significant increase in the quantitative development of *P. robustoides* and the active development of *M. possolskii* in the littoral zone of the lake in the southern direction indicate the ongoing restructuring of the littoral biocenoses of the largest European lake. In 2019, the invasion of *Dreissena polymorpha* (Pallas, 1771) into Lake Ladoga was detected. The available data provide grounds for the conclusion about the successful naturalization of *D. polymorpha* in Ladoga, despite the relatively low mineralization of the water, which is outside the optimum for this species and the low, but already acceptable temperature for it. In the case of the mass development of *Dreissena*, which is usually an edificator species, even deeper rearrangements of the communities of the lake's coastal zone are possible. Taking into account the high adaptive abilities of this species, in the case of its adaptation to low-mineralized water and the temperature regime of the reservoir, it can be assumed that *D. polymorpha* will become the most important factor in the transformation of hydrbiocenoses of Lake Ladoga. In this case, one can expect the still difficult to predict risks of ecosystem transformations for the entire coastal zone, which may be a consequence of the high filtration activity of the mollusk. The most likely effect of zebra mussel on the plankton amount, on an increase in transparency, on an increase in the zone of distribution of submerged macrophytes and phytobenthos, an increase in primary productivity due to macrophytes and phytobenthos, a decrease in phytoplankton production, and the expected restructuring of benthic biocenoses. The intensity of the invasion process in Lake Ladoga and the fact that the consequences of biological pollution are becoming more and more significant for the lake ecosystem is also illustrated by the presence of alien species from the meiobenthos (*Nitocra spinipes* Boeck), zooplankton (*Paraegasilus rylovi* Markewitsch, *Kellicottia bostoniensis* (Rousselet)), aquatic vegetation, and by a large number of diatom species from the periphyton. In the case of Lake Ladoga, the results obtained do not allow us to say that the introduction of new species into the lake has led to significant negative consequences for the aboriginal communities of the lake's aquatic organisms as a whole. Rather, we can talk about the enrichment of biodiversity due to the introduced species, which sometimes can even have a reclamation effect, increasing the diversity and quantitative development of littoral communities. The available facts allow us to say that the species that have invaded Ladoga occupy (this process continues) ecological niches that slightly overlap with those of the aboriginal species, for example, in terms of trophic resources.

COLONIZATION AND CONTROL OF *CYCLACHAENA XANTHIIFOLIA* (NUTT.) FRESEN. IN SEGETAL BIOTOPES

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Until recently *Cyclachaena xanthiifolia* (Nutt.) Fresen. in the Steppe zone of the European part of Russia was considered a typical ruderal species and did not occur in segetal biotopes. But in the last 25-30 years it has become a burdensome weed in agricultural crops. Its specific weight in the total weediness of tilled and vegetable crops reached 12.24-26.75%, grain and forage crops – 2.8-11.0%.

In segetal agrophytocenoses of cereals, row crops, as well as in orchards and vine plantations, it grew in the communities of *Ambrosio artemisiifolia-Chenopodietum albi, Ambrosio artemisiifolia-Cirsietum setosi, Amaranto retroflexi-Setarietum glaucae, Amaranthet-efestival blitoidoid -Consolidetum orientalis, Setario-Galinsogetum, Amaranthetum blitoidi-retroflexi, Convolvulo-Agropyretum repentis* and other agrotypes of crop weediness characteristic of chernozem and chestnut soils of zonal and azonal plant communities. But we never found it in biotopes where *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Avena fatua* L., *Elymus repens* (L.) Gould, *Cynodon dactylon* (L.) Pers.

At the same time, in weedy synusia, it began to displace *Chenopodium album* L., *Fumaria schleicheri* Soy.-Will., *Sonchus oleraceus* L., *Delphinium orientale* Gay.

Today *Cyclachaena xanthiifolia* is included in the list of the 50 most problematic alien plants in Russia and in the top ten most harmful species (Yu.K. Vinogradova, 2016; O.V. Morozova, 2018; O.N. Kurdyukova, E.P. Tyischuk, 2018).

The widespread distribution of *Cyclachaena xanthiifolia* causes not only negative changes in plant communities, but also threatens dangerous ecological, economic and social consequences. In crops, reaching a height of 180-260 cm and accumulating a weight of up to 2.1-3.8 kg/m^2, it carried from the soil 60-80 kg/ha of nutrients and 800-1000 t/ha of water, inhibited or suppressed the growth of cultivated plants. In the presence of 2 *Cyclachaena xanthiifolia* plants, yield losses were 18.0-34.9%, 6-8 plants – by 51.0-59.1%, more than 8 pcs/m^2 – 63.7-100% (S.B. Manzhos, 2001; E.A. Zherdeva, 2013; O.N. Kurdyukova, 2014, 2015; N.I. Konoplya, 2021).

Cyclachaena xanthiifolia served as a reserve of phomopsis (*Phomopsis helianthi*), a dangerous sunflower disease (O. Dzenzelyuk, 1999).

The excess of the standard content of *Cyclachaena xanthiifolia* seeds in grain devalued it as a sowing and food commodity. The coefficient of consumption of green fodder by cattle in the presence of 2-3 *Cyclachaena xanthiifolia* plants per 1 m^2 did not exceed 0.57-0.78.

In the fields heavily infested with *Cyclachaena xanthiifolia*, soil resistivity increased from 0.36 to 0.51 kg/cm^2, fuel consumption increased from 17.6 to 22.7 kg/ha.

During flowering, each *Cyclachaena xanthiifolia* plant produced from 2.6 to 55.0 million pieces of pollen grains, which caused allergenic diseases in humans and animals. At a distance of 100 m from the *Cyclachaena xanthiifolia* cenopopulation with a density of 9 to 26 pieces/m^2 during August-September, an average of 3130 pollen grains were detected in 1 m^3 of air every day, while according to medical criteria, the presence of 101-1000 pieces/m^3 of pollen grains is considered high.

It is possible to prevent and reduce the infestation of segetal biotopes with *Cyclachaena xanthiifolia* plants only by using a complex of the following measures: quarantine ones (prevention of importation, prohibition of sowing with seeds infested with *Cyclachaena*, identification, localization and elimination of foci of weed), organizational (improvement of the general cultural and technical state of land), mechanical (killing of weeds with various methods of soil cultivation), physical (destruction of plants with fire, sterilization and mulching of the soil, etc.), chemical (destruction of plants with herbicides), biological (suppression and destruction of weeds with the help of insects, fungi, bacteria), phytocenotic (increasing the competitive plant capacity) and other control measures.

HOST – PLANTS *METCALFA PRUINOSA* (SAY) (HEMIPTERA: FLATIDAE) ON THE TERRITORY OF M.M. GRYSHKO NATIONAL BOTANICAL GARDEN NATIONAL ACADEMY OF SCIENCES OF UKRAINE

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In May 2016, the invasive species *Metcalfa pruinosa* (Say, 1830) was first discovered on the territory of M.M. Gryshko National Botanical Garden (NBG) NAS of Ukraine, in the botanical-geographical site "Far East" (50° 24′ 45.61″ N, 30° 33′ 44.1″ E). The spread of the insect began from the southern part, which borders on the greenhouse complex ‘Green construction’.

While monitoring plants in the vegetative seasons of 2016 - 2020, we have found out that *M. pruinosa* inhabits mainly on synanthropic, as well as on introductory ornamental plant species of the ‘Far East’ site’s flora, as well as on fruit and vegetable crops grown in the NBG.

The spread of *M. pruinosa* proceeded gradually over the territory of NBG. First, the larvae of this insect appeared on the wild-growing ground cover plants of Ukrainian flora. Among the 13 families, the most attractive were eight species of wild-growing plants, namely: *Conium maculatum, Aegopodium podagraria* L.*, Adenocaulon adhaerescens* Maxim*, Impatiens nolitangere* L.*, Humulus lupulus* L.*, Geum urbanum* L.*, Urtica dioica* L. and *Parthenocissus quinquefolia* (L.) Planch. All the other plants were populated moderately or poorly. Three to four weeks later, we observed the larvae and imago of *M. pruinosa* on introduction shrubs and lower layers of trees, as well as lianas of the ‘Far East’ site’s flora. The representatives of the families *Celastraceae, Fabaceae*, and *Oleaceae* turned out to be the most vulnerable to the leafhoppers’ infestation.

Since 2019, insects have invaded the southwestern part of the botanical garden to other sites. First, the insect was found on herbaceous perennials: *Amaranthus blitoides* Watson, S., *Amaranthus retrofl exus* L., *Arctium lappa* L., *Chenopodium album* L., *Conyza canadensis* (L.) Cronq., *Bromus* sp., *Hypericum* sp., *Digitaria sanguinalis* (L.) Scop., *Phytolacca americana* L., *Plantago* sp., *Setaria* sp., *Pteridium aquilinum* L., *Verbascum* sp., *Solanum nigrum* L., *Viola arvensis* Murray. Larvae and imago of leafhoppers also fed on such ornamental plants: *Hedera helix* L., *Cornus mas* L., *Swida alba* (L.) Opiz, *Thuja occidentalis* L., *Jasminum fruticans* L., *Chaenoméles japónica* Thunb., *Parthenocissus quinquefolia* (L.) Planch. The insect also damaged fruit crops: *Juglans redia* L., *Actinidia chinensis* Plan., *Vitis vinifera* L., *Viburnum opulus* L., *Rubus fruticosus* L., *Rúbus idáeus* L., *Pyrus communis* L. *Prunus americana* Marsh., *Prunus persica* L., *Prunus armeniaca* L., *Prunus cerasus* L. *M. pruinosa* was also found on forage and agricultural plants: *Capsicum annuum* L., *Brassica oleracea* L., *Lycopersicon* sp., *Solanum melongena* L.

We conducted the observations of the distribution of *M. pruinosa* both outside the botanical garden and in the adjacent private sector. Since 2019, we have recorded the invasion of *M. pruinosa* at all stages of development on fruit and ornamental trees, shrubs, vines and agricultural plants of private territories and found.

Metcalfa pruinosa on 28 weed species from 27 families. We also found it on 52 plant species from 28 families: on trees, shrubs, and vines. The most susceptible to colonization by citrus leafhoppers families were: *Rosaceae* - 18 plant species, *Aceraceae* - 5 species, *Oleaceae* - 4 species, *Lamiaceae* - 3 species, *Fabaceae* - 3 species, *Amaranthaceae, Apiaceae, Araliaceae, Balsaminaceae, Cornaceae, Plantaginaceae, Vitaceae* - 2 species each. At conducting the examination, 10 families turned out to be more resistant to phytophage colonization, namely: *Apiaceae, Aceraceae, Araliaceae, Asteraceae, Balsaminaceae, Cannabaceae, Celastraceae, Oleaceae, Rosaceae*, and *Urticaceae*.

Thus, the total number of forage plants *M. pruinosa* was 80 plant species belonging to 55 families.

THE NEW FINDING OF *MUTINUS RAVENELII* (BERK. ET M.A. CURTIS) E. FISCH. (PHALLACEAE) ON THE TERRITORY OF YAROSLAVL REGION

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North American invasive fungus *Mutinus ravenelii* (Berk. et M. A. Curtis) E. Fish. (Fungi, Basidiomycota, Agaricomycotina, Agaricomycetes, Phallomycetidae, Phallales, Phallaceae, *Mutinus*), the representative of tropical forests and humus saprotroph was introduced to England in 1888 with intentionally introduced plants. From England it spread (1943-2000) across Europe (Germany, Netherlands, Norway, and Latvia). In the Russian Federation, its findings were noted in the late 20th and early 21st centuries (Karelia, Leningrad and Moscow oblasts, Crimea, Caucasus, Mordovia, Western Sayan mountains, Primorsky and Khabarovsk krais). *M. ravenelii* occurs from July to October in places associated with human activities: in vegetable gardens, greenhouses, parks, less often in forests, always on soils rich in humus.

In the Yaroslavl Oblast, *M. ravenelii* was first recoded in the early 1990s in Yaroslavl City and was listed (2004) in the regional Red Data Book (RDB), since at that time it was an object of the RDB of the Russian Federation (1988) and had a protective status. However, this fungus is no longer listed in the 2008 and 2017 editions of the RDB of the Russian Federation, it is also excluded from the regional RDB of the Ryazan Oblast (2011, p. 612 - "no longer requires protection measures"). Presumably, in the Yaroslavl Oblast, the successful establishing of *M. ravenelii* is also taking place, as evidenced by its new findings in the Nekouz Municipal Okrug. Here the fungus was recorded in July 2016 in Borok Settlement (N 58°03'35" E 38°14'16"). In the garden, it formed two groups of fruit bodies, five and seven in each group at a distance of 50 cm from one another at the rotting stump of common lilac (*Syringa vulgaris* L.). At the same place he was found in July and in the next two years, but in 2019 the fungus appeared earlier: on June 22. This was preceded by a monthly drought (air temperature of 27–29° C) and a powerful downpour that followed. The fungus formed two fruiting bodies 1 m from the place of last year's finding. After 2.5 weeks, the picture was repeated: *M. ravenelii* appeared in the same place, again after rain. At the end of July, the fruiting body of the fungus was found under raspberry bushes (*Rubus idaeus* L.), 10 m from the previous location.

In the same summer, two villages, a river harbor and three garden partnerships adjacent to Borok were examined for an invader, local residents were interviewed, and the fungus its photo was shown to them. As a result, it was found at three more new points. In the Bol'shoye Dyakonovo Village (N 58°3'25" E 38°14'10"), on July 10, 2019, the maximum number of *M. ravenelii* in the row of raspberry (*Rubus idaeus* L.) was observed: there were eight of its groups at a distance of 1 –1.3 m one from another, each had three to five fruiting bodies at different stages of development.

At the distance of 2 km west of Bol'shoye Dyakonovo in the Third garden partnership, from July 28 to October 2, 2019, four waves of *M. ravenelii* emergence were observed, the penultimate wave (31.08.2019) was the most abundant: 15 fruiting bodies per 1 square meter on the soil overgrown with grass.

In May 8, 2019, at the area of the river harbor (N 58°2'56" E 38°14'41"), a group of three fruiting bodies of the fungus was found, which grew after rain on wet sand. This is its only locality that did not correspond to its ecological characteristics: "*Mutinus ravenelii* is found exclusively on the soil rich in humus" [Lazareva, 2004, RDB of Yaroslavl Oblast].

In all cases described in the present paper, young fruit bodies of *M. ravenelii* were oval or ovoid, 1–3 cm in diameter, in a white shell. The receptacul is cylindrical, spongy, hollow, 6–12 cm high and 0.5–1.0 cm thick, pointed at the apex and crimson-red, its lower part is whitish-pink, the gleba is dark olive-greenish with a rotten smell. These morphological characteristics are fully consistent with the description of *Mutinus ravenelii* in the identification key books. The successful dispersal of the fungus coincides in time with the climatic and landscape changes of the last three decades: the January temperature in the region increased by 2–3° C; in July, by 1–2° C; the duration of winter has decreased from 5 to 4 months [Ecological Atlas of Yaroslavl Oblast, 2015]. The number of gardeners, gardeners' partnerships, and household farms, the biotopes appropriate for the sinanthrop fungus has increased many times over. *M. ravenelii* is hygrophilous and, probably, it is not indifferent to it that in Nekouz Municipal Okrug the average annual precipitation is 14% higher than in Yaroslavl City, the density of the river network is also higher, and Borok is located on the bank of the Rybinsk Reservoir [Ecological Atlas of Yaroslavl Oblast, 2015]. We believe that *M. ravenelii* will be excluded from the pages of the next edition of the regional RDB.

RESETTLEMENT OF PONTO-CASPIAN AND ALIEN ZOOPLANKTON SPECIES IN THE VOLGA AND DON BASINS: THE SCALE OF EVENTS

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The dispersal of the southern species to the north and the northern ones to the south became possible after the creation of a cascade of reservoirs on large rivers and the development of navigation. Large-scale introduction of aquatic organisms into the reservoirs on the Volga, Don and Dnieper rivers, which was carried out in the 1950s – 1970s to improve the food supply of valuable fish, played a significant role in the distribution of the Ponto-Caspian and some other crustacean species (Karpevich, 1975). In the 1960s,> 10 northern species of planktonic crustaceans entered the Middle and Lower Volga along a cascade of reservoirs (Volga i ee zhizn', 1978). At the same time, a counter flow of southern including brackish-water forms from the northern Caspian and along the Volga-Don canal from the Sea of Azov was formed. Thus, in the 1960s – 1970s, three species – *Cornigerius maeoticus*, *Heterocope caspia*, and *Calanipeda aquaedulcis* entered the Volgograd reservoir (Volga i ee zhizn', 1978), one of them (*Heterocope caspia*) spread to the Kuibyshev reservoir (Timokhina, 2000). The Tsimlyansk reservoir, the only one on the Don River, was inhabited by six brackish-water species in the 1950s–1960s (Kaftannikova, 1965; Glamazda, 1971, 1974). Among them, the Ponto-Caspian forms predominated, occupying their old area (Mordukhai-Boltovskoi, 1960). Only the Mediterranean *Calanipeda aquaedulcis* was an alien species. The dispersal intensity of the Ponto-Caspian and alien species of zooplankton upstream of the Volga River increased in the 2000s. By this time, in the Volga River, the northern boundary of the distribution of the copepods *Heterocope caspia* and *E.* cf. *affinis* became the mouth of the Kama River. *Calanipeda aquaedulcis*, *Cornigerius maeoticus* and *Cercopagis pengoi* were not noted above the city of Togliatti. *Podonevadne trigona ovum* lived only in the Volgograd Reservoir (Popov, 2011). In 2015–2019, it was established that the boundaries of the ranges of four Ponto-Caspian crustaceans and *Calanipeda aquaedulcis* in the Volga reservoirs moved to the north by 300–400 km from those at the beginning of the 2000s. The Ponto-Caspian *Heterocope caspia*, *Eurytemora caspica* and *Cercopagis pengoi* settled in the Kama River 800–1000 km from its mouth (Lazareva, 2019, 2020). In 2018, it was shown for the first time that all six species inhabit the Volga-Don Canal, settling in the Volga and Don basins. In 2020, it was proved that not the Atlantic *Eurytemora affinis*, but a new species *E. caspica* lives in the Volga River, the Don River and the Taganrog Bay of the Sea of Azov (Lazareva, 2020; Sukhikh et al., 2020), which was isolated in 2013 from the group of species *E. affinis* s1 based on materials from the North Caspian (Sukhikh & Alekseev, 2013). In the 2010s, alien species not associated with the Caspian and Black Seas appeared in the Volga and Don basins. They are rapidly settling, overcoming the watersheds of large rivers. Since the early 2000s, the American rotifer *Kellicottia bostoniensis* (Zhdanova et al., 2016) has been settling from west to east, mainly north of 56° N, 2012 the Kama reservoir (57° E) became the eastern boundary of its area (Krainev et al., 2018). From east to west, the East Asian copepod *Thermocyclops taihokuensis* quickly spreads, which until 2010 was not found north of the Aral Sea and west of the Caspian Sea (Monchenko, 2008). In 2012, *T. taihokuensis* entered the Volga River below the city of Volgograd, the Volga-Don Canal, and the Tsimlyansk Reservoir on the Don River (Vekhov et al., 2014; Lazareva and Sabitova, 2021). In 2019, it was established that the invader is also common in the Don River downstream of the Tsimlyansk reservoir and is found singularly 240 km above this reservoir. At the same time, it was found at the mouth of the Sura River (56 ° N). That is its northernmost location (Zhikharev et al., 2019). In 2019, the species was found in the upper reaches of the Oka River (Shat Reservoir, 54 ° N, 38 ° E); at present, this is its most western location (Lazareva, 2021). Both biotopes belong to the Middle Volga basin. A detailed analysis of 2015-2019 zooplankton collections from the Volga River showed that *T. taihokuensis* invaded the lower part of the Cheboksary reservoir from the mouth of the Sura River to the Cheboksary HPP back in 2016. In 2017–2018, this species settled downstream of the Volga River into the Kuibyshev reservoir up to the mouth of the Kama River. Thus, over the past ten years, the area of five Ponto-Caspian and three alien species of zooplankton has significantly expanded in the Volga and Don River basins. For several species, a new ultra-fast latitudinal direction of spread is shown, the reasons and vectors of which are not yet clear.

For details see: Lazareva V.I. Spreading of Alien Zooplankton Species of Ponto-Caspian Origin in the Reservoirs of the Volga and Kama Rivers // Russian Journal of Biological Invasions. 2019. Vol. 10. No. 4. P. 328–348. https://doi.org/10.1134/S2075111719040040; Lazareva V.I. First Record of *Thermocyclops taihokuensis* (Harada, 1931) (Crustacea, Copepoda) in the Oka River Basin // Inland Water Biology. 2021. Vol. 14. No. 1. P. 109–112. https://doi.org/10.1134/S1995082921010065

ALIEN FLORA IN A BOREAL REGION OF EUROPEAN RUSSIA: AN EXAMPLE OF KOSTROMA OBLAST

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Despite the increased interest in studies on alien plants, Russia still represents a gap in the global picture of biological invasions. While the number of alien plant inventories available for Russian administrative regions is steadily growing, some areas remain understudied. We present the up to date standardized assessment of alien vascular plants for the Kostroma Oblast (Upper Volga, central European Russia), a region with low human density and high proportions of natural and seminatural habitats (boreal forests). The study is based on data from (i) Russian herbaria, (ii) literature published for 1866–2020 and (iii) direct field observations made in 2011–2020.

Among ca. 1200 vascular taxa listed for Kostroma Oblast, 330 are neophytes, including 125 casual and 172 naturalized species, with 21 species considered invasive; 33 casual species recorded for the region have vanished. Additionally, 14 naturalized species were identified as potentially invasive. Overall, naturalized alien plants made up ca. 14% of the vascular flora of Kostroma Oblast.

Asteraceae, Poaceae, and Brassicaceae are the richest families among all neophytes. Biennial/perennial herbs are the most common naturalized plants, followed by annuals, while woody species are poorly represented. The majority of naturalized taxa originated from Eurasia (i.e. Europe, Mediterranean, and Asia), while in invasive flora, there is a clear dominance of species from North America. The data show that early introductions can be assigned to European and Mediterranean origin, while recently introduced species are of more diverse origin, particularly from North America. Among neophytes, species alien *to* European Russia were more numerous than species alien *in* European Russia. Among deliberately introduced species, those alien *to* European Russia prevailed over species alien *in* European Russia, while in accidentally introduced species, both groups were almost equally represented.

In general, the alien flora of Kostroma Oblast has experienced dramatic enrichment in recent decades, as the total number of neophytes and the number of naturalized taxa have doubled in the last 30 years. The number of naturalized species per district was notably uneven, increasing in districts with higher human population densities (mean = 43). Twenty-five naturalized species (ca. 8% of all neophyte taxa) were recorded in at least the half of all districts in the region. Only 25 species (including 13 naturalized and 12 invasive) were recorded in 12 or more districts (out of 24). *Elodea canadensis*, *Erigeron canadensis*, *Heracleum sosnowskyi*, *Lupinus polyphyllus*, and *Matricaria discoidea* are the most widely distributed invasive species across the region.

The majority of neophyte species are usually found in ruderal habitats. Among natural habitats, grasslands are most represented (9%), followed by riparian habitats (6%). Among the subset of naturalized, non-invasive species, more attention should be paid to those recorded in natural and seminatural habitats (48 taxa in total), especially to alien species that occur in forests and their edges since this vegetation is zonal and covers most parts of the study area.

Compared to other regions in central European Russia (e.g. Ivanovo Oblast or Tver Oblast), Kostroma Oblast has poor alien and particularly naturalized flora; this condition is linked to the socioeconomic features and climatic conditions of the region.

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AGE DISTRIBUTION AND GROWTH OF *PELOPHYLAX RIDIBUNDUS* INTRODUCED INTO KAMCHATKA

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Our study provided the first data about age structure and growth of the marsh frog, *Pelophylax ridibundus*, from the different habitats of invasive part of this species range in Kamchatka. As was revealed by sequencing of molecular markers (Lyapkov et al., 2018), the first population was formed after a single successful introduction that involved a low number of frogs stemming from a single locality. As a result, the initial genetic variation as a background for population differentiation was relatively low. New populations were formed later in habitats with stabile influx of warm water only. Therefore, it is very interesting to study adaptive changes in life history traits as a reaction to local condition of habitats with different influx rate of warm water and respectively – with different duration of activity season within annual cycle.

The study of age structure and growth rate of the marsh frogs was carried out by the skeletochronology according to a standard procedure (Smirina, 1989). The determination of individual age was made by a counting of thin dark lines of arrested growth (LAGs) deposited in the periosteal bone during winter hibernation period. Diameters limited by consecutive LAGs and by the outer bone margins were measured with ocular-micrometer under a light microscope. Means of the minimal and maximal diameters were used to estimate the bone width at the time of a LAG formation and at capture. For back-calculation of individual body length at the time of each LAG formation, the Dahl-Lea formula (Marunouchi et al., 2000) included these LAG diameters was used.

The minimal and maximal ages in males were 1 and 7 years, respectively, with mean age of 2.97 years. The majority of males were 2 or 3 years old. The age in females ranged from 1 to 6 years with mean value of 2.82 years. The majority of females were 2-3 years old also. Due to relatively long activity season, marsh frog males can reach maturation after first wintering, and females – after 1st or 2nd wintering.

Mean values of age (Table) differed between populations, both in females and males: as a rule, populations from habitats with relatively short activity season are characterized by lower mean age. Significant sexual differences in mean age were revealed in some population only, with males being older than females.

In both sexes, the differences between populations in mean body length at each age (see Table) did not change directly with increase of activity season duration. At the same time, the rates of annual increment in body length were some higher in population with shorter activity season.

Table. Average values of age (MeanAge, years) and back-calculated bogy length (mm) for each age of marsh frogs from Kamchatka populations. In parentheses – duration of activity season, months. Sex: ♀ – females, ♂ – males.

Population	**Sex**	**MeanAge**	**Age**	**1**	**2**	**3**	**4**	**5**	**6**
Nalychevo	♀	2.0		32.9	53.8				
(4 months)	♂	1.5		31.4	35.2				
Anavgay	♀	2.56		32.1	54.3	68.9	86.3		
(5 months)	♂	2.81		38.7	59.4	64.1	73.3	81.0	
Malki	♀	2.79		43.4	60.3	66.2	72.2	94.7	
(6 months)	♂	2.69		35.1	55.3	63.8	60.8		
Esso	♀	2.97		39.1	53.8	66.4	74.7	82.0	
(7 months)	♂	3.03		34.9	58.0	65.4	71.2	62.8	67.9
Termalny	♀	2.79		30.8	57.5	70.2	71.7	73.0	
(8 months)	♂	3.50		36.6	59.0	67.2	75.4	75.3	75.9
Paratunka	♀	2.25			51.9	73.1	87.9		
(8 months)	♂	2.50			51.6	65.4	72.1	73.3	
TEC-2	♀	2.95		39.9	59.0	79.4	82.3	91.7	
(9 months)	♂	3.09		34.3	59.5	73.5	72.6	76.4	
Gelios	♀	3.00			57.9	60.9	72.1	89.3	102.0
(10 months)	♂	2.88		39.8	58.3	63.8	78.1		

EFFECT OF GOLDENROD INVASION ON THE NATIVE PLANT-POLLINATOR NETWORKS

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Invasive goldenrods (*Solidago gigantea* Aiton. and *S. canadensis* L.), native to North America and alien to the temperate Palearctic, are highly attractive to insect. Since they flower in late summer-early autumn, when native plants mostly have finished flowering, their invasion are about to interactions of flower-visiting insects and other insect-pollinated flowers. Network approach seems appropriate to investigate effect of invasions on plant-animal interactions.

To investigate possible effect of goldenrod invasion, we compared insect-plant networks in the two adjacent fields, one highly invaded by *S. canadensis* (hereafter invaded), and the other, with only several plants of this species (hereafter not-invaded), in the city of Aleksin (Tula region, Russia) in August-September 2019 and 2020. Number of insect visits to flowers of different plant species were recorded during walking along transects in the studied fields. Insect visitors were classified into several functional groups: honeybees, bumblebees, other bees, hoverflies, muscoid flies, butterflies, beetles and all other insects. Network-level and species-level characteristics of quantitative interaction network were estimated from data on visitation rate of different insect groups to different plant species using *bipartite* package in R 3.6.2.

Most network-level characteristics were very similar for the two studied adjacent fields, or the direction of differences were opposite in the two years of study. Nevertheless, some tendencies could be revealed. For example, niche overlap in insects was higher in the invaded field, whereas interaction diversity is higher in the not-invaded field. This allows to suggest that insects attracted to *S. canadensis*, also visit other plant species in the field.

In the invaded field *S. canadensis* was the plant species with the highest strength (species strength is a measure of relevance of the species to their partners), whereas the second highest strength was in *Hieracium umbelatum* L. (Asteraceae), which has the highest strength in the not-invaded field. Moreover, *S. canadensis* strength in the invaded part of the field is more than twice higher than *H. umbellatum* strength in both parts of the studied field.

To conclude, the results of this preliminary study give no evidences for large effect of *S. canadensis* invasion on plant-pollinator interaction networks. Nevertheless, additional studies from other regions are needed to address the question.

ADVENTIVE SPECIES IN THE MICROPLANKTON OF THE BARENTS SEA

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For the first time adventive species of microplankton were recorded in the Barents Sea from 2007 to 2019:

Bacillariophyta
Proboscia indica Hernández-Becerril
Dinophyta
Amphidoma caudata Halldal
Ceratium strictum Kofoid
Corythodinium diploconus Taylor
Dicroerisma psilonereiella Taylor et Cattell 1969
Dinophysis hastata Stein
Dinophysis nasuta Parke et Dixon
Dinophysis ovata Claparède et Lachmann
Gotoius mutsuensis Matsuoka
Heterodinium milneri Kofoid
Mesoporos perforatus Lillick
Oxytoxum caudatum Schiller
Pentapharsodinium dalei Indelicato et Loeblich III
Podolampas palmipes Stein
Pronoctiluca rostrata Taylor
Protoperidinium brochii Balech
Protoperidinium laticeps Balech
Protoperidinium thulesense Balech
Pyrophacus horologium Stein
Spatulodinium pseudonoctiluca Cachon et Cachon
Ciliophora
Amphorellopsis tetragona (Jörgensen)
Ormosella haeckeli Kofoid et Campbell
Parundella caudata (Ostenfeld)
Tontonia gracillima Fauré-Fremiet
Radiolaria
Actinomma leptoderma (Jörgensen) Nigrini et Moore
Lithomitra lineata (Ehrenberg)
Rhizoplegma boreale (Cleve)
Rotifera
Synchaeta triophthalma Lauterborn
incertae sedis
Leptocylindrus mediterraneus Hasle +
Solenicola setigera Pavillard

The appearance of most of the above planktonic species in the Barents Sea is consistent, as they are common in the adjacent water area of the North Atlantic (North, Norwegian, or Greenland Seas); new records for the region are a consequence of an increase in the volume of the studied material and the availability of special or taxonomic literature.

Predominantly non-indigenous species are boreal or tropical-boreal distribution and have become common in the Barents Sea:

Pentapharsodinium dalei – a common species of dinoflagellates in the pelagic zone of the North Atlantic (Greenland, Norwegian Seas); cysts are regularly found in surface sediments of Arctic seas. In the Barents Sea, we observed almost everywhere and all year round;

Dicroerisma psilonereiella – a relatively recently described species of dinoflagellates is recorded in the boreal and tropical regions of the Pacific and Atlantic. Widely distributed in the Barents Sea: from the Kola Bay in the south to Franz Josef Land in the north. Probably, the dinoflagellate has a cosmopolitan area, since we also noted it in the southwestern part of the Kara Sea (February 2002 and 2005) and in Isfjord, Spitsbergen archipelago (June 2010 and March 2015);

Oxytoxum caudatum – a common species of dinoflagellates in the North Atlantic. In the Barents Sea, it is observed almost everywhere, and one of dominant species during the polar night in the southwestern part;

Synchaeta triophthalma – currently a common rotifer in the southwestern part of the Barents Sea; has a clearly pronounced seasonality: it is observed only in June-July.

In addition, we have repeatedly noted tropical-boreal or boreal plankton species: dinoflagellates *Corythodinium diploconus*, *Podolampas palmipes, Amphidoma caudata*, radiolaria *Rhizoplegma boreale*, and tintinnid ciliate *Parundella caudata*. About a dozen other adventive species of North Atlantic common microplankton were found 1-2 times in the Barents Sea from 2007 to 2019.

A remarkable case is findings of completely unique and exotic species for the Barents Sea. Previously, dinoflagellates *Ceratium strictum, Dinophysis ovata, Heterodinium milneri,* tintinnid ciliates *Amphorellopsis tetragona* and *Ormosella haeckeli* have not been observed outside the tropical region.

A small part of the adventive species is rare and poorly studied; their pattern of geographical distribution is still unclear. It is about dinoflagellates *Gotoius mutsuensis, Pronoctiluca rostrata, Protoperidinium laticeps, P. thulesense*, and the unusual symbiotic consortium complex of two organisms: the diatom *Leptocylindrus mediterraneus* and the flagellate of unknown genesis *Solenicola setigera*.

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A GROUP OF SUCCESSFUL FISH INVADERS WITH LOW PHENOTYPIC DIVERSITIES

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Phenotypic diversity is considered one of the signs of a species' high adaptive capacity, including its ability to disperse and occupy new habitats (reviewed in Forsman, 2014).

However, this adaptation strategy does not appear to be the only one. Indeed, D.I. Berman (2002) described a fundamentally different adaptive strategy used by the Siberian salamander (*Salamandrella keyserlingii*). Individuals of this species have a pronounced ability to settle into new habitats due to an unusually high resistance to abiotic environmental factors. However, it should be noted that despite the vast range of this species all individuals are morphologically homogeneous. In any case, it is not possible to divide individuals of the species into separate forms with different phenotypes.

Analysis of the results of our own studies and literature data suggest that such the adaptive strategy is characteristic of some alien fish species. Thus, a comparison of individuals of the black bullhead catfish (*Ameiurus melas*) from four recently formed European populations showed that this species had less phenotypic variability than other invasive fish species. Based on these results, the authors concluded that morphological variation alone is not always important for successful invasion of a species (Novomeská et al., 2013).

No morphological differences were found between samples from alien populations of the western tubenose goby (*Proterorhinus semilunaris*) from the fresh waters of the Black and Caspian sea basins. At the same time, the level of genetic polymorphism in this species was high and morphologically homogenous individuals belonging to two different phylogenetic lineages are found in water bodies belonging to the basins of both seas (Slynko et al., 2013).

The rotan, *Perccottus glenii*, does not form distinct ecological or geographical forms (e.g., Kasyanov, Goroshkova, 2012) that differ in phenotype, despite the fact that its current range is quite extensive (Reshetnikov, 2009; Caleta et al., 2011; Reshetnikov, Karyagina, 2015).

In addition, another successful invader, the Chinese ricefish (*Oryzias sinensis*), does not form ecological or geographical forms, and is even weakly differentiated morphologically from a closely related species, the Japanese ricefish, *O. latipes* (Chen et al., 1989; Park et al., 2006; our data).

The common adaptive strategy of the above-mentioned species can probably be explained by the similarity of their origins - they are invaders to temperate climatic zone from subtropical regions. For some, a large part of their native range currently is in the subtropics (western tubenose goby and Chinese ricefish), while other species inhabit the temperate zone, despite their ancestors originating from the subtropics (Siberian salamander, black bullhead, and rotan).

Importantly, fish introduced to the temperate zone from cold (arctic and mountainous) regions use the opposite adaptive strategy. This group of species is characterized by high phenotypic plasticity and the formation of diverse geographical and ecological forms, significantly differing in lifestyle, nutrition and morphology, which allows them to inhabit a wide variety of habitats (reviewed by Makhrov, Artamonova, 2020).

In contrast, the strategy described by Berman (2002) appears to ensure successful incorporation of non-native species into different regions by occupying a specific ecological niche, which may be available in different ecosystems, if effective morphological adaptations that were formed in the native range allow for inhabiting in such conditions.

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RECORDS OF CHINESE RICEFISH (*ORYZIAS SINENSIS*) IN THE ROSTOV PROVINCE, RUSSIA, AND THE TIBETAN AUTONOMOUS REGION, CHINA, AND RECONSTRUCTION OF DISPERSAL ROUTES OF THIS ALIEN SPECIES

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Correct taxonomic identification of alien species is important for understanding their dispersal routes, especially when closely related species are on the list of potential invaders. Information on the species identity of ricefish (*Oryzias* sp.) that has formed self-sustainable populations in some regions of Eurasia is contradictory - some authors believe it is the Japanese ricefish (*O. latipes*), others believe it is the Chinese ricefish (*O. sinensis*). We have studied fish samples from non-native populations of ricefish from different regions of Eurasia, including the Rostov province, Russia, where ricefish were found for the first time. The results of a *COI* gene sequence analysis and morphological analysis indicate that all investigated specimens belong to the species *O. sinensis*. Moreover, analysis of our own and literature data shows that all currently known non-native populations of ricefish in continental Eurasia (in Kazakhstan, Middle Asia, the Tibetan Autonomous Region and Xinjiang Uyghur Autonomous Region of China, Ukraine and the Krasnodar territory and Rostov province of Russia) belong to the same species. We reconstructed the history of Chinese ricefish dispersal across the region. In particular, the record of ricefish in the Don River delta suggests that one of the recent routes of secondary dispersal of this species ran from the Kuban geographical region through the lower part of the Don River basin to Cis-Azov area, which may have been the result of accidental transportation (for example, together with commercial fish species) and subsequent self-dispersal.

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NON-INDIGENOUS SPECIES OF ZOOPLANKTON IN SARATOV RESERVOIR

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The transformation of the Volga River into a cascade of reservoirs led to a change in the conditions of existence of aquatic organisms and to an increase in the possibility of dispersal of zooplankton species both in the northern and southern directions. Monitoring studies of zooplankton carried out at the Saratov Reservoir have shown that at present the rheophilic species characteristic of the river sections are preserved in the upper zone. In addition, some species (*Limnosida frontosa* Sars, 1862) can enter the reservoir through the hydropower facilities of the Zhigulevskaya HPP from the Kuibyshev reservoir. The lower part is dominated by forms typical of lakes (Malinina, Zotova, 2005).

Taking into account, the studies of recent years in the Saratov reservoir, in different years, from 98 to 191 species of zooplankton were noted. Currently, the constantly occurring, often dominant species - invaders of the Ponto-Caspian region include: *Cornigerius maeoticus maeoticus* (Pengo, 1879), *Cercopagis pengoi* (Ostroumov, 1891), *Halicyclops sarsi* (Akatova, 1935), *Heterocope caspia* (Sars, 1897), *Podonevadna trigona ovum* (Zernov, 1901), to northern invaders: species of the genus *Eudiaptomus*, some species of the genus *Bosmina*, *Cyclops kolensis*, and species of the genus *Notholca*, *Keratella*.

According to the results of recent studies, the species diversity of the Ponto-Caspian species of invaders exceeds the fauna of invaders in the northern regions, which is facilitated by a decrease in flow due to the creation of a cascade of the Volga reservoirs and an increase in water temperature due to climate change.

Studies have shown that the proportion of invasive species in the Saratov Reservoir in different years varies from 1 to 26% in abundance and from 21 to 55% in biomass, making up a significant part of the food supply for juvenile fish and fish - zooplanktophages.

ONONIS ARVENSIS L. IN KOSTROMA REGION - A NEW INVASION OR RANGE EXPANSION?

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The plant *Ononis arvensis* L. belongs to the *Fabaceae* family and has not previously been found in the territory of Kostroma region, since the range of this plant is confined to southern regions.

However, during a floristic study in Krasnoselsky district of Kostroma region in the vicinity of Isakovskoye settlement, vegetative plants *O. arvensis* were found and photographed. This species was found at two spots on the side of the road during the flowering phase. The first spot was located not far from the waterlogged area dominated by sedges on medium loam. The second spot was located not far from the plowed field, while the plants grew on slightly loamy soil.

The appearance of this plant at such high latitudes is most likely associated with mild winters and, in general, changes in weather and climatic conditions. Previously, Kolomensky district of Moscow region was considered the northernmost area of detection. In this regard, a question arises whether this species is invasive for Kostroma region or is it a natural expansion of its range?

To study the population of *O. arvensis* on the territory of Kostroma region, geobotanical studies were carried out with the processing of obtained data in EcoScaleWin program, and the selection of soils was carried out to determine the particle size distribution and pH of the soil solution. The coordinates of the detection spots are set (Figure). The studies were carried out through the 2018 field season.

Figure. *O. arvensis* in Krasnoselsky district

Geobotanical studies were carried out with the establishment of two sitesof 10 m^2 each. The sites were established in the area with the highest concentration of *O. arvensis*. Then the coverage was determined for each plant, including the studied species. Coverage was assessed using the Broun-Blanquet scale. To process the results obtained, the method of the weighted average of the middle of the interval was used. All the data obtained were entered into the algorithm of the EcoScaleWin program, where the obtained geobotanical descriptions were processed using the amplitude scales of L.G. Ramensky and D.N. Tsyganov, and also on the point scales of G. Ellenberg and E. Landolt.

Soil samples were taken from the sites to determine the granulometric composition using the rolling method and the pH of the soil solution using a professional HANNA HI2211 pH meter. Using the eTrexH navigator, the coordinates of the *O. arvensis* detection spots were determined.

According to the obtained geobotanical data, the plant grows on neutral or slightly acidic soils, which are quite rich in nitrogen and humus, with sufficient moisture and with a predominance of a wet-meadow regime. According to the granulometric composition, the soils are fine sandy, silty enough aerated. The plant *O. arvensis* is an inhabitant of semi-open and open spaces, tending to a moderately warm, low-oceanic climate with mild winters and avoiding extreme continental regions.

Measurement of the pH of the soil solution using a professional pH meter HANNA HI2211 showed that the results coincide with the amplitude scales. For the first site, the soil pH was 6.52, and for the second site - 6.81, which corresponds to a slightly acidic, close to neutral reaction of the medium.

O. arvensis detection points have been determined using the eTrexH navigator. The coordinates of the first spot: 57°32'43 " N, 41°13'11" E, height 123 m. The coordinates of the second spot: 57°32'41" N, 41°13'19" E, height 124 m.

The discovery of *O. arvensis* in the territory of Kostroma region is of great interest not only from the point of view of a new floristic discovery, but also indicates that the climatic conditions are changing, this, as we believe, allows the species gravitating towards more southern regions, including the found species, to expand their range to northern latitudes.

INVASIVE PACIFIC MUSSEL *MYTILUS TROSSULUS* IN THE BARENTS SEA: DISTRIBUTION, DECADAL SCALE DYNAMICS, HYBRIDIZATION WITH ABORIGINAL *MYTILUS EDULIS*

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Boreal blue mussels *Mytilus edulis* (ME) and *M. trossulus* (MT) are old evolutionary lineages of Pliocene origin. The more common ME is native to the Atlantic, while the originally Pacific MT has colonized the Atlantics in a series of natural and anthropogenic invasions. Now these two species co-occur and hybridize in several areas of North Atlantic and neighboring Arctic, including the Barents Sea coast of Kola Peninsula. ME and MT are cryptic species indistinguishable morphologically. Knowledges about their ecological peculiarities are scared however, it is known that MT has less commercial value as aquaculture object than ME.

The presence of MT and its early generation hybrids with ME in Kola Bay was first recorded in early 2000s. Thence we decided to map the distribution of species in the regional (Kola Bay, 50 km long fjord) and local (3.5 km long Tyuva inlet in the northern part of the Kola Bay) scales. At some point we got an impression that the system under consideration is changing at a speed we study it. This set us to resample some populations. Here we present the results of 19 years-long survey of spatial-temporal dynamics of taxonomic structure of blue mussel populations in Kola Bay.

Mussels (> 4000 individuals in total) were genotyped by four diagnostic allozyme loci. Contribution of MT and ME genes into individual genotypes was assessed using approach implemented in the program Structure. We determined age of all genotyped mussels by counting "winter rings" - marks of winter growth delays on shells. This allowed us to study the dynamics at the levels of individual mussel generations.

The distribution of mussel genotypes in mixed samples was always bimodal: parental genotypes dominated while hybrids constituted ~20% of mixed samples. In further analyses, we classified genotypes into two categories: genotypes with the dominance of ME genes and genotypes with the dominance of MT genes.

MT dominated the southern and central parts of Kola Bay, which is an urbanized and harbor area. ME dominated the freshened top of the Bay, on the one hand, and the neighboring open oceanic coast, on the other. In the southern part of the Bay genotype frequencies changed gradually. In the northern part of the Bay, distribution of species was mosaic. This mosaic was analyzed in details using broad data from Tyuva inlet.

In Tyuva Inlet, MT and ME demonstrated tendencies for ecological segregation. Proportions of ME in samples positively correlated with the depth and negatively with the distance from the mouth of the river. On the littoral, MT was more common on algal substrates while ME on the bottom ones. The latter tendency was observed everywhere in Kola Bay.

During the observation period, the taxonomic structure of populations in the Kola Bay has experienced large-scale dynamics. Through 2001-2016, the proportions of MT decreased everywhere, by 30%. Later on, the opposite tendency has been observed. The temporal dynamics could be partly explained by natural selection against adult mussels, as exemplified by observations over individual generations through time. We also notice that invasive MT outperform aborigine ME in Kola Bay during periods of high anthropogenic activities. We suppose that MT is a more opportunistic species than ME.

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ALIEN INSECTS RECORDED IN DONBASS IN 2000–2020

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Alien insects, similarly to adventive plant species, are confined to anthropogenically transformed habitats, therefore the greatest species richness of alien species is associated with highly industrialized regions, as Donbass – one of most urbanized regions with the developed industry in Eastern Europe.

In total, 60 new alien species of insects from 7 orders were registered over 20 years of the XXI century (2000–2020) in the territory of Donbass (within the limits of Donetsk and Lugansk regions): Hemiptera – 21, Coleoptera – 13, Hymenoptera – 9, Lepidoptera – 8, Diptera – 5, Odonata – 3, Mantodea – 1. Consequently, on the average three alien species per year penetrated our region.

Alien species are represented by four trophic groups in terms of trophic relations. Predators (5 species): Odonata – *Selysiothemis nigra* (Vander Linden, 1825), *Hemianax ephippiger* Selys, 1883, *Lindenia tetraphylla* (Vander Linden, 1825); Mantodea – *Hierodula transcaucasica* Brunner-Wattenwyl, 1878; Hemiptera – *Perillus bioculatus* Fabricius, 1775. Parasites (1 species): Hymenoptera – *Platygaster robiniae* Buhl et Duso, 2008. Mixed-feeding species (3 species): Coleoptera – *Harmonia axyridis* (Pallas, 1773); Hymenoptera – *Isodontia mexicana* (de Saussure, 1867), *Sceliphron curvatum* (F. Smith, 1870). The largest group consists of phytophages, represented by 51 species, including monophages (35 species): Hemiptera – *Arboridia kakogawana* (Matsumura, 1932), *Tautoneura polymitusa* Oh & Jung, 2016, *Scaphoideus titanus* Ball, 1932, *Penestragania apicalis* (Osborn & Ball, 1898), *Japananus hyalinus* (Osborn, 1900), *Appendiseta robiniae* (Gillette, 1907), *Cinara pruinosa* (Hartig, 1841), *Cinara pilicornis* (Hartig, 1841), *Mindarus abietinus* Koch, 1857, *Pineus orientalis* (Dreyfus, 1889), *Prociphilus fraxinifolii* (Riley, 1879); Coleoptera – *Agrilus planipennis* Fairmaire, 1888, *Megabruchidius dorsalis* (Fåhreus, 1839), *Exechesops foliatus* Frieser 1995, *Lignyodes bishoffi* (Blatchley, 1916), *Orchestes steppensis* Korotyaev, 2016, *Pityogenes bistridentatus* (Eichhoff, 1878); Lepidoptera – *Acalyptris platani* (Müller-Rutz, 1934), *Cameraria ohridella* Deschka & Dimic, 1986, *Macrosaccus robiniella* (Clemens, 1859), *Parectopa robiniella* Clemens, 1863, *Phyllonorycter issikii* Kumata, 1963, *Phyllonorycter platani* (Staudinger, 1870), *Protocryptis laricella* (Hübner, 1817), *Garella musculana* (Erschoff, 1874); Hymenoptera – *Aproceros leucopoda* Takeuchi, 1939, *Euura tibialis* (Newman, 1837), *Pristiphora abietina* (Christ, 1791), *Pristiphora wesmaeli* (Tischbein, 1853), *Tenthredo talyshensis* Zhelochovtsev, 1988; Diptera – *Dasineura gleditchiae* (Osten Sacken, 1866), *Monarthropalpus flavus* (Schrank, 1776), *Obolodiplosis robiniae* (Haldeman, 1847), *Dioxyna bidentis* (Robineau-Desvoidy, 1830), *Liriomyza chinensis* (Kato, 1949); oligophages (8 species): Hemiptera – *Cinara cupressi* (Buckton, 1881), *Cinara tujaphilina* (del Guertio, 1909), *Dichrooscytus gustavi* Josifov, 1981, *Gonocerus juniperi* Herrich-Schaeffer, 1839, *Leptoglossus occidentalis* Heidemann, 1910, *Dichrooscytus gustavi* Josifov, 1981; Coleoptera – *Lamprodila festiva* (Linnaeus, 1767), *Phloeosinus aubei* (Perris, 1855); Hymenoptera – *Bruchophagus sophorae* Crosby et Crosby, 1929; polyphages (8 species): Hemiptera – *Metcalfa pruinosa* (Say, 1830), *Aspidiotus nerii* Bouché, 1833, *Carulaspis juniperi* (Bouché, 1851), *Lepidosaphes juniperi* Lindinger, 1912; Coleoptera – *Glischrochilus quadrisignatus* (Say, 1835), *Cynaeus angustus* (Leconte, 1851), *Anisandrus maiche* (Kurentsov, 1941), *Xyleborinus attenuatus* (Blandford, 1894).

The following main factors are contributed to the invasion of alien insect species in Donbass: the range expansion due to number fluctuations and climatic changes, anthropogenic transformation of natural ecosystems (urbanization, forest management and agricultural activities, plant introduction) and unintentionally translocation. The majority of alien insect species entered Donbass as a result of secondary self-distribution from the recipient regions, where they finished the first acclimatization stages.

Among the species which entered Donbass in the XXI century, *P. fraxinifolii*, *M. dorsalis*, *P. bistridentatus*, *C. ohridella*, *A. leucopoda*, *T. talyshensis*, *B. sophorae*, *D. gleditchiae*, *O. robiniae* demonstrate outbreaks in number. The following species can damage native forests of Donbass: *A. planipennis*, *E. foliatus*, *P. issikii*, those threatening artificial coniferous forests are *P. bistridentatus*, broadleaf forests – *A. planipennis*, ornamental plantations – *L. festiva*, *P. aubei*, *A. platani*, *P. abietina*, *P. wesmaeli*, *M. flavus*, gardening – *G. musculana*, viticulture – *A. kakogawana*, *S. titanus*, agricultural crops – *M. pruinosa*, *L. chinensis*.

None of an alien insect species that have penetrated into terrestrial ecosystems of Donbass has changed natural communities so far.

BIOLOGY OF *APROCEROS LEUCOPODA* (TAKEUCHI, 1939) IN DONBASS: RESULTS OF 6-YEAR MONITORING

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The East Asian zigzag elm sawfly *Aproceros leucopoda* Takeuchi, 1939 (Hymenoptera: Argidae) was registered in the territory of Donbass (Lugansk Region) for the first time in 2006. In 2014 an outbreak of this sawfly was registered in the south of Donetsk and Zaporozhye regions. Local foci of mass reproduction were found for the first time incentral areas of Donetsk Region in 2015.

Aproceros leucopoda is a monophagous insect which develops on elm (Ulmaceae). In Donbass the plant genus *Ulmus* L. is represented by four species: native *Ulmus minor* Mill., *U. laevis* Pall., *U. glabra* Huds. and introduced *U. pumila* L., widely used in forest tenure activities. The larval development was observed only on *U. pumila* and *U. minor*, but the first species is the main host plant in our region. In the foci of mass reproduction, 100 % defoliation of affected trees of *U. pumila* is observed, while in *U. minor* it does not exceeds 10%.

Zigzag elm sawfly was recorded in all types of elm plantations present in our region: monospecies, mixed, with or without shrub layer. The distribution of *A. leucopoda* has a focal character everywhere, with affected afforests located among relatively healthy ones. Large foci are formed in roadside and windbreaks; local damages are characteristic for central areas of settlements. The sawfly number in city roadside and park plantations of Donetsk and Lugansk is very low, that is associated with unfavorable conditions for eonymph overwintering in the soil under the host plant canopy. The limited area and soil cover compaction, harvesting of leaf litter are restricting factors for the pest colonization of urban cenoses.

Aproceros leucopoda is a parthenogenetic polyvoltine species; overwintering is at the stage of eonymph in dense cocoons inside the leaf litter and soil upper layers near food plant at a depth of nearly 3 cm. Pupation occurs in spring of the next year; dates of adult emergence are individual for each year depending on the conditions and is observed from mid-April. In Donbass three main colour forms of adults are observed, which we conditionally indicated as black, brown and orange ones. All adults that emerged from overwintering cocoon belong to the black colour form. For adults of summer generations, all colour forms are observed in various proportions in different populations and in the same population in different years.

In Donbass the sawfly develops from one to four generations throughout the year. At the initial stage of invasion (2015), the development of four generations was registered. Subsequently, a decrease in the number of generations was registered: in 2016, 2017 and 2019 there were only up to three ones, in 2018 – no more than two. In 2020, the development of only one generation was registered, which led to a significant reduction in the pest number in our region. The reasons for this phenomenon are unknown. Possibly, it may be explained by the incomplete naturalization process of the species in the regional conditions.

Larvae of the first generation develop mainly in the lower and the middle crown layers, the upper layer is affected in the last turn, when the leaf mass in the lower crown part is completely destroyed. Upper layer defoliation is not observed before the beginning of the second generation development in areas with a high abundance of these phytophages. Part of the larvae of all generations, having completed their development, transfers into the soil, where they form wintering cocoons, creating a reserve population part, while the majority of individuals continues their seasonal development. Imagines of the last summer generation, after emerging from cocoons, don't lay eggs and probably die, since we didn't observe wintering in the adult phase. The biological meaning of this phenomenon needs further explanations. Possibly, the death of adults of the last summer generation and restoration of the abundance due to the reserve part of the population, formed by the previous generations, explain the pronounced aggregation in the sawfly distribution.

The wasps *Paravespula germanica* (Fabricius, 1793) and *Polistes gallicus* (Linnaeus, 1761) (Hymenoptera, Vespidae) actively hunt for the sawfly larvae of older and middle ages, while the bug *Himacerus apterus* (Fabricius, 1798) (Heteroptera: Nabidae) is observed feeding on the sawfly eonymphs and pupae of the summer generations. No specialized parasites of *A. leucopoda* have been identified. The highest degree of damage to the sawfly pupae by ichneumonids (28%) was recorded in 2015 in Donetsk. The presence of a complex of non-specialized predators and parasites does not appear to have a noticeable effect on the pest number in our region.

SOME ECOLOGICAL ASPECTS OF ALIEN AMPHIPODS INVASION IN THE LAKE BAIKAL REGION

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There are two species *G. fasciatus* and *M. wohli*, which are known to be expanded in the water bodies of the Lake Baikal Region. Both *G. fasciatus* and *M. wohli* are the species of baikalian origin, which penetrated the lakes and rivers to the east of Lake Baikal Region. Now the initial phase of their distribution in the water bodies of the Lena and the Amur rivers basin is observed.

Both species were found at the territory the Republic of Buryatia in the lakes of the Selenga River valley, such as the deep mesotrophic Lake Gusinoe, the eutrophic lakes Thorma and nearly located Lake Beloe. In the Uda River basin, they inhabit the eutrophic lakes of the Eravnoe-Kharga system (the Great Eravnoe, Sosnovskoe, Gunda), which are located at the watershed of Yenisei and Lena rivers, and the ice-free creek near Ulan-Ude. The only species *G. fasciatus* was found in the eutrophic lakes Great Kharga and Schuchie. Definitely, the number of water bodies, which were occupied by these species at the territory of Buryatia along valleys of Selenga and Uda rivers, is much more than that aforementioned.

To date, the only species *G. fasciatus* has been found at the territory of Transbaikalian Krai. It was registered in the Ivan-Arakhley lakes system (from mesotrophic to eutrophic type), located at the watershed of Yenisei and Lena rivers and in the eutrophic Lake Kenon (the Amur River basin).

The alien species may co-exist with native *Gammarus lacustris* (the lakes Arakhley, Gusinoe, Sosnovskoe, Gunda and Lake Schuchie) due to the wide zone of bottom macrophytes, such as *Chara*, *Aegagropila*, *Lemna* etc. Apart from the lakes, the alien species were found jointly with *G. lacustris* in the ice-free creek near Ulan-Ude. This may occur due to the high spatial heterogeneity and abundance of microniches that provide refugees for *G. lacustris* in the macrophyte debris. We believe that such refugees are important for *Gammarus* in its escaping fish predation and this fundamental factor is prior to the alien species invasion.

The abiotic factors, such as drought and the lake level fluctuations, can influence the state of invasive amphipods populations. In 2016 we registered the disappearance of *M. wohlii* in the Lake Sosnovskoe as a result of exacerbation of its low-water phase. The abundance of *G. fasciatus* was less than that found here in 2008-2009. The most probable mechanism of impact of the lake level fluctuations on the invasive amphipods populations was through decreasing the dissolved oxygen concentrations in water, which were extremely low in winter season 2015-2016. Noteworthy, the low lake level and oxygen also had negative impact on fish fauna of Lake Sosnovskoe. By contrast, the native species *G. lacustris* was abundant there and this species appeared to be more tolerant to the low oxygen in natural water bodies. The similar situation with decreasing the alien amphipods abundance was registered in the Great Eravnoe Lake in 2016, although there was not full disappearance of *M. wohlii*. The latter can be explained by higher oxygen concentrations, compared to Lake Sosnovskoe. Thus, the abundance of the alien species *G. fasciatus* and *M. wohli* in the shallow eutrophic lakes of the Lake Baikal Region decreases during the low-water phase and their co-occurrence with native species may depend on this factor.

NON-NATIVE ANNELID SPECIES IN THE GULF OF FINLAND (BALTHIC SEA)

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The Gulf of Finland is an area of intense shipping, and its fauna has long been affected by biological invasions. The introduction of freshwater oligochaetes, apparently, began as early as the 18^{th} – 19^{th} centuries after the connection of the Baltic and Volga basins by navigable routes. The Ponto-Caspian oligochaetes *Tubifex newaensis* was found by the first explorers of benthic fauna of the Neva Estuary. Others species have probably appeared in the Gulf of Finland relatively recently. However, Oligochaeta is a very difficult taxonomic group. As a rule, these worms are not identified in routine monitoring studies, and distribution of many species is poorly documented. *Potamothrix moldaviensis* was absent from the Neva Bay in the first half of the 20^{th} century. Both of these tubificid oligochaetes have now become widespread and numerous species. Brackish water oligochaetes of Ponto-Caspian origin (*Paranais friči* and *Potamothrix vejdovskyi*) were earlier introduced to other regions of the Baltic Sea and, apparently, penetrated into the Gulf of Finland from the west in the second half of the 20 century.

The invasion of the North Sea oligochaete *Tubificoides pseudogaster* took place before our eyes. In the Gulf of Finland *T. pseudogaster* was first detected in 1995 at one station located near the shipping fairway. In the 2000s and 2010s we observed a gradual expansion of this species. Currently, the *T. pseudogaster* population has occupied more than 1000 km^2 of bottom space. The distribution of oligochaetes was accompanied by a drastic decrease in the abundance of the glacial relict amphipods *Monoporeia affinis*, which previously dominated in benthic communities (Maximov, Tsiplenkina, 2012).

The fauna of polychaetes was especially changed. In the early 1990s polychaetes in the Gulf of Finland were rare and/or few in number. The Russian waters in the eastern Gulf of Finland were inhabited by two species of polychaetes (*Manayunkia aestuarina* and *Bylgides sarsi*) only. The latter species was occasionally found only near the western boundary of the studied water area, near island Gogland. At the turn of the 21^{th} century the eastern areas of the Gulf of Finland were colonized by two spionid polychaetes from the genus *Marenzelleria*. The North American species *Marenzelleria neglecta* were first encountered in 1996. The following years, they colonized large areas of the bottom and became a common component of benthos in shallow (<20 m) areas (Maximov, 2009). The invasion of the Arctic representative of this genus, *Marenzelleria arctia*, in 2000s impacted the deep open areas (Maximov, 2010). *M. arctia* entered the Russian waters of the Gulf of Finland in 2008. By next year polychaetes occupied the most of the water area of the Gulf of Finland, and become the dominant component of the soft-bottom macrofauna. The mass development of polychaetes led to a manifold (almost 45 times) increase in the abundance and biomass of macrozoobenthos in the deep-water areas. At present, *M. arctia* remained the most widespread and abundant benthic species in the Gulf of Finland. Recently, the fauna of polychaetes in the Gulf of Finland was replenished with next species – sabellid pololychaete *Laonome xeprovala* (Tamulyonis et al., 2020).

Annelid worms are well known habitat modifiers. Through bioturbation and bioirrigation they affect the physical structure of sediments and exchange processes at the sediment-water interface. By this time, large-scale invasion of *Marenzelleria arctia* leaded to cardinal reconstructions of soft-bottom community and whole ecosystem of the eastern Gulf of Finland (Maximov et al., 2014, 2015). Consequently, further invasion of other annelids has great potential to alter ecosystem-level properties and processes in the Gulf of Finland.

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INVASIVE SPECIES IN ZOOPLANKTON AND ZOOBENTHOS KUIBYSHEV RESERVOIRS IN 2018

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According to literary data and our own research of the Kuibyshev reservoir, the fauna of invasive species of zooplankton is represented by approximately 30 species from groups Rotifera (13), Cladocera (9) and Copepoda (7). The largest number of zooplankton invasive species that have been appeared in the Kuibyshev reservoir after the Volga regulation, belongs to the northern complex (Romanova, 2010). However, in recent years there has been an active penetration of southern species up the reservoir cascade. According to literature, the fauna of zoobenthos invasive species includes more than 40 species represented by Polychaeta (3), Oligocheta (2), Hirudinea (2), Mollusca (7) and Crustacea (around 25). Most of them are members of the Ponto-Caspian fauna complex (Biological..., 2004). As part of the bottom invertebrates in the upper reaches of the reservoir invasive species account for more than 67% both in number and in biomass (Yakovleva, Yakovlev, 2014).

Zooplankton. According to the results of the hydrobiological survey of the Kuibyshev reservoir in 2018, 22 invasive species that was found in the zooplankton belong to Rotifera (*Brachionus budapestinensis* Daday, 1885, *B. diversicornis* (Daday, 1883), *Kellicottia longispina* (Kellicott, 1879), *Keratella tropica* (Apstein, 1907), *Polyarthra major* Skorikov, 1896, *Pompholyx sulcata* Hudson, 1885, *Conochiloides coenobasis* Skorikov, 1914 and *C. unicornis* Rousselet, 1892), Cladocera (*Bosmina (Eubosmina) coregoni* (Baird, 1857), *B. (E.) crassicornis* Lilljeborg, 1887, *B. (E.) longispina* Leydig, 1860, *Bythotrephes* x hybridus, *Limnosida frontosa* Sars, 1862, *Cornigerius maeoticus* (Pengo, 1879) and *Daphnia cristata* Sars, 1862) and Copepoda (*Acantocyclops americanus* (Marsh, 1893), *Cyclops kolensis* Lilljeborg, 1901, *Eudiaptomus gracilis* (Sars, 1863), *Calanipeda aquaedulcis* Kritschagin, 1873, *Eurytemora caspia* Sukhikh et Alekseev, 2013, *Heterocope appendiculata* Sars, 1863 and *H. caspia* Sars, 1897). Almost throughout the whole water area of the reservoir floating larvae of the bivalve mollusk *Dreissena* sp. were found.

In terms of abundance, the share of invaders in the total indices of zooplankton was <0.1%, where the main role was played by representatives of Rotifera and Cladocera. The contribution of invasive species to the whole biomass of zooplankton is on average 2.5±0.4%, where Rotifera accounted for 0.9±0.2% from total indicators, Cladocera – 0.8±0.1 and Copepoda – 0.7±0.1%. The *Dreissena* sp. content in average abundance was at the level of 14.2±2.3% and biomass – 5.6±1.0%. In spatial terms, the major role of invasive species was noticed on the Volga reach by number (0.9±0.1%), and on the Volzhsko-Kamskiy reach – by biomass (4.6±2.4%). Invasive species with the lowest presence were found on the Undor (<0.1%) and Ulyanovskiy (1.0±0.4%) reaches. The biggest indicators of dreissen veligers were noticed on the Kama reach (in terms of abundance 27.6±6.6, of biomass – 6.1±2.9%), and the smallest – on the Ulyanovskiy reach (3.6±2.1 and 0.3±0.2% respectively).

Zoobenthos. In 2018, the fauna of invasive species in the bottom community of the Kuibyshev Reservoir was presented by 13 species from groups like Polychaeta (*Hypania invalida* (Grube, 1960) and *Hypaniolla kowalewskii* (Grimm, 1877), Hirudinea (*Archaeobdella esmonti* Grimm, 1876), Mollusca (*Dreissena polymorpha* (Pallas, 1771), *D. bugensis* Andrusov, 1897, *Monodacna colorata* (Eichwald, 1829) and *Lithoglyphus naticoides* (C. Pfeiffer, 1828)), Crustacea (Cumacea – *Pseudocuma (Stenocuma) cercaroides* Sars, 1894 and *P. sowinskyi* (Sars, 1894), and Amphipoda – *Cheliocorophium sowinskyi* (Martynov, 1924), *Dikerogammarus haemobaphes* (Eichwald, 1841), *Obessogammarus crassus* (Sars, 1894) and *Niphargoides macrurus* (Sars, 1894)). The gastropod mollusk *L. naticoides* was showed up most frequently (51.1% of samples).

On average, invasive species from the total indicators of zoobenthos was accounted for 44.1±3.6% by abundance 61.2±3.9% – by biomass. The main contribution to the quantitative indicators from invasive species was made by Mollusca (in abundance 23.6±2.9%, in biomass – 49.0±4.1%), the second place belongs to Crustacea members (15.9±2.8 and 9.5±2.3% respectively). Invasive species impact to the formation of the benthic fauna abundance was observed at high level for Priplotiniy and Tetyushskiy reaches (70.0±14.2 and 63.7±10.0% respectively), and of biomass – for Tetyushkiy reach (84.2±6.1%). Low relative indicators for invasive species were identified at the upper course of Kuibyshev reservoir (less than 25% by abundance and less than 38% by biomass).

CONSEQUENCES OF INVASION OF ALIEN BIRD SPECIES IN NATURAL ECOSYSTEMS OF EASTERN SIBERIA

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Modern climate warming is making significant changes in the composition of the bird fauna in Russia. This is especially evident in areas with pronounced climate change processes. One of these regions is Eastern Siberia. On average, the warming in the Northern Hemisphere of the Earth is 0.7 ° C / 100 years, and in Eastern Siberia it is 1.9 ° C / 100 years, i.e. 2.7 times more. At present, it can be even more pronounced, since the treatment carried out does not include the last decades with the most pronounced warming. The observed changes in the circulation of air masses, leading to dramatic climate changes, strongly affect the bird fauna of the Central regions of Asia. The development of large and prolonged droughts, as well as the increasing frequency of their repetitions in its southern regions, caused a significant outflow of birds to the northern regions, primarily to the territory of Eastern Siberia. Inner Asia is characterized by the formation of very long (several tens of years) dry periods, combined with shorter, but very strong, extensive and rather long (from 5 to 10 years) droughts. On the basis of many years of work by ornithologists, covering the entire second half of the past and the beginning of the current century, the features of the dynamics of the bird fauna of Inner Asia as a result of climate warming are considered. Severe droughts, followed by long dry periods, observed in the arid regions of Central Asia in the second half of the 20th century, caused massive migrations of birds to the north. The greatest changes in habitat were observed in birds using intrazonal lacustrine-bog ecosystems for nesting. Primordially steppe and desert birds mastered the territories within their natural zone. They are characterized by separate flights to the northern boundaries of their ranges towards the end of the second half of the period under study. As a result of mass settlements, the diversity of birds in Eastern Siberia increased by 22.6% (110 species), but the abundance of the main part of new species remains insignificant. At present, the number of coastal birds in the south of Eastern Siberia, as well as in Central Asia, has greatly decreased, as a result of the shift of their range optima to the north. A detailed list of birds makes it possible to highlight the most important aspects of their dispersal and to understand the features of the development of this process. It undoubtedly gradually intensified, and in the second decade of the current century, birds with more southern ranges began to form the basis of new spreading species, and earlier, even in Mongolia and Northern China, were few in number for nesting or were found only by flight. It should be noted that the bulk of the new species are migratory birds, or they are occasionally observed at the nesting site in separate pairs or small groups. It is necessary to pay attention to the fact that droughts and long dry periods covered the desert and steppe and forest-steppe natural zones of Inner Asia, as well as the outskirts of the southern taiga subzone. Consequently, the birds of these territories should be the most numerous among the migrating species. However, primordial steppe and desert birds, despite the fact that a number of their species are nomadic, have demonstrated very high resistance to dry periods. Undoubtedly, this is due to the formation in them of special adaptations for existence in these natural zones. In general, the massive appearance of new, atypical for Eastern Siberia, bird species has dramatically increased their species diversity. Earlier, 376 bird species were registered on its territory (taking into account new taxonomic changes associated with giving a number of subspecies the status of new species). Their modern fauna (the second half of the 20th and the beginning of the 21st centuries) is formed by 486 bird species, and the process of the formation of the bird fauna of Eastern Siberia continues - each year of research brings new species. At the same time, the abundance of new species is insignificant and cannot determine the number of birds in the region. Noticeable changes in numbers are associated with a sharp shift to the north of the habitats of the most common and widespread species of near-water and waterfowl in arid regions of Eastern Siberia. Everywhere there is a high instability of habitats and a shift of their boundaries to the north, as well as a noticeable exchange between the faunas of birds of different regions, going in all directions, incl. and from the north. Zoogeographic boundaries have also largely lost their significance - birds easily overcome them. High dynamics of areas and species diversity is characteristic of birds using the intrazonal habitats of these natural zones - wetland ecosystems. The number of a small group of ichthyophagous birds has noticeably increased: the Great Cormorant, the Gray Heron, the Great Crested, Red-necked, Black-necked and Slavonian Grebes. Of these, only the cormorant can affect the birds of coastal ecosystems and the fish productivity of water bodies. Its massive appearance on the lake Baikal was accompanied by a decrease in the abundance and changes in the distribution of the most numerous species of gull birds: Mongolian, Common, Black-headed and Little gulls.

CYCLACHAENA XANTHIIFOLIA (ASTERACEAE) - A NEW ALIEN SPECIES OF THE ASTRAKHAN RESERVE IN THE TERRITORY OF THE LOWER PART OF THE VOLGA DELTA

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The North American invasive species of *Cyclachaena xanthiifolia* (Nutt.) Fresen is currently found in many regions of Russia. In the Astrakhan region this plant was found in 1972 by G.E. Safonov along the highway near the village of Kucherganovka, later found on a railway embankment in the vicinity of Astrakhan; on the side of the road near the village of Enotaevka; in the vineyards, near the Narimanov airport, etc. In the publication on the flora of the Astrakhan region (Laktionov, 2010) *C. xanthiifolia* is found on the roadside, clogged dry places, settlements, melons and fallow lands for all floristic regions except Bogdinsky and Baskunchaksky as a common plant.

Finds of this species in the Volga delta are confined to the upper zone of the above-water delta along settlements and roads. In 2021 *C. xanthiifolia* the was first recorded in the lower zone of the above-water delta on the territory of the Damchiksky cluster of the Astrakhan Reserve. A single plant was found in June at the central cordon near the outbuilding. At the moment this is the southernmost point of distribution of the species on the territory of the Astrakhan region on the border with the sea edge of the Volga delta.

COMPILATION OF ACCUMULATED DEGREE DAYS RASTER COMPUTER MAPS FOR SOLVING THE PROBLEMS OF STUDYING INVASIONS OF ALIEN SPECIES AND MONITORING THE INVASIVE PROCESS

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Seasonal and spatial dynamics of ectothermal organisms is determined by environmental factors, primarily temperatures as well as accumulated temperatures. It is the lack of heat supplies that is the main environmental factor limiting the spread of biological objects, including alien species, to high latitudes, and also the factor determining their development. However, in packages of climatic maps, widely used in ecological-geographic modeling, such as BioClim (WorldClim Bioclimatic variables), there are no Accumulated Degree Days (ADD) maps. In this regard, the creation of ADD maps is relevant. Additional parameters can also be considered while creating ADD maps. So, reducing the duration of daylight hours to a certain value – critical photoperiod value could be taken into account. This parameter defines the diapause of insects and serves as a signal factor that determines the possibility of the second generation development, while the ADD calculated starting from the day of the photoperiod threshold value should be sufficient for the species to pass the entire complex of adaptive reactions necessary for successful overwintering. The ADD for the period with the corresponding day length also determines the possibility of plant seeds ripening and, accordingly, the potential for the spread of harmful species to the north.

We have worked out a technique for creating global and regional ADD maps. The basis for global maps producing were the layers of monthly mean temperatures of the WorldClim 2.1 database (Fick and Hijmans, 2017), as well as temperature data obtained from space sensors, primarily MODIS (product MOD11C3). The method of recalculating monthly mean temperatures into ADD (Kelchevskaya, 1971) was adapted for the algorithm for recalculating maps of average monthly temperatures into ADD maps with any given temperature and photoperiodic threshold. The created maps were used for modeling the spread of dirofilariasis (*Dirofilaria* L.) – a parasitic species that is a great danger to humans in case of invasion from countries with tropical and subtropical climates, and emerald ash borer (*Agrilus planipennis* Fairmaire) – the East Asian species, which is invasive for North America and the European territory of Russia, rapidly expanding in its range and causing enormous damage to the ash forests of the invasive territories.

The basis for regional maps producing were the layers of 8-day mean temperatures of the MODIS/Terra sensor of the satellite product MOD11A2. The technology of computing the maps of the dynamics of ADD in real time and recalculating them into phenological maps of the dates of the onset of critical (vulnerable) stages of development of harmful biological organisms has been worked out by the example of the codling moth (*Cydia pomonella* L.). The author's method based on regression modeling of the land surface temperature into meteorological station temperature data was described. This method was tested for the territory of the southeastern part of Kazakhstan. For the development of the method temperature of 140 °C was used as the critical value of ADD, which corresponds to the actual ADD of the codling moth biofix1 in the study region.

Thus, monitoring of ADD values calculated by Modis data makes it possible to predict the timing of the codling moth vulnerable developmental stages, and, as a consequence, to define optimal dates for farmers to implement pesticide treatment in apple orchards. The calculations have confirmed the possibility of using this formula for other years' data; the deviations of the calculated transition dates of the ADD over the critical values from the meteorological dates are within the permissible deviation values (do not exceed the validity period of pesticides).

The developed technologies and compiled ADD maps can serve as elements of an integrated system of environmental monitoring and forecasting the distribution and development of various biological objects, including alien species. The created maps will be presented open access on the Internet through the Web GIS interface that has already been worked out by Afonin et al. in 2016 – http://app.o-gis.org.

For details see: A. Afonin, B. Kopzhassarov, E. Milyutina, et al. Prototype Spatio-temporal Predictive System of pest development of the codling moth, *Cydia pomonella*, in Kazakhstan, Hellenic Plant Protection Journal, 13, 1-12 (2020) https://doi.org/10.2478/hppj-2020-0001

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PATHWAYS AND ENDANGERED AREAS FOR PLANTHOPPER *LYCORMA DELICATULA* (WHITE) (INSECTA, HEMIPTERA, FULGORIDAE) IN RUSSIA

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An assessment of the risk of introduction and the potential economic consequences of the spread of planthopper *Lycorma delicatula* (White, 1845) in Russia was carried out. The host plants of planthopper *Lycorma delicatula* are about 70 species of woody and herbaceous plants, including economically significant fruit, ornamental and forest plants. Among them are such widely distributed plants in Russia as grapes, apple trees, apricots, cherries, peaches, nuts, many ornamental crops.

Over the past two decades, this species has shown itself as an invader, having introduced from China to Korea (2004) and the United States (2014), where it causes economic damage to the production of grapes. The introduction and spread of this species occurs mainly through the import and internal movement of planting material of host plants and other goods that represent a suitable substrate for laying planthopper eggs (stone, brick, wood products, metal and other items).

The likelihood of entry of planthopper *Lycorma delicatula* into Russia is estimated as high (6.16 points out of 9), since the import of planting material of the host plants of the planthopper and other goods that are potentially a suitable substrate for laying eggs is not prohibited in Russia and is carried out, including from countries where the pest is widespread (China, Korea, the USA).

The likelihood of establishment of planthopper *Lycorma delicatula* in Russia is estimated as medium (5.97 points out of 9) due to the partial similarity of the climatic conditions of the current area of this species and the areas of its potential establishment, as well as the wide distribution of host plants on the territory of Russia. The area of the current pest distribution is limited to climate types that have the following codes in the Köppen-Geiger climate classification: Cfa, Cwa, Dfa, Dfb, Dwa. In the Russian Federation, there are regions with a Cfa, Dfa and Dfb climate. Therefore, the regions of the Russian Federation with a climate of Cfa (the Western Caucasus and a significant part of the Crimea), Dfa (the south of the European part of Russia) and Dfb (the center of the European part of Russia, the south of Western Siberia and the south of the Far East) can be attributed to the areas that are at risk of establishing *Lycorma delicatula*.

The potential damage to the economy and nature of Russia in case of introduction of planthopper *Lycorma delicatula* in Russia is estimated as medium (5.19 points out of 9). The anthropogenic pathway through the import and movement of planting material of ornamental, forest and fruit plants, as well as a number of other goods, transport and packaging are considered as the main way of introduction of the planthopper. The potential impact of planthopper *Lycorma delicatula* on the production of fruit crops in Russia is estimated as large in accordance with the scale of economic damage (from small to huge). *Lycorma delicatula* may be the most economically significant species for industrial fruit growing, primarily for viticulture, and the area of the highest potential consequences of the planthopper in Russia is the areas of grape cultivation.

The overall score of pest risk assessment (1.91 points), integrating estimates of the likelihood of entry and establishment, potential consequences of spread in Russia, exceeds the threshold indicator, which allows us to classify the pest corresponding to the quarantine status and recommend the regulation of planthopper *Lycorma delicatula* as a quarantine pest by including it in the Quarantine Pest List for Russia.

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INTRODUCED GAME MAMMALS IN THE STAVROPOL TERRITORY FAUNA

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A set of state measures for the introduction of valuable biological species was carried out in our country in the thirties of the last century. This also affected the Stavropol Territory. For the first time, a number of species of the class of fish, birds and mammals were introduced or reaclimatized. Since then, the hunting fauna has been replenished with at least a dozen valuable species, which have increased regional biodiversity, increased the efficiency of using the stations and resources of natural ecosystems. Unfortunately, a number of miscalculations associated with the introduction were revealed, incl. concerning partial competition with indigenous species, creation of prerequisites for the spread of infectious and parasitic diseases, incl. anthropozoonoses. The present communication is devoted to the ecological resource summary of the state of species-introduced species of the fauna of hunting mammals of the Stavropol Territory.

Sika deer (*Cervus nippon hortulorum*). In the Stavropol Territory, it is a rare and scarce species; it lives in reserves, incl. Beshtaugorskiy and forests of the Foothill region. Now the number is stable and slightly exceeds 200 individuals. Fallow Deer (*Cervus dama*) - Western European form, introduced in the region. Currently, it is not observed in the natural environment in the Stavropol Territory. Wild rabbit (*Oryctolagus cuniculus*) 1968-69 imported from the Kherson region, Ukraine in Novoselitsky district, and in 1978 - in Kirovsky district of Stavropol Territory. Currently not observed. Eurasian red squirrel (*Sciurus vulgaris altaicus*) was brought from Altai and introduced in the Teberda Nature Reserve in 1937. In 1941, 500 individuals were released into the forests of the river basins. Bolshoi Zelenchuk and Urup. Penetrated and settled in the parks and forests of Stavropol. At present, the number has stabilized at the level of 500–600 individuals. The Raccoon dog (*Nyctereutes procyonoides ussuriensis*) is a mesopredator introduced species. It was imported in the thirties of the last century in the European part of the Russian Federation. In the Stavropol Territory, it was released in 1934 in the Foothill region and the lower reaches of the Kuma near the village. Velichaevskoe, in 1954 - about the village. Levokumskoe. To date, the number has stabilized at the level of 400 individuals. The Raccoon (*Procyon lotor*) is a rare introduced species. Initially introduced in several districts of the Krasnodar Territory, naturalized and, probably, in the floodplain forests of the tributaries and the river itself. Kuban penetrated into the Stavropol kr. First recorded in 2001-2002 in the floodplain forest r. Kuban between with. Supervisory and Barsukovskaya (Khokhlov, Mishvelov, Ilyukh et al., 2004). Currently, there is a tendency towards an increase in the number of the species. By 2020, the number reached 230 specimens, mainly in fixed hunting grounds. Muskrat (*Ondatra zibethicus*) is an introduced species, it is found everywhere in the Stavropol Territory. For the first time it was officially brought in 1962 from Krasnodar kr. in the floodplain r. Levokumsky and Neftekumsky districts. The last 4 years, up to 2020, the number of muskrat has stabilized at the level of 26-27 thousand individuals. Coypu (*Myocastor coypus*). Spontaneous and directed introduction did not lead to naturalization of the species. Currently, the species has not been recorded in the natural environment in the Stavropol Territory.

Thus, starting from the 30^{s} of the last century, hunting activities for the introduction of hunting mammals, which are essentially invasive, in the Stavropol Territory led to successful naturalization: muskrat, raccoon dog, eurasian red squirrel, raccoon - their numbers are stable. The introduction of species: European fallow deer, wild rabbit and coypu can be considered not successful. The sika deer (introduced species), as well as the red deer (an extinct autochthonous species), can apparently be attributed to the initial period of naturalization, with the observance of hunting support, their number is steadily increasing, there are good prospects for naturalization.

INTRA- AND INTERPOPULATION VARIABILITY OF *BYTHOTREPHES* IN CENTRAL EUROPE

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Currently, there are many inaccuracies about the genus *Bythotrephes* in Central Europe, for the last several years it was believed that only the monotypic species *Bythotrephes longimanus* exhibiting high morphological variability. However, according to the recent review of this genus by Korovchinsky, there are at least seven species. The 'most popular' species, *B. longimanus* in fact occurs only in the Alps, while in North America it is considered an invasive species. Our preliminary results indicate that *B. brevimanus* is a more common species in Central Europe, but some lakes in NE Poland also contain *B. liljeborgi*. Furthermore, we have found hybrid forms between these species. We performed genetic analyzes of COI gene and we have found no significant differences between these species. The main goal of this work is to analyze the intra- and interpopulation variability of *Bythotrephes* occurring in Central Europe by a detailed morphological analysis. We will compare main characteristic features according to the protocol proposed by Korovchinsky (e.g. body length, head length, trunk length, abdomen and postabdomen length, length of thoracic limbs of first pair, the claws of postabdomen and caudal process, length of postabdominal claws, interclaw distance, interclaw thickness) in 15 females from every population. To detect hybrids, in addition to standard measurements, we will check additional features distinguishing *B. brevimanus* and *B. liljeborgi* (e.g. pseudognathobasic process, and apical end of antennal branches). Finally, we will compare molecular and morphological differences within these species and their hybrids in Central Europe.

CHANGES IN THE NATURAL FLORA DIVERSITY AS A RESULT OF ALIEN PLANT SPECIES NATURALIZATION

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The addition of alien plant species to flora on a regional scale, as a rule, 1) changes the level of taxonomic biological diversity, 2) can change the structure of the flora, 3) affects the ratio of similarities and differences of flora, i.e. the spatial structure of the flora of a large region. The changes are considered on the example of the floras of the regions of the middle zone of European Russia (Central Russia) and the participation of naturalized alien plant species (NSP) in them. The invasive status of the species was assessed using the approach [Richardson et al., 2020]; species with the “naturalized” and “invasive” statuses were taken into account.

With the addition of NSP to the natural flora of the analyzed regions for all ranks of the taxonomic hierarchy, an increase in diversity is noted: the richness of species and genera increased by 18-38% of the natural value, families - by 8-16%. Only 20 families are alien in different areas.

According to the family representation index [Kostina et al., 2015], taxonomic spectra include 16 leading families. In addition to the increase in diversity with the addition of NSP, some changes in the taxonomic structure of floras were revealed. 1). In most regions of Central Russia, the set of leading families of taxonomic spectra of regional floras practically does not change as a result of naturalization of alien species. Significant changes in the position of the leading families occur only in the flora of the Voronezh Region (Wilcoxon's test $W = 2.31$, $p = 0.021$). 2). With the addition of NSP, some leading families increase their rank, which can change the subtype of flora: in five regions, the Rosaceae family "moves" to the third place in the spectrum, as a result, there is an expansion of the Rosaceae-zone, which is mainly characteristic of the European regions. In the northern regions of the Central Russia (Tver, Ivanovo, Vladimir), the subtype Caryophyllaceae, which is characteristic of the floras of the boreal zone, changes to the subtype Rosaceae. In the areas adjacent to the Fabaceae zone, the Fabaceae subtype is replaced by the European (Rosaceae subtype or type), which is noted, for example, for the flora of the Penza region. 3). The rank of the Brassicaceae and Chenopodiaceae families rises by 1-4 places, however, in general, this does not lead to a change in the type or subtype of flora. It is any increase in the ranks of these families in the spectrum that is usually used to confirm the thesis about the more “southern” nature of the floras as a result of the participation of alien species.

The spatial diversity of floras and the degree of their homogenization/differentiation were assessed by the difference in the Bray–Curtis similarity coefficients before and after the addition of NSP. Taxonomic (*HT*) and functional (*HF*) homogenization/differentiation, are considered, the latter based on the relationship of plant biomorphs [Zhmylev et al., 2017; Morozova, Zhmylev, 2020]. For the regional floras of Central Russia, the taxonomic differentiation was confirmed, and not homogenization due to differentiated naturalization depending on natural conditions. However, the presence of different structural groups has a different effect on the similarity/differences of floras. A greater homogenizing effect has 1) annual/biennial species, in contrast to herbaceous perennials and woody species, 2) archaeophytes compared to neophytes, and 3) species biogeographically related to the analyzed flora, compared to species whose natural ranges lie entirely behind outside the territory of the Central Russia. An increase in the taxonomic difference of floras is accompanied by functional homogenization, which, taking into account groups of biomorphs of species, it consists in an increase in the proportion of annual/biennial and woody plants and a decrease in the proportion of herbaceous perennials.

Both processes – changes in taxonomic and functional similarities/differences – are interrelated, but proceed at different rates. The number of species in floras grows faster than the number of common species increases or changes occur in the ratio of functional types in the structure of floras. On a regional scale, the observed changes in *HF* can be explained by the strong anthropogenic disturbance of the Central Russia territory and the naturalization of alien species in disturbed habitats. In this case, annual/biennial species have the greatest homogenizing effect, and an increase in their proportion contributes not only to functional, but also to taxonomic homogenization.

These facts are important from the point of view of both ecological and botanical-geographical theory and environmental practice.

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NORTH-WESTWARD EXPANSION OF THE INVASIVE RANGE OF EMERALD ASH BORER, *AGRILUS PLANIPENNIS* FAIRMAIRE (COLEOPTERA: BUPRESTIDAE): FROM MOSCOW TO SAINT PETERSBURG

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The emerald ash borer *Agrilus planipennis* Fairmaire is a devastating invasive pest of ash trees in European Russia, Ukraine, and North America. To monitor the north-western limit of its European invasive range, in June 2018 we established 10 study plots along the federal highway M10 (Russia) that runs between Moscow and Saint Petersburg through Tver' City (approx. 180 km from Moscow), and lined with ash trees. On each plot, 2–4 *Fraxinus pennsylvanica* trees with heights ranging 6.1–17.0 m and diameters ranging 7.0–18.0 cm were girdled, i.e., 50 cm of their bark were removed. The study plots were visited and girdled trees were examined in September and November, 2018, and in October, 2019. Observations revealed that the current continuous north-western limit of *A. planipennis* range in European Russia coincides with the north-western border of Tver' City and this range limit has not distinctly shifted north-westward during 2015–2019. In spite of the rich food supply (due to abundant *F. pennsylvanica* and *F. excelsior* plantings) in Tver' City and along roads going to and from, the population density of *A. planipennis* in the area is currently low.

Recently (in September 2020), a sudden outbreak of *A. planipennis* was unexpectedly recorded far north-westward – in Petrodvorets (Peterhof) district of Saint Petersburg, at the distance of approx. 520 km from Tver' City. Our preliminary observations indicated that about 200 ash trees (approx. 90% of those *F. pennsylvanica* and 10% *F. excelsior*) have been infested and most of them were killed. Analysis of archived Yandex Panorama and Google Street View photographs suggested that the emerald ash borer arrived at this location in the mid-2010s. Keeping in mind that over the previous years *A. planipennis* was intensively searched for in areas stretching from Tver' towards Saint Petersburg (ash hedges along the M10 (Russia) highway route were thoroughly investigated) without any record of the beetle beyond the limits of Tver' City, we believe that *A. planipennis* arrived at Saint Petersburg as a result of its accidental introduction by means of, e.g., "insect-hitchhiked" vehicles, transported plants for planting, and/or other commodities. Notably, the adults of the emerald ash borer can easily travel by cars being hidden behind flanges of the car body; the insect can stay even on a tree branch pressed by a wiper to a windshield at a car driving at speeds of up to 120 km/h. Railway cars also often serve as substrates for traveling beetles. As a result, in the suburb of Saint Petersburg *A. planipennis* has currently established, although relatively small, local, and geographically isolated, a nevertheless destructive population.

"Natural" spread of the emerald ash borer towards the European Union from north-western Russia appears to be slow and limited, and long-distance spread here is mainly governed by human-mediated means, thus plant quarantine regulations to restrict further spread in such case are relevant. But also, in this case one should take into account the fact that woodlands of ash are common along the north-eastern Baltic coast, stretching from Saint Petersburg towards both Estonia (120 km) and Finland (130 km). These woodlands potentially provide an excellent route pathway for *A. planipennis* towards the European Union, especially in the context of ongoing global climate change. Moreover, during the last two decades the ongoing massive ash dieback has devastated over 95% of European *Fraxinus* population. The question remains open as to how much of it will remain following (inevitable) the emerald ash borer invasion.

In conclusion, the future of ash in Europe is under the threat. The proximity of the reported *A. planipennis* outbreak to the borders of the European Union (approx. 130 km to Estonia and Finland) requires urgent measures for its containment and control, and constant monitoring.

For details see: Musolin D.L., Selikhovkin A.V., Peregudova E.Y. et al. North-westward expansion of the invasive range of emerald ash borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae) towards the EU: From Moscow to Saint Petersburg. Forests 2021, 12, 502. https://doi.org/10.3390/f12040502

INVASION OF BOREAL FLORA ELEMENTS IN THE ARCTIC ALONG THE LENA RIVER WATERCOURSE (RUSSIA, YAKUTIA)

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Due to the warming of the climate, many boreal plant species began to expand their northern borders, moving into the Arctic. Along with latitudinal-oriented mountain systems, such as the Urals and the Verkhoyansk Range, similarly oriented valleys of major rivers in Asian Russia (the Ob, Yenisei, Lena, etc.) serve as an ideal corridor for plant migration to the north. In the process of floristic works carried out in the right-bank part of the lower reaches of the Lena River (about 20 km below the Tit-Ary island), in the period 2015-2017, we identified several plant species mainly in the taiga-forest distribution area, the northern boundaries of which were previously noted by specialists much further south. Among the plants that used the "corridor" of the Lena River are the following species found at the turn of the N 72°08' (some species are found further north):

Larix dahurica Turcz. subsp. *cajanderi* (Mayr) Dyl.
Calamagrostis langsdorffii (Link) Trin.
Poa pratensis L. s.str.
Zigadenus sibiricus (L.) A. Gray
Salix abscondita Laksch., *S. dasyclados* Wimm. and *S. udensis* Trautv. et C. A. Mey.
Duschekia fruticosa (Rupr.) Pouzar
Acetosa thyrsiflora (Fingerh.) A. Löve et D. Löve
Rumex sibiricus Hult.
Stellaria longifolia Muehl. ex Willd.
Ranunculus propinquus C. A. Mey.
Trollius sibiricus Schipcz.
Papaver angustifolium Tolm.
Dichasianthus humilis (C. A. Mey.) Soják
Dimorphostemon pinnatifidus (Willd.) H. L. Yang
Rorippa palustris (L.) Bess.
Rosa acicularis Lindl.
Rubus arcticus L.
Angelica decurrens (Ledeb.) B. Fedtsch.
Conioselinum tataricum Hoffm.
Ledum palustre L. var. *angustum* N. Busch. and var. *dilatatum* Wahlenb.
Vaccinium uliginosum L. subsp. *uliginosum* and *V. vitis-idaea* L. subsp. *vitis-idaea*
Primula matthioli (L.) V. A. Richt. subsp. *sibirica* (Andrz. ex Besser) Kovt.
Myosotis suaveolens Waldst. et Kit. s.l.
Pedicularis sceptrum-carolinum L. and *P. tristis* L.
Boschniakia rossica (Cham. et Schlecht.) B. Fedtsch.
Galium densiflorum Ledeb. and *G. trifidum* L.
Adoxa moschatellina L.
Antennaria villifera Boriss.
Saussurea alpina (L.) DC.
Crepis nana Richards.

In our opinion, these species have acquired a tendency to expand the northern territory in a relatively recent period of time and have the prospect of increasing their influence on the Arctic vegetation.

ENVIRONMENTAL REQUIREMENTS OF POLEMOHORA-SPECIES AND DYNAMICS OF THEIR NATURALIZATION IN THE TVER REGION

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Since 2018, we have focused on polemochores which expanded their range in the course of military operations during The Great Patriotic War of 1941–1945. As of today, 25 polemochore species in the places of deployment of German troops have been identified in the Tver Region. The specificity of their distribution in the regional flora may be explained with the influence of historical, military and ecological factors. The initial level of polemochores diversity was determined by the volume and composition of imported seeds, which depended on the occupation duration and military operations specifics. The biggest number of polemochores was found in the immediate vicinity of transit hubs on the territory of the Rzhev-Vyazma bridgehead (a key strategic object of wartime). We have considered biological and ecological characteristics of polemochores on two key model territories, along with succession dynamics of phytocenoses with polemohora plants. It enables us to make a preliminary assessment of their naturalization and invasive potential.

Table. Phytocenotical features of some polemochores on the model territories, and in Central Europe

R	M	E	F	Species	FAG	PUB	GER	MOL	MUL	FES	POP	PUR	EPI
z,p	**z,p**	z,p		*Arrhenatherum elatius* (L.) J. et C. Presel			GER, 01B,05D	MOL*, 01A**, *[01F, 03A]****		01A			02C
z	z			*Chaerophyllum aureum* L.				03A, *[01A]*	01A				EPI, 02C
	z,p	p		*Colchicum autumnale* L.	03A			MOL, 01A, 03A *[01A, 03A]*		01A	02A,C	01B	
p	**p**	p	p	*Cruciata laevipes* Opiz				01A	03A				EPI, 02C
		z,p	p	*Festuca heterophylla* Lam.	FAG		01B,05D	01A					
z,p	z,p	p		*Heracleum sphondylium* L.	02B			MOL, 01A, 03A, 08C, *[01F, 03A]*	MUL 01A	01A	02A	01B	02B,C, 03A,05A
	z			*Meum athamanticum* Jacq.				03A*, [01A, 03A]*					
	z			*Muscari botryoides* (L.) Mill.				03A					
	z	z		*Phyteuma nigrum* F.W.Schmidt				*03A, [03A]*					
z,p	**z,p**	**z,p**	**p**	*Pimpinella major* (L.) Huds.		01B		MOL,01,01A,03A,B, *[03A]*	01A		02A		01A
	z	z,p	p	*Primula elatior* (L.) Hill.	03A	01B		MOL, 03A, B *[03A]*	03A		02A,C		
z,p	z,p	p		*Ptarmica vulgaris* Hill.				MOL, 05A, C, F					
z,p	**z,p**	z,p		*Trisetum flavescens* (L.) Beauv.				MOL,01,01A,E,03A *[03A]*					

Note. Communities of model territories: R – ruderal, M – meadows, E – edges forests, F – forests. Classes of European vegetation: z – near the railway platform 208 km (Zubtsovsky district), p – near Papino (Rzhevsky district). Bold font – a significant abundance of species. Classes of European vegetation: FAG – *Carpino-Fagetea sylvaticae*; PUB – *Quercetea pubescentis*; GER – *Trifolio-Geranietea sanguinei*; MOL – *Molinio-Arrhenatheretea*; MUL – *Mulgedio-Aconitetea*; FES – *Festuco-Brometea*; POP – *Alno glutinosae-Populetea albae*; PUR – *Salicetea purpureae*; EPI – *Epilobietea angustifolii.* We have given syntaxonomic codes (by: Mucina et al., 2016): * – classes, ** – alliances, for which this species is diagnostic, *** – alliances that include associations, for which this species is diagnostic.

The type of plant communities, the level of landscape transformation, the nature of the economic use of the territory and the specifics of the successional dynamics of the vegetation cover were of great importance for the preservation of polemochores. Polemochores are stable in meadows, some ruderal and edges forests communities (see Table), that are not affected by intensive economic activity and are little transformed during successional shifts. Since most polemohora-plants are mainly meadow species, fringes and forests communities were less suited for their conservation. In secondary forest communities (with *Alnus incana* (L.) Moench, *Populus tremula* L., *Betula pendula* Roth.), a formed on the site of meadow and ruderal habitat, first of all, species with wider ecological and phytocenotic amplitude are preserved. This is for example *Pimpinella major*, *Primula elatior*, *Cruciata laevipes* (see Table). The vast majority of polemochores do not tend to spread further, but some species may settle outside their initial habitats. This is for example *Arrhenatherum elatius*, *Pimpinella major, Ptarmica vulgaris*. Further studies of polemochores can help to understand the ecological specifics in the mechanisms of their naturalization.

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ECOLOGICAL CONSEQUENCES OF THE APPEARANCE OF INVASIVE FISH SPECIES IN FRESHWATER BODIES OF THE EUROPEAN NORTH

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Over the past half century, a number of new fish species have appeared in the water bodies of the European North of Russia as a result of acclimatization work (Far Eastern pink salmon and Pechora peled in the White Sea basin, sterlet and Siberian sturgeon in the Pechora River); directional introduction (pike perch in the Onega and Northern Dvina river basins); accidental (spontaneous) introduction (rotan in lake ecosystems of the Severodvinsk basin); as well as self-settlement of white-eye, asp, zander, sabrefish in the Severnaya Dvina river (Novoselov, Reshetnikov, 1988; Novoselov, Studenov, 2002; Novoselov, 2020). In relation to the water bodies of the considered region, the negative impact of invasive species can be expressed in the following.

Changes in species diversity. As a result of the self-settlement of southern fish, the species composition of the ichthyofauna has become more complex due to the addition of cyprinids. In a stable ecological environment, they can develop free ecological niches without leading to a depression of the aboriginal ichthyofauna. At the same time, under the conditions of global warming and subsequent eutrophication of river basins, thermophilic invaders will receive advantages in reproduction as phytophilic species and can dramatically increase their numbers. Against this background, a depression of the species of the salmon-whitefish complex is quite probable, and the ongoing "expansion" of the southern species threatens to preserve the original biological diversity of the ichthyofauna of the northern rivers.

Changes in trophic connections. It is manifested in the aggravation of the food competition of fish-invaders with commercial representatives of the native fauna. The appearance of the white-eye in the Northern Dvina River led to the emergence of quite tense trophic relations with bream and whitefish. The resulting food competition should be regarded as an additional negative factor that increases the degree of environmental risk for the population of the Severodvinsk whitefish. Asp, as an active predator, poses an additional threat to the young of both local partial and whitefish species, as well as sloping salmon juveniles, using them as potential victims.

Decrease in the fishery status of water bodies. With the introduction of predatory fish, there is a risk of decreasing in the number or loss of valuable species inhabiting adjacent water bodies. So, with the appearance of pike perch in the river Onega there emerged an additional risk factor for juvenile Atlantic salmon, since the peak of migration of juveniles ("downstream migrants") of salmon coincides in time with the end of spawning of pike perch and the beginning of its intensive feeding (Studenov and Novoselov, 2005). In this regard, with the further spread of pike perch along the Onega River system and its ecological progress, it is likely that the productivity of both the Onega River itself (for salmon) and the commercial lakes in the basin (for vendace) will decrease.

Increased risk in natural reproduction of native species. Given the controversial issue of competitive relations between acclimatized pink salmon and native species – Atlantic salmon and brown trout, it is still possible that the regime of their natural reproduction will deteriorate. It has not yet caused concerns in large river systems (Pechora and Dvina basins). At the same time, in small rivers of the coasts of the White and Barents Seas, the simultaneous use of spawning areas of acclimatized pink salmon and local salmon fish both in time and space may take place.

Deterioration of the epizootic situation. The penetration of alien species into the reservoirs of the North is also a sanitary and biological danger. If in the delta of the Northern Dvina River cyprinid fish species affected by tapeworm were found only once, now this is a common phenomenon that is becoming widespread. The role of invasive species in this process is not yet fully clear, but the trend is clear. This problem also affects the economic aspect, since it is directly related to the commercial quality of commercial ichthyofauna.

ALIEN SPECIES OF FISH SELF-SETTLED IN THE NORTHERN DVINA RIVER BASIN

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In recent decades, the processes of fish self-settlement from the southern regions to the waters of high latitudes have accelerated, which should attract close researchers’ attention to this phenomenon. This process is quite clearly manifested in the Northern Dvina River basin – one of the largest water systems in the European north of Russia. The research results showeфd that in different parts of the Northern Dvina River basin there are a total of 48 species of fish-like and fish, among which 4 (white-eye, asp, pike perch and spined loach) are new species that penetrated here as a result of self-settlement (Novoselov, 2020).

White-eye *Abramis sapa* (Pallas, 1814) is a minor commercial fish of the Caspian complex. It was first noted in the river Vychegda in 1971, then appeared in the river Northern Dvina, rapidly increasing its numbers. In the fishery statistics for a long time white-eye was included in the catch as juvenile bream or silver bream. Now the white-eye has spread widely along the river Northern Dvina, and the situation with it today is becoming problematic. Being a brackish-water species with a wide food spectrum, the white-eye can in the near future create a serious food competition for the whitefish in its food biotopes in the delta part of the river and near the estuary seaside.

The asp *Aspius aspius* (Linnaeus, 1758) is a predatory representative of cyprinids that appeared in the Severodvinsk basin after the white-eyed fish. In the river Vychegda (a tributary of the Northern Dvina River) the asp is a rare species (Boznak, 2003; Zakharov and Boznak, 2009). Until 1998, there were only verbal reports of repeated catches of asp in the Northern Dvina in the area from the mouth of the river Vychegda to the mouth of the river Vaga, as well as in the mouth of the river. In the last decade, regular catches of asp have been recorded both in the middle reaches of the Northern Dvina River and in the near-estuarine seaside areas, including the Dry Sea Bay (Novoselov, 2020).

Pike perch *Sander lucioperca* (Linnaeus, 1758) – in the river Northern Dvina it appeared as a result of direct introduction (settling) into the river Sukhona from Lake Kubenskoye. Pike perch actively self-settled throughout the Dvina basin, and at present, both sexually mature individuals and juveniles are regularly observed not only in the channel part of the river, but also in the estuarine seaside areas (Dry Sea Bay).

Spiny loach *Cobitis taenia (*Linnaeus, 1758) – penetrated from the river Sheksna into the rivers and lakes associated with the Northern Dvina channel. And then it spread widely in the basins of Lake Kubenskoye and river Sukhona (Konovalov and others, 2015) and, further, entered the Northern Dvina, in the basin of which it also spread widely.

Particular attention is drawn to the sabrefish *Pelecus cultratus* (Linnaeus, 1758) – a commercial fish of the Caspian basin, which, according to available scientific publications, is already part of the ichthyofauna of the river Vychegda (Boznak, 2003). In view of this, we can expect its imminent appearance in the river Northern Dvina.

Volga species (white-eye, sabrefish and asp) could appear in the river Northern Dvina in two ways: through the rivers Vychegda and Sukhona. In the first case, they reach the Catherine Canal along the river Kama and its tributaries (Vyatka and South Keltme). The canal no longer functions as a navigable one, but in years of high water abundance, fish migrations along it are quite possible. Further, along the river North Keltma these species penetrate into the river Vychegda, and then through the river Malaya Dvina they inhabit the Dvina basin. The second route runs through the Rybinsk reservoir → then Sheksna and Parazovitsa rivers along the Parazovitsky canal in the lake Kubenskoe, and further → in the river Sukhona, which gives at the confluence with the river Vychegda the beginning of the Malaya Severnaya Dvina. In addition, the migration of asp and pike perch from the water bodies of the Baltic basin is possible through the Parazovitsky Canal. This path runs from Lake Onega → through the river Vytegra → to the Volga-Baltic channel → river Kovzhu → lake White → in the river Parazovitsa → and further according to the already considered scheme of penetration of the Caspian species into the river Sukhona.

The appearance of the sterlet *Acipenser ruthenus* (Linnaeus, 1758) in the Northern Dvina River basin is still debatable. For a long time, this was associated with the construction and operation of the Catherine Canal – namely, the breakthrough of the lock by the high spring flood of 1810 (Dogel, 1939). At the same time, the discovery of sterlet remains in the sediments of the river Onega basin, dated from the II-III millennium BC, led to the assumption of its penetration also into the river Northern Dvina, where it has survived to this day (Nikolsky, 1943; Berg, 1945).

FOOD RELATIONSHIP OF THE WHITE-EYE SEPARATED IN THE RIVER OF NORTHERN DVINA WITH LOCAL COMMERCIAL FISH SPECIES

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It is known that interspecific food relations of fish arise as a result of their use of common food resources and are manifested in the form of direct competition or indirect food relations. Food competition is currently understood as the feeding of two or more species with the same type of food, that is insufficient to meet the nutritional needs of all feeding individuals (Reshetnikov and Mikhailov, 1988). The study of fish trophic relationships is of particular importance due to the growing level of invasive processes in freshwater bodies, issues related to the nutrition of alien species in new conditions and the formation of food (trophic) relationships with native species.

Analysis of nutrition and food relations of the white-eyed fish that self-settled in the Northern Dvina River basin with local fish species showed that there were indeed quite tense food relationships between them (Table).

Indexes of food similarity (SP) and food niche overlap (Cλ) in the self-settled white-eye and local commercial species in the Northern Dvina River (%)

Table. Food niche overlap index

Fish species	White-eye	Whitefish	Bream
White-eye	-	89.9	84.1
Whitefish	62.8	-	85.5
Bream	57.8	60.6	-

Food similarity index

White-eye – whitefish. The index of food similarity (Shorygin, 1952) of white-eye and whitefish was 62.8%, the index of overlapping food niches – Cλ (Horn, 1966) – 89.9%. This was due to the fact that these species mainly feed on similar types of food. The food spectra of both species were based on aquatic insect larvae, the total proportion of which in weight ratio was equal to 70.2% in white-eye and 57.8% in whitefish. Among them the dominant species were the chironomid larvae (which made up 52.9% in white-eye food clumps, and 49.8% – in whitefish). Both fish species actively consumed aquatic vegetation, the share of which in the food spectrum of the white-eye was 21.2%, whitefish – 10.4%. Molluscs were present in the gastrointestinal tracts of both species, but whitefish consumed them more intensively (17.9%) compared to the white-eye (0.8%).

White-eye – bream. Approximately the same picture was observed when comparing the feeding patterns of white-eye and bream. The index of food similarity (FS) of white-eye and bream was 57.8%, the index of overlapping food niches (Cλ) – 84.1% (see the table). This occurred as a result of their common feeding on the same chironomid larvae (52.9% and 85.6%, respectively) and mollusks (0.8% and 10.2%, respectively, of the weight of the contents of the gastrointestinal tract).

In other words, the appearance of the white-eye in the basin of the river Northern Dvina led to the emergence of a rather tense food relationship with whitefish and bream. The main types of food for the invasive species of white-eye are aquatic larvae of chironomids, caddis flies and aquatic vegetation, for local commercial species of whitefish – larvae of chironomids and vegetation, bream – larvae of chironomids. Considering that white-eye and bream consume generally similar types of food items (SP = 60.6%; Cλ = 85.5%), the appearance of the white-eye in the river Northern Dvina aggravated the tension of food relations not only among themselves, but also with the new invasive species.

It should be borne in mind that any appearance of new species in the reservoirs of the North already in itself implies a serious problem, and should immediately attract the attention of specialists. Practice has shown that, once in new conditions, invasive species can oppress or even completely displace native species due to their biological aggressiveness, higher viability and greater adaptive potential. Leading to irreversible changes in aquatic ecosystems, they cause irreparable damage not only to the biological diversity of the regions, but also to the socio-economic interests of humans.

SPECIES IDENTIFICATION AND ANALYSIS OF PHYLOGENETIC RELATIONSHIPS OF INDIVIDUALS OF THE GENUS *AMEIURUS* IN WATER RESERVOIRS OF BELARUS

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A vivid example of biological invasion of freshwater fish species is the distribution of the American catfish *Ameiurus nebulosus* (Lesueur, 1819) in water bodies of Belarus. The natural distribution area of this species is fresh waters of North America from the Great Lakes region to Florida. In 1871, *A. nebulosus* was first recorded in France, Europe, and then it began to settle in other countries.

The first information from scientific literary sources about the location of the American catfish in the reservoirs of Belarus and its morphological features dates back to 1951. According to the author's data, the American catfish appeared in the water reservoirs of Belarus (ponds and lakes of the Brest region) as early as the 1930. At present, this invasive species is widely spread within the territory of the Brest region and beyond.

There is a possibility of appearance of another invasive species of American catfish in our water reservoir - the American (black) catfish *Ameiurus melas* (Rafinesque, 1820). As in the case of *A. nebulosus*, the American (black) catfish *A. melas* was first discovered outside the native range in Europe in France in 1871. Unlike A. *nebulosus, A. melas* spread over the territory of Europe considerably slower. *A. melas* is a potentially invasive species for the territory of Belarus.

In this work, we present the initial data on species identification and analysis of phylogenetic relationships of individuals of the genus Ameiurus living in water reservoirs of Belarus, based on the analysis of the COI gene, and their comparison with the data available in the international databases BOLD and GenBank.

Materials and methods. As research material, we used the sequences of the American catfish (*A. nebulosus*) obtained by the authors of the article, as well as the sequences from the international databases BOLD and GenBank.

The samples of representatives of the genus *Ameiurus* were caught in water reservoirs of Belarus. The tissue from each captured individual was placed into a separate test tube and stored in 96% alcohol at a temperature of - 20 ° C. DNA was extracted using a «Primetech» kit. To obtain the target fragment, we used the primer pair gene region with cytochrome *c* oxidase subunit I (*COI*). Amplification started with an initial denaturation step for 2 min at 94 °C followed by 35 cycles of denaturation for 30 s at 94 °C, annealing for 40 s at 52 °C, elongation for 1 min at 72 °C, and terminating with a final elongation step for 10 min at 72 °C. Sequence alignment and construction of phylogenetic trees were performed through the use of MEGAX program.

Results and discussion. In the course of the work, 45 sequences of the COI gene of representatives of the genus *Ameiurus* were analyzed (21 sequences were obtained by us, 24 were taken from the international databases BOLD and GenBank) with a length of 474 bp. It was found out that all analyzed individuals, which were caught in water bodies of Belarus, belong to the species Ameiurus nebulosus. In the course of the work, a phylogenetic tree was built using the maximum likelihood (ML) method. The reliability of the branching of the phylogenetic tree was determined using bootstrap analysis, taking into account 500 pseudo-replicas. Another representative of the genus *Ameiurus* was chosen as an outgroup for phylogenetic analysis: American (black) catfish *A. melas* (GenBank acc.no. KX909402.1).

Based on the results of the constructed tree, it is clearly visible that the samples caught in the water reservoirs of Belarus form a single cluster with the samples from Canada, Bulgaria, the USA and Poland (bootstrap support 64).

The obtained results are initial and open up a number of subsequent tasks: a further study of the genetic variability of the American catfish inhabiting the territory of Belarus in comparison with individuals from the native range (North America) and the acquired range (Western European countries). This will make it possible to trace the pathways of invasion, the features of settlement and microevolutionary processes that occur when the species populate new territories.

RECENT CHANGES (INCREASE IN ABUNDANCE, NEW RECORDS AND RANGE EXTENSIONS) OF ICHTHYOFAUNA OF SIBERIAN ARCTIC: RESULTS OF CLIMATE CHANGE?

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The seas of the Siberian Arctic (Kara, Laptev, Chukchi and East Siberian) are still poorly studied. In the conditions of the rapidly changing climate of the Arctic, accompanied by a noticeable reduction of its ice cover and warming, studies of their biota (including ichthyofauna) and changes in its composition are becoming particularly relevant. In the conditions of climatic changes occurring in the Arctic in recent years, there are an extension of the ranges and an increase in the abundance of a number of species.

The materials for this communication were collected during the expedition on board the RV "Professor Levanidov" in August-October 2019 in the Chukchi, East Siberian, Laptev and Kara seas both in the territorial waters and within the exclusive economic zone of Russian Federation. The results obtained are based on the catches of bottom trawl hauls conducted during the bottom trawl surveys, which were performed according to standard methods using a bottom trawl DT-27.1/24.4 (with horizontal opening 14-16 m, vertical opening 4-6 m, mesh in the codend 10 mm). The duration of most hauls was 30 minutes at an average speed of 3.0-3.1 knots.

According to the results of the bottom trawl survey in 2019, the walleye pollock *Gadus chalcogrammus*, the polar cod *Boreogsdus saida* and the Bering flounder *Hippoglossoides robustus* significantly increased their abundance in the Chukchi Sea. Thus, the biomass of large walleye pollock was more than 28 times higher than in the previous survey of 2018 (Orlov et al., 2019). In the East Siberian Sea, the average density of polar cod concentrations exceeded that in the survey of 2015 (Glebov et al., 2016a). For the first time, walleye pollock (5 specimens), northern wolffish *Anarhichas denticulatus* (1 specimen) and beaked redfish *Sebastes mentella* (1 specimen) were registered in the Laptev Sea. In 2015, a representative of the family Sebastidae was caught in the Laptev Sea, but was not identified to the species level (Glebov et al., 2016b). The Greenland halibut *Reinhardtius hippoglossoides* was recorded along the entire continental slope of the Laptev Sea within the depth range from 27 to 750 m in an amount of 2 to 117 specimens per haul with maximum catches in the central and western parts of the surveyed area. In 2015 (Glebov et al., 2016b), in contrast to the 2019 survey (Orlov et al., 2020), early juveniles were absent in catches, and Greenland halibut was recorded in the western part of the sea only. In the Kara Sea, the polar cod biomass exceeded the estimates of 2013 by more than 8 times.

The analysis of the obtained data indicates that in recent years, due to climatic changes (warming, reduction of ice cover, changes in water exchange, etc.), serious changes of ichthyofauna have occurred in the seas of the Siberian Arctic. On the one hand, the abundance of individual species, for example, polar cod, has increased significantly. Walleye pollock appeared in commercial quantities in the Chukchi Sea, which makes it possible to organize its large-scale fishing here. On the other hand, some species have significantly extended their range, for example, Greenland halibut in the Laptev Sea. On the third hand, new species have appeared in the ichthyofauna of the Siberian Arctic seas, such as northern wolffish, beaked redfish, and walleye pollock, which were not previously recorded in these areas.

ALIEN YET TERRESTRIAL: XEROPHILOUS SNAILS AS A CASE STUDY OF INVASIVE SPECIES DISTRIBUTION MODELLING (SDM)

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Over the last two decades Species Distribution Modelling a.k.a. SDM became a major tool for computation ecology. This technique takes advantage of the ecological niche concept that is basic to ecology as well as biology and implemented with supervised machine learning (ML). Many researchers from various fields use SDM in their work investigating shifts in species ranges under climate change, nature conservation management, and many other fundamental as well as applied tasks. This paper aims at estimating the potential range of two xerophilous land snails: *Xeropicta derbentina* (Krynicki, 1836) and *Brephulopsis cylindrica* (Menke,1828), (Gastropoda: Stylommatophora). Both species currently expand their geographical ranges thus demonstrating invasion potential. Being native to the steppe zone of the Black sea region (more particularly, *B. cylindrica* initially inhabited the Crimean peninsula), the gastropods are spread now across Ukraine (as west as Transcarpathia in the case of *X. derbentina*) and in Belarus where one occurrence of *B. cylindrica* has been documented. Both are sighted in southwestern Russia in the Belgorod region. Well fitted for arid environments, they are likely to spread further in Europe.

In the presented work, we used information on ca. 300 actual localities, i.e. places where the species were reported. The data came both from GBIF.org database, published materials, and unpublished field observations by V. Adamova.To lessen sampling bias, caused by. uneven coverage of the study region by observations, the initial dataset was reduced with spatial thinning procedure

Environmental predictors, i.e. variables describing ecological conditions, included: a) 19 bioclimatic covariates taken from worldclim.org; b) elevation; c) surface type, and d) enhanced vegetation index (EVI) derived from remote sensing (MODIS). Only most impactful and least correlated predictors as evidenced by exploratory data analysis were further used for ML based on 4 different algorithms. Subsampling and repeated model training were performed in each case. As a result, we obtained 20 models for *X. derbentina* and 20 for *B. cylindrica* as well as their prediction i.e. estimates of distribution ranges. To summarize their predictions and lessen the bias of a particular model, we also used ensemble modelling that produced a consensus prediction.

The predictions in our work suggest that the main area of potential range of xerophilous snails *X. derbentina* and *B. cylindrica* covers the steppe and forest-steppe zones of the East European Plain. The high suitability for *X. derbentina* falls in the Azov region and comprises the territory of the Donetsk ridge, the Dnieper lowland, and the Dnieper Upland. Highly suitable for *X. derbentina* invasion region spans to the south and east of the Central Russian Upland.

The SDM results support the common notion that *Xeropicta derbentina* and *Brephulopsis cylindrica* are likely to continue their resettlement thus posing a threat to native steppe ecosystems outside of their current range. The obtained models provide means for invasion management and ecology of object species.

DISTRIBUTION AND INVASION OF SNAKES IN YAKUTIA

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The exceptionally cold and long winter and the accompanying almost ubiquitous permafrost create unfavorable conditions for the existence of poikilothermic animals on the territory of Yakutia.

Until recent years, only one species of snake, a common viper (*Vipera berus*) has been reliably recorded in this vast region. This species is distributed in the south-west of the republic, in the territories of Lensky and Olekminsky districts and along the valley of the Lena River to the north to the Lena pillars (Khangalassky district, up to the 62nd parallel). In the 19th century, researchers of the fauna of Yakutia and travelers pointed out the existence of a viper in these places. *V. berus* is distributed unevenly here, depending on the availability of wintering sites. The viper (like other snakes) can passively move along the rivers, being on trees floating on the rivers, especially during floods. Such cases are known: in the 1950s, after a strong flood, vipers were found on the so-called "Green" meadow flooded by the Lena River near the city of Yakutsk; in 2015, apparently, in the same way, several vipers reached Yakutsk and they were found in one of the riverside houses; in August 2018, two vipers were found in the vicinity of the village of Tulagino, located 26 km below the city of Yakutsk along the Lena River. However, there is no evidence of successful wintering of snakes in these places.

In the 1980s, local residents brought a large snake (about 1.5 m long) killed in a dacha area in the vicinity of the city of Yakutsk to the zoology laboratory of the Institute of Biology, Yakut Branch, Siberian Dep., Ac. Sci. USSR. The identification showed that this was the Amur rat snake (*Elaphe schrenckii*). Natural penetration of this snake in the vicinity of Yakutsk was excluded due to the remoteness of the species range (basin of the Amur River, Primorye and Khabarovsk Territory) and the lack of communication between the basins of the Amur and Lena Rivers.

In the last decade, the penetration of the Siberian pit viper (*Gloydius halys*) has been recorded on the territory of the republic (Orlov et al., 2018). This species is common in the south of Siberia. Until recently, the habitats of *G. halys* closest to the territory of Yakutia were located in Transbaikalia, the Chita Region, and the Amur Territory. Probably, in recent years, due to the warming of the climate, the range of the Siberian pit viper has expanded to the northern Baikal region and reached southwestern Yakutia. For the first time on the territory of Yakutia, a Siberian pit viper was caught in the summer of 2010 in the vicinity of the village of Oktemtsy (lef bank of the Lena River, about 40 km from Yakutsk to the southwest). In the summer of 2016, three individuals of *G. halys* were caught on the territory of the Olekminsky district of Yakutia: the first - at the end of July at the confluence of the Tokko River with the Chara River, the second - in August near the village of Tokko on the left bank of the Chara River and the third - on the Molbo River (left tributary of the Chara River) (Orlov et al., 2018). On August 5, 2021, on one of the islands located on the Lena River opposite the village of Grafsky Bereg (about 100 km downstream from the city of Yakutsk), another specimen of *G. halys* was captured by local residents. To date, this is the northernmost find of this species. The exceptionally distant penetration of the Siberian pit viper into central Yakutia (environs of the village of Oktemtsy and vicinity of the Grafsky Bereg settlement) may have occurred as a result of its introduction through waterways from the basin of the Olekma River.

A certain warming of the climate, observed in recent years on the territory of Yakutia, suggests the appearance here of other species of snakes (for example, the grass snake (*Natrix natrix*) inhabiting the Upper Lena River basin).

ALIEN FISH SPECIES OF THE PENZA REGION (RUSSIA, MIDDLE VOLGA)

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Penza region is situated on the watershed of the Volga (Caspian Sea basin) and the Don (Black Sea basin) rivers, so it has diverse fish fauna. But regional features of ichthyofauna are poorly studied, and invasive species are practically not covered by researchers.

The aim of our work was analysis of species composition and spatial distribution of fish, and assessment of possibility of new invasions to aquatic ecosystems of the region. According to our data there are more than 48 species of lamprey and ray-finned fish in Penza region. In compare of neighbor territories of the Middle Volga, fauna of alien fish is poor – only 8 species. They are the Chinese sleeper *Perccottus glenii*, the black-striped pipefish *Syngnathus abaster*, the goldfish *Carassius auratus* complex, the round goby *Neogobius melanostomus*, the monkey goby *Neogobius fluviatilis*, and aquaculture fish: the grass carp *Ctenopharyngodon idella*, the bighead carp *Aristichthys nobilis*, the silver carp *Hypophthalmichthys molitrix* and the bigmouth buffalo *Ictiobus cyprinellus* (absent in recent times).

The most abundant alien species are *P. glenii* and *C. auratus*. The distribution of the Chinese sleeper is primarily confined to the highly eutrophied floodplain water bodies of large urban agglomerations. The goldfish could be found in majority of lentic waters, and even in upper reaches of rivers, that was observed recent years. The alien carps inhabit fish ponds and cannot breed in natural water-bodies. The black-striped pipefish was found in early 2000s in the vicinity of the Penza city in the Sura river (the Volga basin) below dam of the Sura Reservoir. In that place the *N. melanostomus* was found in 2020, according on information from local fishermen (Polumordvinov, 2020). The same year two individuals of *N. fluviatilis* was caught by us in the Khoper River (the Don basin) near the Sakhzavod settlement. Though it is considered alien only for the Sura river basin.

Thus, besides the Chinese sleeper and goldfish, in Penza region alien fish species are distributed locally with low abundance. On our opinion, the reason is relative isolation of regional water objects from reservoirs of the Middle Volga, which are the main vector of invasion of alien species (Slynko et al., 2010). The possible route is the 800-km sector from the Cheboksary Reservoir (on the north) to the Sura river (on the south), but its impact is limited by absence of the cascade of dams and navigation. The only Sura Reservoir has area of 11 km^2, and situated in the upper flow. Its fauna has no typical invasion species from the Volga (e.g. *Dreissena polymorpha*, Gobiidae, Black and Caspian Sea Sprat *Clupeonella cultriventris*), so that prove some isolation of the region (Osipov et al., 2007). Findings of the pipefish and round goby were local in the vicinity of the Penza city and may be associated with unintentional release by amateur fishermen. The south part of the Penza oblast (the Don basin) is isolated more, because of shortage of large water courses. The monkey goby, that was found in the upper flow of the Khoper, is native for that part of the river valley (Zavyalov et al., 2007). Nevertheless, we cannot rule out the invasion of this species into the rivers of the Volga basin, as that was done previously by the Ukrainian lamprey *Eudontomyzon mariae* (Levin, 2001), that is considered as relict autoinvader (Slynko et al., 2010).

Potentially, in the Penza region we could expect invasions of the ninespine stickleback *Pungitius pungitius*, the tubenose goby *Proterorhinus marmoratus* (the Sura valley), the southern ninespine stickleback *Pungitius platygaster*, the stone moroko *Pseudorasbora parva* (the Khoper valley), the lake minnow *Rhynchocypris percnurus* (the Moksha and the Sura valleys). The frequent and abundant bitterling *Rhodeus sericeus*, that is expanding its area northward and southward, is considered as native species. Overall, abundance and spatial distribution of alien fish species of the Penza region requires further research.

XEROLENTA OBVIA (MENKE, 1828) (GASTROPODA, HYGROMIIDAE) – A NEW INVASIVE SNAIL IN THE MALACOFAUNA OF GOMEL (REPUBLIC OF BELARUS)

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Xerolenta obvia (Menke, 1828) is a xerophilic mollusk species, originates from south-eastern Europe (Wiktor 2004, Welter-Schultes 2012), from where it was introduced into Central and Western Europe. It has since extended its range further (Urbański 1957, Wojtaś & Wojtaś-Stokłosa 2001). The snail dispersed mainly along railway embankments and rivers (Riedel 1988). Now its distribution extends from Asia Minor to the eastern and central Balkans, Northern Italy, Carpathian countries (in the east to Moldova and north of Ukraine) and to the Baltic Sea (Welter-Schultes 2012). It inhabits low-grass (Georgiev 2008), calcium-rich meadows (Kozlowski 2012) and is an indicator of thermophilic conditions (Juřičková & Kučera 2005).

In Belarus *X. obvia* occurs in central and southern parts of country, occupying mainly urbocenosis. On the territory of Belarus, populations of this species have been recorded in Brest, Baranovichi and Grodno. In these cities, the habitat of *X. obvia* is the territories along the slopes of the railway tracks (Zemoglyadchuk 2009, 2020).

In Gomel, local population of *X. obvia* was first encountered in June 2021. The material (59 ex.) was collected on 03.06.2021 in the area of JSC "Gomel Fat Plant" (GPS 52º23'52"N, 31º01'32"E, 124 a.s.l.). Frequent mowing of grass create on such surfaces the conditions approaching those of xerotherms (Figure 1).

Figures 1–2. *Xerolenta obvia* (Menke, 1828): 1 – the habitat of the local population in the Gomel; 2 – general view of shell.

Diagnostic signs: she shell is flattened, radially striated, with five slightly convex whorls, the last of which is rounded in profile and gently descends to the mouth, is white with 1-2 bright brown spiral stripes on the upper side of each turn and thinner and less distinct stripes on their underside, often breaking up into a series of spots. It has a developed, promising navel, and is also characterized by a sloping mouth, varying in shape from rounded to broadly oval, with sharp, simple edges inside and a thin lip (Figure 2).

It is supposed that eventual way of penetration of this species is casual importing by railway or highway transport.

DECORATIVE AND USEFUL ALIEN PLANTS OF THE SOUTHERN HEMISPHRE

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Numerous botanical collections of ornamental plants are sources of the introduction of alien plants into the flora of different countries. The South African Department of the Environment (DEA) published the National Environmental Law Amendment Act for Invasive Species in 2014. In this document, 198 invasive plant species are classified into three categories:

Category 1: Invader plants must be removed & destroyed immediately.

Category 2: Invader plants may be grown under controlled conditions only.

Category 3: Invader plants may no longer be planted.

An example of plants from the first category is *Acacia longifolia* (Andrews) Willd, which was introduced to South Africa as early as 1864 to prevent soil erosion and as a food plant (flowers and beans are edible), as well as for wood. This Australian acacia has the advantages of faster growth than native legumes and adaptability to all soil types. About $ 60 million is spent annually in South Africa to combat Australian acacia on agricultural land. *Tecomastans* (L.) Juss.ex Kunth, a highly ornamental tree of the Bignoniaceae family from Central and South America, is also a plant in the first category. It used to be grown for its large, showy, vibrant golden yellow flowers. The plant easily escapes from gardens to rocky or sandy disturbed habitats and produces many seeds. But the most dangerous weed is the Mexican prickly pear (*Opuntia*), nine species of which were introduced to South Africa for their edible fruits. Fruits have a high nutritional value; they contain more than 50% fiber, many amino acids, and a large number of vitamins and minerals. The prickly opuntias are well armed against herbivores, which makes them highly competitive, capable of gradually displacing local vegetation from pastures. The dry and rocky savannas and areas of the Karoo were hit hardest. Two types of chemicals have been registered as herbicides for killing prickly pears in South Africa, but biological control is the most environmentally friendly method. Cactus moth and some weevils were introduced to the country. Examples of Category 2 plants are the seven Australian eucalyptus species, which already have more than 16 million trees in South Africa. *Eucalyptus* plantations occupy about 40% of all forest land. The attempt to grow eucalyptus to produce wood for furniture and papermaking has led to an uncontrollable situation. *Eucalyptus* trees are characterized by a high growth rate, while they require a colossal amount of water: up to 400 liters per plant per day. Covered with cultured and spontaneous eucalyptus dead-cover groves, South Africa has become one sizeable arid region. The governments of Namibia, Botswana, and Zimbabwe have asked the UN to stop the South African "eucalyptus expansion" as aggressive trees are now storming these countries. Of the eight alien pine species, two have entered the natural habitat. *Pinus elliottii* Engelm., a tree from the south-eastern United States, reaching 30 meters in height, is widespread in the forest edges of the Mpumalanga province. The government annually provides grants to authors of innovative approaches to the destruction of this pine and its replacement with local conifers. Every year, at the end of summer, the roadsides in Mpumalanga turn into colorful carpets due to the expansion of the decorative *Cosmos* Cav. from Mexico. Their seeds were brought with sacks of fodder for British horses during the Boer War. *Senna* Mill., *Bauhinia* L., and *Metrosideros* Banks ex Gaertn. belong to the third category of plants. They were introduced to South Africa as ornamental plants. The invasive alien plant situation does not appear to be as dire in South America (Argentina) as it is in South Africa. Two species of the Mexican *Argemone* L. have become widely naturalized in many parts of the world. They are pioneer plants, drought-tolerant, and well adapted to poor roadside soil. Their seeds are similar and therefore are often mixed with mustard seeds making mustard poisonous to eat.

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FINDING THE GASTROPOD *RAPANA VENOSA* (VALENCIENNES, 1846) IN THE COASTAL EMISSIONS OF THE KAZANTIP BAY (SEA OF AZOV)

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Rapana venosa (Valenciennes) is a well-known invader species whose original habitat is in the Sea of Japan (Kantor and Sysoev, 2005). In the 1940s, it was brought into the Black Sea (Chukhchin, 1961; Smirnova, 2016). The main food item for rapana is bivalve mollusks, whose settlements have been significantly affected in the Black Sea. According to V.V. Anistratenko et al. (2011) *R. venosa* expands (in the book Anistratenko et al., 2011, the authors indicate the name *Rapana thomasiana thomasiana* Crosse) into the Sea of Azov. The species was found in the Kerch Strait and along the Arabat Spit. A possible obstacle to settling in some areas of the sea may be low salinity, as well as summer kill phenomena in shallow water, which warms up well in summer. Potential prey of the predatory mollusk may be, first of all, the bivalve mollusks *Mytilus galloprovincialis* Lamark, as well as the large-shell invading species *Anadara inaequivalvis* (Bruguiére) and *Mya arenaria* L., although they are infaunal species. *R. venosa* has not potential enemies in the Sea of Azov. In this abstract will be describe new cases of *R. venosa* finds in the Kazantip Bay of the Sea of Azov. The data were obtained on the basis of monitoring of littoral emissions of the bay opposite to village Pesochnoe (Crimea Peninsula) in 2009–2013 and 2017. The first find - in the summer of 2010, a large clutch of gastropod mollusk eggs was found (see also Figure 1). The elongated eggs were at least 25 mm high. Such a large clutch, with the exception of *R. venosa*, could not have been deposited by any gastropod mollusk, since other species with large shell do not occur in the Sea of Azov (see Anistratenko et al., 2011). The shell of the largest and rarest mollusk, *Cerithium vulgatum* (Bruguiére), reaches a height of 55–60 mm. But it does not occur in the Kazantip Bay. In the summer of 2017, an empty, partially destroyed, and worn shell of *R. venosa* was found in littoral emissions (Figure 2).

Figure 1 A clutch of *Rapana venosa* in a coast of Temryuk Bay (2021). Photo by A. Kuz`min.

Figure 2. Shell of *Rapana venosa* from the littoral emissions of the Kazantip Bay, Sea of Azov (2017).

Thus, the gradual expansion of *R. venosa* into the Sea of Azov is currently taking place. Despite the low salinity, summer kill, the mollusk began to settle in the Azov bays.

INVASIVE PLANT SPECIES IN FOREST COMMUNITIES OF THE BRYANSK REGION

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The phytocenotic confinement of 80 species of the invasive component of flora in forest communities of the Bryansk region was estimated.

Zonal forest communities (*Piceion excelsae* Pawłowski et al. 1928, *Querco roboris-Tilion cordatae* Bulokhov et Solomeshch in Bulokhov et Semenishchenkov 2015, *Betonico officinalis-Quercion roboris* Goncharenko & Semenishchenkov 2020) are characterized by low invasiveness. Registered in these communities: *Acer negundo, Amelanchier spicata, Arrhenatherum elatius, Erigeron annuus, Erigeron canadensis, Heracleum sosnowskyi, Impatiens parviflora, Lupinus polyphyllus, Parthenocissus inserta, Physocarpus opulifolius, Quercus rubra, Sambucus nigra, Sambucus racemosa, Symphytum asperum, Vinca minor.* The most often invasive species are confined to demutational changes in broad-leaved forests (*Corylo avellanae–Pinetum sylvestris* Bulokhov et Solomeshch 2003 var. *Sambucus racemosa, Vinca minor*, *Parthenocissus vitacea*). Invasive species are not found in intact communities of boreal and broad-leaved forests.

The pine forests (*Dicrano-Pinion sylvestris* (Libb. 1933) Mat. 1962) are marked with: *Acer negundo, Amelanchier spicata, Amorpha fruticosa, Aronia mitschurinii, Caragana arborescens, Erigeron annuus, Erigeron canadensis, Festuca trachyphylla, Oenothera biennis, Oenothera rubricaulis, Physocarpus opulifolius, Sambucus racemosa. Amelanchier spicata* plays a phytocenotically significant role in pine forests (*Vaccinio vitis-idaeae–Pinetum sylvestris quercetosum roboris* Bulokhov et Solomeshch in Bulokhov et Semenishchenkov 2015 var. *Amelanchier spicata*).

In floodplain broad-leaved forests (*Fraxino–Quercion roboris* Passarge 1968) and black alder forests (*Alnion glutinosae* Malcuit 1929) there are: *Acer negundo, Amelanchier spicata, Aster × salignus, Bidens frondosa, Cornus alba, Echinocystis lobata, Epilobium adenocaulon, Erigeron annuus, Erigeron canadensis, Fraxinus pennsylvanica, Impatiens grandulifera, Impatiens parviflora, Solidago canadensis.* Invasive plants in these communities are extremely rare and do not play a significant phytocenotic role.

Acer negundo, Fraxinus pennsylvanica form communities in the floodplain: *Bidenti frondosae–Aceretum negundi* Bulokhov et Kharin 2008, *Filipendulo ulmariae–Fraxinetum pennsylvanicae* Kholenko et al. 2019 var. *Acer negundo, Bidens frondosa*.

The communities of riparian willows (*Salicetea purpureae* Moor 1958) penetrate: *Acer negundo, Bidens frondosa, Cornus alba, Echinochloa crusgalli, Echinocystis lobata, Erigeron annuus, Erigeron canadensis, Fraxinus pennsylvanica, Heracleum sosnowskyi, Impatiens grandulifera, Impatiens parviflora, Populus alba, Salix fragilis, Sambucus racemosa, Xanthium albinum*. Invasive species form communities *Salicetum albae acerietosum negundo* Bulokhov et Kharin 2008 var. *typica, Fraxinus pennsylvanica, Salicetum fragilis* Passarge 1957 var. *typica, Swida alba.*

PECULIARITIES OF THE DISPERSAL AND IDENTIFICATION OF ALIEN FISH SPECIES OF THE VOLGA-KAMA REGION

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The waters of the Volga-Kama basin are inhabited by 124-140 species of fish, according to different systematic reports. However, even in the case of a conservative approach, the share of alien species in the Volga reservoirs ranges from 8% to 32%. For the reservoirs of the Kama, the proportion of alien species is much less – from 2 to 16%. Thus, invasive fish are a stable (albeit often small in number) component of coastal communities.

Benthophilus stellatus (Sauvage, 1874), stellate tadpole-goby. A rare species, most often found in the Lower and Middle Volga, single finds up to the Rybinsk reservoir.

Clupeonella cultriventris (Nordmann, 1840), common kilka. Mass invasive species, the new range covers all reservoirs of the Volga and Kama. According to the results of genetic-biochemical analysis, the species originates from the Saratov backwaters (Saratovskie Zatony) now flooded by the waters of the Volgograd water reservoir.

Coregonus albula (Linnaeus, 1758), European vendace. Representative of the "northern" invaders. The extreme southernmost point of its finding is the upper reach of the Zhigulevskaya HPP. Haplotypes typical for peled were also found in the Volga, which requires additional study.

Knipowitschia longecaudata (Kessler 1877), longtail dwarf goby. The natural area covers the lower reaches of the Volga and Don, as well as the reservoirs of the Manych River. A single find that indicating the invasive status of the species in the Volga was made near the Volga-Don Canal exit.

Neogobius fluviatilis (Pallas, 1814), monkey goby. It is common in the Lower and Middle Volga, and probably inhabits other reservoirs of the Volga-Kama cascade.

Ponticola gorlap (Iljin, 1949), Caspian bighead goby. It is the largest gobiid species spreading along the Volga. Common on the Lower Volga and in the reservoirs of the Middle Volga. It has not been found in the Kama reservoirs, but the probability of its expansion in this direction is extremely high.

Neogobius melanostomus (Pallas, 1814), round goby. Successfully settled throughout Volga, along the Kama up to the upper reaches of the Votkinsk reservoir.

Osmerus eperlanus (Linnaeus, 1758), European smelt. One more "northern" invader, with the acquired range now limited to the Upper Volga reservoirs.

Perccottus glenii Dybowski, 1877, Chinese (Amur) sleeper. Rarely found in the coastal waters of the Kuibyshev and Cheboksary reservoirs, single finds in the coastal areas of the Rybinsk reservoir. The possibility of stable river populations is unclear.

Ponticola syrman (Nordmann, 1840), syrman goby. Found only on the Lower Volga in the area of Astrakhan.

Proterorhinus semipellicidus (*P.* cf. *marmoratus*), Caspian tubenose goby. Genetically, Volga's tubenose gobies correspond to the species *P. semipellucidus* (according to records in the NCBI GenBank and Taxonomic Database). It is present in almost all Volga reservoirs. The issue of the donor region and taxonomy of tubenose gobies of the Volga-Kama basin requires a separate study.

Syngnathus abaster Risso, 1827, black-striped pipefish. Mass invasive species in the reservoirs of the Lower and Middle Volga, and the Lower Kama. The genesis of populations requires clarification. Genetically, the Volga-Kama populations differs from the samples from the Don basin.

In addition to these mass alien species, there are data on extremely rare (or doubtful) captures of 11 more invasive fish species.

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ROADS AND RAILWAYS AS CORRIDORS FOR THE SPREAD OF ALIEN SPECIES

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Humans transport species, both purposefully and unintentionally, beyond their natural distribution ranges. Some introduced species survive, establish populations and become permanent additions to local floras that lose their uniqueness, a phenomenon called biotic homogenization. Many alien species are recorded in ruderal habitats such as cities, ports, and transport routes; these habitats serve as entry points for most plant invasions. For such localities, floristic inventories exist but were mostly studied in isolation rather than as a part of dynamic road/railway/river networks. Moreover, such inventories usually lack the temporal dimension.

Our study presents data from road and railway inventory in the Czech Republic. Road inventory was done along the main roads, focusing on ca 80 alien plants. The inventory carried out along railways included complete railway floras and was used to analyze the historical aspects of spread based on recording time. Both studies addressed a scale that allows differentiating between habitats with frequent and regular management from abandoned sites with spontaneously developing flora.

We found infrequently managed zones along roads harboured the greatest amounts of alien plants. The same pattern was found in railway stations where most aliens occurred in less managed sites neighbouring rails. Most species found were contaminants of the transported material. The survey results are useful for management recommendations for the relevant stakeholders.

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FROM WEST TO EAST AND BACK AGAIN: TRANS-SIBERIAN RAILWAY AS A CONTINENTAL PATHWAY OF PLANT INVASIONS; PROJECT OVERVIEW

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The project "From West to East and back again: Trans-Siberian Railway as a continental pathway of plant invasions" focuses on analyzing the role of human-mediated pathways. It uses the Trans-Siberian railway (Транссибирская магистраль, Transsibirskaya magistral, TSR) as the model system, and is based on studying floras at individual TSR stops. The railway, which spans across much of Eurasia, provides a unique opportunity for analyzing the spread of alien plants at a continental scale. It connects two continents differing in their native species pools, and because more than 50% of foreign trade and transit cargo in Russia is transported via the TSR, its role in the unintentional movement of plant species is crucial. Because TSR is so isolated, there is little interaction with other traffic networks in contrast to e.g. Europe, where it is nearly impossible to disentangle the influence of road and railway networks on species introductions. We aim at studying the transported plant species and biogeographical patterns of their spread. The project also aims to predict the invasion risk of alien species along TSR in the future.

Within the project, we will combine (i) field inventories of alien and native plants along the TSR corridor, (ii) laboratory experiments aimed at the identification of plant species' reproductive and dispersal traits, and (iii) analysis of socioeconomic vectors and biogeographical drivers associated with alien species dispersal. The project will thus contribute to understanding the role of human-mediated pathways (based on the model system of TSR) in transporting plant species, elucidating the biogeographical patterns of their spread, and predicting the invasion risk of alien species spreading along TSR in the future. Lastly, this study will improve the knowledge about alien plant species in temperate Asia.

The project is based on cooperation between the Institute of Botany, Czech Academy of Sciences, NV Tsitsin Main Botanical Garden, Russian Academy of Sciences, and Botanical Garden of the Belgorod state national research University (BelSU).

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SPATIAL AND TEMPORAL DISTRIBUTION OF INVASIVE OLIGOCHAETE *QUISTADRILUS MULTISETOSUS* (SMITH, 1900) IN THE VOLGA RESERVOIRS

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The oligochaete *Quistadrilus multisetosus* (Smith, 1900), known from the water bodies of North America, was first discovered in the Rybinsk reservoir in 2013. At the same time, a very high density and biomass (8100 ind./m^2, 3.57 g/m^2,) of the invasive species were recorded on gray silts rich in organic matter, in the former mouth of the Mologa River.

In 2015, a high abundance of *Q. multisetosus* were also recorded at this site, 2400 ind./m^2, 0.72 g/m^2. The frequency of occurrence of *Q. multisetosus* in the benthos of the Rybinsk Reservoir reached 56%, which made it possible to conclude, that this species was successfully naturalized. The analysis of long-term observations of 2013–2019 showed, that the highest values of the frequency of occurrence and abundance of the invasive species were recorded in 2013 (Table), when, apparently, there was an outbreak of its abundance after the introduction into a new water body.

In subsequent years, the abundance and occurrence tended to decrease (Table).

Table. Long-term changes in the occurrence and abundance of *Q. multisetosus* in the Rybinsk Reservoir.

Year	P, %	N, thous. ind./m^2		B, g/m^2	
		Mean	Min-max	Mean	Min-max
2013	68	1.38±0.84	0.04–8.10	0.71±0.43	0.04–3.57
2014	25	0.80±0.55	0.02–1.14	0.14±0.14	0.02–0.37
2015	56	0.44±0.27	0.02–2.40	0.19±0.09	0.02–0.72
2016	27	0.15±0.08	0.02–0.50	0.05±0.02	0.01–0.13
2017	23	0.66±0.55	0.04–3.64	0.31±0.26	0.01–1.76
2019	27	0.09±0.02	0.02–0.32	0.05±0.01	0.01–0.32

Note: P, % - occurrence; N - density; B - biomass.

According to long-term observations, in 2013–2019, the density and biomass of *Q. multisetosus* in the Rybinsk Reservoir varied significantly from season to season. The maximum abundance of the species was always recorded in autumn (September-October), the minimum one, in spring and summer. Currently, the oligochaete *Q. multisetosus* are found in the Rybinsk Reservoir at depths of 5 to 15 m, on different types of soils, which include sand, shell rock, peat, etc. The greatest abundance was found in the channel and estuarine areas with an intensive silt accumulation. The analysis of the Pantle-Buck saprobity index at the sites of *Q. multisetosus* occurrence showed, that it can dwell both under conditions of moderate organic matter content (β-mesosaprobic zone) and at high organic matter content (α-mesosaprobic zone). Based on the average values of the saprobic index (3.12 ± 0.04), it is found that the species is more common in the α-mesosaprobic zone. This species is considered an indicator of eutrophic waters (Schloesser et al., 1995); therefore, its appearance and distribution, as well as its high abundance, may indicate an increase in the trophic status of the Rybinsk Reservoir. As for the other Volga reservoirs, solitary findings of the species have been recorded so far only in the Gorky and Cheboksary reservoirs. In the summer of 2015, *Q. multisetosus* were first identified in the Gorky Reservoir near the city of Ples at a depth of 11 m in the biocenosis formed by the invasive species *Dreissena polymorpha* Pallas, 1771 and *Dreissena bugensis* Andrusov, 1897. In 2016, *Q. multisetosus* were first detected in the Cheboksary Reservoir, also in the biocenosis of *Dreissena*, at the station near the mouth of the Sura River, at a depth of 2 m. In both cases, its density and biomass were minimal and amounted to 0.02 thous. ind./m^2 and 0.02 g/m^2, respectively.

NEW INVASIVE SPECIES IN THE MACROZOOBENTHOS OF THE RYBINSK RESERVOIR

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In the second half of the 20th century, several invading species appeared in the macrozoobenthos of the Rybinsk Reservoir, mainly representatives of the Ponto-Caspian fauna. Their advancement in the northern direction was due to the construction of dams on the Volga and intensive shipping. In addition, one of the factors in the dispersal of alien species was the acclimatization of invertebrates to improve the food supply of commercial fish. A significant role in the resettlement of new species in the reservoir played changing environmental conditions associated with global warming, the results of which became even more evident in the early 21st century.

Analysis of long-term observations (2009-2019) showed a significant increase in the abundance, biomass and changes in the species composition of the macrozoobenthos of the deep-water zone of the Rybinsk reservoir compared to the end of the 20th century. In 2009, the Caspian species, the leech *Archaeobdella esmonti* Grimm, 1876, was first discovered in the Rybinsk reservoir. In 2013, the oligochaete *Quistadrilus multisetosus* (Smith, 1900), known from the water bodies of North America, was recorded for the first time in the Rybinsk Reservoir. In subsequent years, these invasive species successfully spread throughout the reservoir.

The mollusc *Lithoglyphus naticoides* (C. Pfieffer, 1828) is a species that is actively expanding its range in Europe, including in the Volga River basin. Currently, *L. naticoides* intensely moving up the Volga, it has occupied some sites, from the water to considerable depths and mastered almost all biotopes most reservoirs (Yakovlev et al, 2010). Along with *L. naticoides*, parasitic trematodes also spread, the range of which coincides with the range of the host mollusc. In the Rybinsk Reservoir, metacercariae of trematodes of the genus *Apophallus* associated with *L. naticoides* were first recorded in fish caught in 2005, and in 2006 molluskc themselves were recorded during manual collection in the inshore area (Tyutin et al, 2013). Until now, L. naticoides has not been recorded in the deep-water zone of the Rybinsk Reservoir, despite the regular collection of macrozoobenthos. In July 2019, *L. naticoides* was first detected in quantitative samples of macrozoobenthos in the Yugsky Bay of the Rybinsk Reservoir (58 ° 07.478 ′ N; 38 ° 37.570′E). In the biotope of silt with plant remains (depth 2 m), its abundance and biomass were 0.25 thousand ind./m^2 and 21.2 g / m^2, respectively.

The Ponto-Caspian amphipod *Pontogammarus robustoides* (G.O. Sars, 1894) is a species characteristic of brackish and freshened bays, coastal lakes and lagoons, and river estuaries. *P. rubustoides* belongs to a complex of Ponto-Caspian relic gammarids (Mordukhaj-Boltovskoj, 1960, 1964; Dedju, 1967; Greze, 1977). In its native range, the species has been found in the brackish and freshwater bays of the Black Sea, the Azov Sea and the Caspian Sea; coastal lakes; and lagoons, lower courses and estuaries of major rivers of the Ponto-Caspian basin: Volga, Don, Kuban, Bug, Terek, Kura, Kuban, Dnieper, Dniester, Danube, Prut (Mordukhaj-Boltovskoj, 1964; Grabowski, 2011). The native range covers Russia, Turkey, the Caucasus, Romania, Bulgaria and Ukraine territories (Carausu et al., 1955; Mordukhaj-Boltovskoj et al., 1969; Dedju, 1980; Jazdzewski, 1980). Tolerance to high pollution and low salinity of water, as well as the ability to reproduce and adapt quickly, provides this species with a high potential for spreading. In October 2019, *P. robustoides* were first detected in the Rybinsk reservoir at Koprino station (58 ° 04.228 ′ N; 38 ° 17.563′E). In the biotope of grey silt, at a depth of 11 m, its abundance was 0.02 thousand ind./m^2, and the biomass was 0.26 g / m^2. That is the first record of *P. robustoides* in the Upper Volga basin.

In the Rybinsk reservoir, the appearance and spreading of pollution-resistant invasive species are caused by changes in environmental conditions associated with climate warming.

DYNAMICS OF RANGES OF THE WORST INVASIVE SPECIES IN RUSSIA UNDER DIFFERENT SCENARIOS OF THE GLOBAL CLIMATE CHANGE

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The combined effect of global climate change and invasive species (IS) pose a serious threat to biodiversity, ecosystems and human being. Climate change and IS are widely recognized as threats to biodiversity that require urgent action to minimize their negative effects on the environment, socioeconomic and human health. We present results of the computer modelling of range changes of the IS included bacteria, chromists, fungi and vascular plants from the "TOP-100" list of worst invasive species under different scenarios of the climate change based on the set of new generation climate models (CMIP6 - Coupled Model Intercomparison Project Phase 6). The importance of IS studies associated with their significant characteristics (the ability to survive under unfavorable conditions, high growth rate and wide distribution) which help them successfully compete with aboriginal (native) species under various environmental conditions including climate change thus posing a threat to other species, ecosystems and economy. The goal of this study is to predict dynamics of the ranges of the most dangerous invasive species under CMIP6 - scenarios of climate change, to assess the consequences of potential invasions and identify regions of possible environmental threat. Research objectives include: 1) to compare 40 Global climate change models (GCCM) belonging to the new generation climate models (CMIP6 science 2021) and choose models that are the most suitable for analyzing the dynamics of IS ranges; 2) to create the models of landuse change under different scenarios of climate change; 3) to create a raster-vector database including a set of predictor variables (bioclimatic, landscape and topographic) of the IS habitat at the global level with a 2.5 arc minutes (5 km) for the most sensitive models of climate change; 4) to establish the most important predictor variables and make forecasts of the invasion rates of the most dangerous IS based on ensemble modelling using a set of 7 individual models (Generalized Linear Model - GLM, Generalized Additive Model - GAM, Generalized Boosting Model – GBM; Random Forest - RF, Flexible Discriminant Analysis - FDA, Artificial Neural Network – ANN; Maximum Entropy - MaxEnt) of species distribution (ESDM) under different scenarios of climate change and landuse for the period of 2021-2100 with a step of 20 years; 5) to build predictive ensemble niche models (EENM) using the most sensitive global models of climate change and landuse for the period of 2021-2100 with a step of 20 years. These ESDM's predict the habitat suitability in Russia for species from the «TOP-100 list» of the worst invasive species and their potential expansion rate during the period 2021-2100 (with a step of 20 years). The data on predicted changes in the ranges of IS will allow us to assess the vulnerability of various regions of Russia to potential invasions. Prediction of the potential distribution of IS is important for developing preventive and effective management measures against introductions of IS and for eradicating dangerous species. We constructed invasion risk maps for various regions of Russia and assess vulnerability of different habitats to invasive species which can be useful tools for predicting invasions of species and controlling their distribution. The identification of critical zones is very important for understanding the synergies of climate change, landuse and biological invasion management in terrestrial and aquatic ecosystems in Russia.

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INVASIVE POPULATIONS OF STONE MOROKO *PSEUDORASBORA PARVA* IN LORI LAKES (NORTHERN ARMENIA)

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Stone moroko *Pseudorasbora parva* (Temminck & Schlegel, 1846) appeared in the reservoirs of Armenia at the end of the last century, and currently it is a widespread and numerous species. The presence of Stone moroko species in Lori Lakes is of particular interest. More than 20 lakes and wetlands are located onto the flat plateau valley of the Dzoraget and Tashir rivers, at 1450-1475 meters a.s.l. The Lori lakes system is included into the Emerald Network List (Bern Convention) as an Area of Specific Conservation Interest (ASCI) because they render increasingly favorable habitats for plenty of wildlife species, though many of them have been subjected to enduring anthropogenic pressure and exhibit a range of invasive species which evidently damage growth of certain native populations. In this work we shortly present most prominent cases of invasion in some Lori lakes.

Clear Liman (N 41.0523° E 44.3105°) is a mesotrophic lake dedicated for protection on the local level, covering an area of 10.66 hectares, with average depth 2.1 m, maximum depth 5.4 m. *Nymphaea alba* L. densely grows on the lake periphery forming a rim 50-70 meters wide, thus open water area equals 2.76 hectares. During the study conducted in this lake in 2020-2021, Stone moroko formed 41.8-59.6% of the total number of fish caught, in which the ratio of females and males was 9:1. Lakes Novoseltsovo-1 (N 41.0567° E 44.2834°) (area 13.59 hectares) and Novoseltsovo-2 (N 41.0681° E 44.2803°) (area 14/81 hectares) have been extensively used by the local population as the reservoirs in the channel drainage system connected with the Novoseltsovo small hydroelectric power station. The Lakes Novoseltsovo-1 and Novoseltsovo-2 are mainly surrounded by the coastal species *Phragmites australis* (Cav.) Trin. ex Steud. and *Typha latifolia* L. In Lake Novoseltsovo-1 Stone moroko formed only 1.1% of the total number of fish caught, and in Lake Novoseltsovo-2 - 93.1%. Lake Stepanavan-2 (N 41.0339° E 44.3594°) (area 3.64 hectares) is one of the lakes in the group of four reservoirs that lie 5 km east from the Novoseltsovo lakes and Clear Liman. Water surface of the lake Stepanavan-2 is densely covered with floating vegetation (mostly *Potamogeton natans* L.). Damming effect caused by the adjacent road is the only anthropogenic impact to modify hydrology of all four Stepanavan lakes. In Lake Stepanavan-2 Stone moroko formed 97.4% of the total number of fish caught, in which the ratio of males to females was 8:1.

Thus, in most of the Lori Lakes, Stone Moroko dominates the local fish fauna. Having a great potential to increase its population, it can significantly affect the number of other fish species occurring here by feeding on their fish egg and fingerlings, as well as becoming their fodder competitor, feeding on various invertebrates.

At the same time, 5.7% of the studied individuals of Stone Moroko are infected with *Ligula intestinalis* metacercariae. This figure tends to increase due to at least 19 species of fish-eating birds either inhabiting or regularly being encountered in the lakes, which are potential owners of *Ligula intestinalis* and its spreaders in these and other reservoirs.

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DEVELOPMENT *ANADARA KAGOSHIMENSIS* (TOKUNAGA, 1906) (MOLLUSCA: BIVALVIA: ARCIDAE) IN THE BLACK SEA

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There was studied the development of the bivalve mollusc *Anadara kagoshimensis* (Tokunaga, 1906), a recent invader into the Black Sea. During a short period of time, the mollusc has spread in the western part of the sea, along the Caucasian and Crimean seacoasts, where it lives on various types of bottom at a depth of up to 20 m. The species is eurythermal and euryhaline; it can bear extreme oxygen conditions due to its hermetically closing valves and haemoglobin in red blood cells. Their spawning period comes when water temperature exceeds 20°C.

Under experimental conditions, spawning of mature individuals (shell length from 19.2 to 30.4 mm) was stimulated with a 0.003% serotonin solution at water temperature of 25°C. The effusion of mature eggs with a diameter of 52.5±1.67 µm occurred at the stage of diakinesis of the prophase of meiosis. The nuclear envelope of the oocytes that got into the sea water dissolved and the chromosomes passed into the stage of metaphase I. They remained at this stage until fertilization, i.e. the blocking of meiotic processes occurred at metaphase I. On the metaphase plate, there were 19 bivalents from 2.3 to 11.2 µm big. The duration of meiotic divisions I and II, which was determined from the moment of fertilization till the appearance of telophase I and telophase II in the samples, was 15 and 25 minutes, respectively. The process of karyogamy occurred at the 45th min, and after that, 10 min later, two blastomeres and the formation of the first polar lobe were observed. The synchronicity of the first mitotic division reached 90%. At the 60th minute, the second mitotic division (4 blastomeres) was noted, and 15 minutes later, the third one (8 blastomeres) took place. The development of the larval stage, the trochophore, was completed 6 hours 15 minutes after fertilization, and the sterroblastula stage was noted at the 10th hour. 19 hours after fertilization, a growing shell in the form of a two-lobed plate was observed on the dorsal side of the larvae, and after 4 hours and 30 minutes, all the larvae entered veliger stage. The shell length of the larva at the veliger stage (2 days old) was 82.6 ± 3.64 µm; shell height - 63.2±3.78 µm; the ratio of height to length was 0.77. The hinge edge of the early veliger of the anadara is a kinked curve, with an angle of 166 ° locating closer to the anterior edge. The hinge line is about 59 µm long, which is 71.4% of the shell length.

The details of the structure of the hinge edge of the veligers were studied by using a JSM-6060 LA scanning electron microscope. The lock of the right and left valves of the anadara veliger consists of 5 teeth. The anterior edge of the right valve has three teeth (1, 3, 5), separated by two notches. The shape of the 1st and 5th teeth is trapezoidal with a maximum width of 5.4 and 2.8 µm, the third is rectangular (width - 4.6 µm). In the posterior margin of the provinculum, there are two rectangular teeth: 7 and 9, with the seventh being 2.5 times wider than the ninth one (4.8 and 1.9 µm). They are separated from each other by a notch; another notch separates the 7th tooth from the midline, and the 9^{th} tooth is separated from the posterior edge of the shell with one more notch. The length of the midline of the castle is 22.7 µm, the width is from 1.3 µm (in the center) to – 2.6 µm (at the edges). The structure of the provinculum of the left valve is complementary to that of the right one, i.e. each tooth (protrusion) on the right valve corresponds to a hollow space on the left valve, similar in size and shape. A cross-striation is visible across the entire join area where the locking lines meet on the right and left valves. The teeth of the provinculum located on the lateral surfaces have also characteristic grooves, similar to tiny teeth of adult molluscs belonging to Arcidae family.

The bivalve mollusc *A. kagoshimensis* is currently an important component of the Black Sea ecosystem and a promising object for mariculture due to its high abundance, physiological characteristics and biochemical composition of its soft tissues. Data on the duration of the stages of meiosis and embryonic development are need for the developing biotechnics of mollusc's cultivation and genetic enhancement; data on shell and castle morphology will facilitate early identification of anadara larvae's within plankton.

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ALIEN FLORA OF THE REPUBLIC OF MORDOVIA: CHANGES IN THE COMPOSITION OVER THE 20 YEARS (2000 – 2020)

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In 2020, there were two round dates for Mordovian phytogeography – 20 years from a special inventory of alien plant species (Barmin, 2000) and 10 years from the last inventory of regional flora (Silaeva et al., 2010). We compared data on the alien flora of Mordovia for two decades from 2000 to 2020 in order to identify changes in its taxonomic and typological composition.

We checked the list of alien flora compiled by N.A. Barmin in 2000. Checklist of N.A. Barmin (2000) consists of 375 species. We excluded the following species from this list: 1) species, the native nature of their ranges by 2021 we confirmed: *Saponaria officinalis* L., *Polygonum rurivagum* Jord. ex Boreau, *Onobrychis viciifolia* Scop., *Trifolium fragiferum* L., *Vicia biennis* L., *Crataegus rhipidophylla* Gand., *Potentilla supina* L., *Arabidopsis thaliana* (L.) Heynh., *Bunias orientalis* L., *Erucastrum armoracioides* (Czern. ex Turcz.) Cruchet, *Sisymbrium strictissimum* L., *Daucus carota* L., *Pastinaca sativa* L., *Silaum silaus* (L.) Schinz et Thell., *Nymphoides peltata* (S. G. Gmel.) Kuntze, *Artemisia dracunculus* L., *Centaurea stoebe* L., *Chondrilla juncea* L., *Cynoglossum officinale* L., *Lamium album* L., *Carex arnellii* Christ, *C. capillaris* L., C. *diluta* Bieb.); 2) we didn't find reliable information about the findings (*Eremopyrum triticeum* (Gaertn.) Nevski); 3) species - synonyms (*Oenothera biennis* L. = *O. rubricaulis* Klebahn, *Pisum sativum* L. = *P. arvense* L., *Setaria pycnocoma* (Steud.) Henr. ex Nakai = *S. viridis* (L.) Beauv.). The checklist was supplemented by the species found in Mordovia before 2000. For various reasons, N.A. Barmin didn't put them on his checklist (for example, *Hirschfeldia incana* (L.) Lagr.-Foss. - collected in 1998, identified in 2004). After checking the alien flora of Mordovia consisted of 347 species, 218 genera, 59 families in 2000.

By 2010, 38 species were added to the checklist the alien flora of Mordovia: *Amaranthus blitum* L., *Atriplex hortensis* L., *Portulaca grandiflora* Hook., *Vitis vinifera* L., *Ornithopus sativus* L., *Amelanchier alnifolia* (Nutt.) Nutt., *Armeniaca vulgaris* Lam., *Aronia mitschurinii* A. Skvorts. et Maytulina, *Cerasus pumila* (L.) Michx., *Crataegus chlorocarpa* Lenné et C. Koch, *Malus prunifolia* (Willd.) Borkh., *Prunus cerasifera* Ehrh., *Rosa caryophyllacea* Bess., *R. glauca* Pourr., *Sanguisorba minor* Scop., *Juglans mandschurica* Maxim., *Viola × wittrockiana* Gams ex Hegi, *Lavatera trimestris* L., *Aesculus hippocastanum* L., *Apium graveolens* L., *Chaerophyllum aureum* L., *Coreopsis tinctoria* Nutt., *Gaillardia aristata* Pursh, *Helianthus × laetiflorus* Pers., *Tragopogon podolicus* (DC.) S. Nikit., *T. ruthenicus* Bess. ex Krasch. et S. Nikit., *Zinnia elegans* Jacq., *Anchusa arvensis* (L.) Bieb., *Brunnera sibirica* Stev., *Melampyrum arvense* L., *Marrubium vulgare* L., *Lemna minuta* Kunth, *Allium cepa* L., *A. sativum* L., *Bromus hordeaceus* L., *Elymus novae-angliae* (Scribn.) Tzvel., *Hordeum bogdanii* Wilensky, *Lolium persic*um Boiss. Many of these finds come from agricultural crops.

From 2011 to 2020, 24 new alien species were found in Mordovia: *Dicentra spectabilis* (L.) Lem., *Eschscholzia californica* Cham., *Adonis aestivalis* L., *Reynoutria × bohemica* Chrtek et Chrtkova, *Amaranthus powellii* S. Watson, *Atriplex patens* (Litv.) Iljin, *Dianthus chinensis* L., *Silene wolgensis* (Hornem.) Bess.ex Spreng., *Oenothera villosa* Thunb., *Potentilla indica* (Andrews) Th. Wolf, *Rosa caesia* Sm., *Quercus rubra* L., *Acer ginnala* Maxim., *Lysimachia punctata* L., *Achillea leptophylla* M.Bieb., *Coreopsis grandiflora* Hogg. ex Sweet, *Petunia × atkinsiana* D. Don, *Solanum physalifolium* Rusby., *Veronica filiformis* Smith., *Cruciata laevipes* Opiz., *Allium caeruleum* Pall., *Typha elata* Boreauv., *Digitaria sanguinalis* Scop., *Sorgum halepense* (L.) Pers. (Pismarkina et al., 2020; Khapugin et al., 2020). "Runaways from culture" again dominate among the finds. In 2020, the checklist of alien flora of Mordovia consists of 411 species, 250 genera, 65 families.

We believe that among the alien species of the region, species that have increased the degree of naturalization deserve special attention. These are, first of all: *Geranium sibiricum* L., *Epilobium pseudorubescens* A. Skvorts., *Oenothera biennis* L., *Amelanchier spicata* (Lam.) C. Koch, *Lonicera tatarica* L., *Helianthus tuberosus* L., *Juncus tenuis* Willd.

Determination and confirmation of herbarium and analysis of our data and literature were done as a part of the state budget tasks of the Russian Academy of Sciences, Ural Branch: Institute Botanic Garden.

KELLICOTTIA LONGISPINA AND *K. BOSTONIENSIS*: THE SPECIFITY OF THE OCCURRENCE IN THE FLOODPLAIN LAKES

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It is very interesting to observe the interactions of new inhabitants with the environment and their influence on the native species. There are very many examples of various strategies in alien species behavior on the new territories. So, it is very important to investigate the alien species preferences in comparison with the native relatives for their spreading prediction.

The floodplain lakes were studied in the basin of the Upper Volga (Yaroslavl' district) in 2014–2015 and in the Middle Volga (The Chuvash Republic) in 2016–2020. The studied floodplain waterbodies in the Sura River lower course basin (the right Volga River tributary) are located in the Prisursky State Nature Reserve protection area. The alien rotifer *Kellicottia bostoniensis* (Rousselet, 1908) and indigenous *K. longispina* (Kellicott, 1879) occurrence and abundance were analyzed totally in 38 objects. And some abiotic parameters in the studied lakes were defined. Water transparency was measured using Secchi disk (Abakumov et al., 1992). Water surface temperature and dissolved oxygen concentration were measured using a HANNA HI-9147-04 dissolved oxygen meter; water acidity (pH), using a HANNA HI-83141 pH meter with electrode and temperature probe; and electrical conductivity (EC) and total dissolved solids (TDS) using a HANNA HI-98129 tester. The data on the main morphometric characteristics (Aleksandrov, 2018) were also provided for analyses. The canonical correspondence analyses methods (ter Braak, 1998) were used for a variation in the species occurrence with respect to environmental conditions.

The *K. bostoniensis* occurrence in the Upper Volga basin floodplain lakes was about 5% and it was in spring only. The indigenous rotifer *K. longispina* was rather common in this region. These two species coexisted there.

In 2016 *K. bostoniensis* was found in the Sura River lower course basin for the first time. It was present in two lakes only. By the 2018 its occurrence in the Sura basin (lower course) was measured up to 56%. The rotifer *K. longispina* encounter rate was less (22%). The alien *K. bostoniensis* inhabited the same waterbodies as *K. longispina*, but they were different in abundance. *Kellicottia longispina* preferred deeper waterbodies with an undeveloped litoral and with a higher transparency ($p < 0.05$) by contrast with *K. bostoniensis*. As in the Sura river basin the shallow lakes with a rather high trophy are numerous, *K. bostoniensis* can find the appropriate conditions here and become rather common.

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DISTRIBUTION OF ALIEN POLYCHAETES OF THE SPIONIDAE FAMILY OFF THE COAST OF CRIMEA (BLACK SEA)

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At the present time, 10 species of invasive polychaetes belonging to 5 families have been found in bottom biotopes of the coast of Crimea. The largest number of species (5) is represented by the Spionidae family. Many species of this family are eurybiontic and are registered as invaders in various regions of the World Ocean.

The material for our research was the bottom grab collection of macrozoobenthos from the cruises of the R / V «Professor Vodyanitsky» (2010–2017). We also treated materials from the shore-based expeditions in shallow areas of the Crimean coast in 1998–2019. In total, about 600 samples were collected and processed. To analyze the species distribution modern literature data are used.

The first species of Spionidae Family that invaded the Black Sea – *Polydora cornuta* Bosc, 1802. *Polydora*, which was first found by G.V. Losovskaya in Odessa area in 1962, was initially identified as *P. limicola* (Losovskaya and Nesterova, 1964). Subsequently, with the participation of V.I. Radashevsky, it was assigned to the species *P. cornuta* (Radashevsky, Selifonova, 2013). Near the Crimean coast, *P. cornuta* was recorded at a depth of 0.5 m to 31 m. The species is tolerant to a wide range of salinity and temperature. In 2008–2009 in a shallow and largely freshened apex area of the Karkinit Bay at a salinity of 8.0 ‰, the density of *P. cornuta* reached 113 ind.· m^{-2}, at 18.3 ‰–325 ind.· m^{-2}. Currently, the species has spread widely and become abundant in benthic communities in the northern part of the Black Sea.

Another species of the genus *Polydora* that penetrated the Black Sea is *P. websteri* Hartman in Loosanoff & Engle, 1943. It was first recorded in 2005 from samples collected at the Romanian shores (Surugiu, 2005). In 2009 *P. websteri* was found in the study of *Crassostrea gigas* oysters grown on oyster farms off the coast of the southwestern Crimea and in Lake Donuzlav. In the Black Sea, this species, in addition to oysters, perforates stones, shells of mollusks *Rapana venosa* (Valenciennes, 1846) and *Anadara kagoshimensis* (Tokunaga, 1906) (Bondarev, Boltacheva, 2021, in the press; Semin et al. 2021).

Dipolydora quadrilobata (Jacobi, 1883) was first discovered in 2003 in the waters of Bulgaria (Todorova, Panayotova, 2006, cit. according to Surugiu, 2009). Near the southern coast of Crimea, *D. quadrilobata* was first recorded in 2010, and in 2013 it was found in the Kerch pre-strait area. *D. quadrilobata* distributed at depths from 17 to 100 m. The population of this species attained their highest density (up to 1184 ind. m–2) in the northwestern part of the sea proximate to the Zernov phyllophora field at a depth of 30–50 m in the community of *Mytilus galloprovincialis*. Near the southern coast of Crimea, *D. quadrilobata* was found only at great depths, which are the limit for the habitation of macrozoobenthos in the Black Sea (80–100 m).

Streblospio gynobranchiata Rise & Levin, 1998 in the Black Sea was recorded in 2007 in the Sevastopol Bay. Polychaetes were found at a depth of 2–17 m, on silted soils. Their number reached 2275 ind.· m^{-2} in the estuarine zone, where the salinity level decreased from 17.7 to 14.3‰. *S. gynobranchiata* are well adapted to organic pollution and attain particularly high densities in the port water areas of Novorossiysk, Odessa and at the mouth of the Danube.

The last of the invading spionid species, *Marenzelleria neglecta* Sikorski & Bick, 2004, first entered the Sea of Azov (in 2014) and then was found in the Kerch Strait of the Black Sea. In 2016 we found this species near the western coast of Crimea, at a depth of 25 m.

The listed species of the family Spionidae have a long pelagic developmental stage and probably have been transported to the Black Sea with ship’s ballast waters. The perforator polychaete *P. websteri*, in addition to ballast water, could be brought to the Black Sea with aquaculture objects. At present, alien species are at different stages of invasion. *P. cornuta*, *D. quadrilobata*, *S. gynobranchiata* naturalized and become representative species of a number of benthic communities of the Black Sea. The Black Sea is characterized by a depleted taxonomic composition, therefore, the appearance of new species increases biodiversity and increases the stability of its ecosystem.

For details see: Boltachova, N.A., Lisitskaya, E.V. & Podzorova, D.V. Distribution of Alien Polychaetes in Biotopes of the Northern Part of the Black Sea. Russ J Biol Invasions 12, 11–26 (2021). https://doi.org/10.1134/S2075111721010033

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SPREAD OF THE CHINESE SLEEPER (*PERCOTTUS GLENII*) THROUGH BALTIC SEA

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Chinese sleeper (*Percottus glenii*) is actively spreading across Europe. Several pathways for the invasions have been described over the network of freshwater bodies there. Moreover, enthusiasts of fishing often move them to every possible direction into new habitats for some reason. It was recently revealed that the Baltic Sea is also a pathway for its spread.

The source of the Chinese sleeper invasion in Europe was the eastern extreme of the Gulf of Finland of the Baltic Sea. The place of release (north of the Neva Bay) geographically belongs to the sea, but the water is practically fresh there due to the confluence of the full-flowing Neva River. Chinese sleepers have successfully settled in it, and fishermen still catch them there to release into new habitats. The active spread of Chinese sleepers through the Baltic Sea has not been reported so far. Salinity in the Baltic Sea is low, but it is still not a freshwater body. Only in the coastal zone the water is freshened being suitable for Chinese sleepers. These fishes gradually spread along the coasts in a western direction. In 2013, they were found in the canals of a nuclear power plant located on the southern coast of the Gulf of Finland at a distance of about 100 km from the place of release. Recently it turned out that they can also cover considerable distances in the open sea since they appeared near Gogland Island. The island is located in the center of the Gulf of Finland. The distance to the nearest point of the coast in the south is 55 km, in the north - 40 km. In 2017, a dead specimen was found on the shore of Gogland after a storm, and in 2021 live Chinese sleepers were observed at the coastline. One specimen was caught. The find was unexpected because Gogland Island seemed to be unsuitable for this species. Chinese sleepers in the Gulf of Finland were previously recorded only in highly freshened areas of shallow waters, where macrophytes are abundant. The waters around Gogland differ significantly from such habitat as the depth rapidly increases at the coastline there. The zone of shallow freshened waters at the coasts is extremely narrow, it is hardly more than a few meters or does not exist at all.

Intentional release of Chinese sleeper by humans to the waters at the coasts of Gogland is unlikely. Fishing enthusiasts usually release these fishes into small lakes, where they like to sit with a fishing rod. The coasts of the Gogland Island of are of little use for this. Moreover, the human population is almost absent there. Most of the island is "abandoned". There are only small military posts, a weather station, and two lighthouses, where a small number of employees work. Probably, either adult Chinese sleepers or their juveniles got to the island due to storms and currents from the coastal zone of the Gulf of Finland. Further settlement by sea can be expected.

South from the Gulf of Finland the Chinese sleepers already populated freshwater bodies, but they have not been reported from the northern mainland, i. e. territory of Finland. Most likely, they will settle there or have already settled. The finds near the Gogland Island once again showed that Chinese sleeper can be satisfied with an extremely small area, and therefore even small desalinated areas of the sea can serve as pathways for the invasions.

ALIEN SPECIES OF COLLEMBOLA IN AGROECOSYSTEMS IN THE EUROPEAN PART OF RUSSIA

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Collembola are abundant, small (1-3 mm) arthropods inhabiting the soil of different habitats, including anthropogenic ones. This group is studied intensively in applied biology to use in biotesting, ecological monitoring and bioindication of ecosystem disturbances. Although research on Collembola fauna began at the end of the 19th century, more recently several hundreds of species new to science are described every year. Nevertheless, the diversity of springtails have been rather poorly studied, as many territories still remain unexplored. The difficulty of identifying species, the boundaries of ranges and, moreover, of following the dynamics of the distribution ranges significantly complicates the task of identifying alien species in this group.

We considered an alien, or invasive species, for the European part of Russia species that is common in natural ecosystems of any other region but occurs in the mentioned region only in anthropogenic habitats. Among such habitats, agroecosystems are the most widespread and include fields, orchards, pastures and compost heaps. In this work, we collected known records of invasive species in these habitats in recent years. We did not consider a rather large number of forest-steppe species moving northward through disturbed habitats as invasive. We consider this phenomenon as a manifestation of Bei-Bienko's rule (1966) of zonal changes of habitats preferred by species.

The invasive species found in various types of agroecosystems on the territory of the European part of Russia include:

Parisotoma trichaetosa, a Far East - Siberian forest species. It spreads westward, in Europe it is found in anthropogenic habitats (Fjellberg, 2007). We observed it in a pasture in the Moscow Region (Shakhovkaya District).

Desoria trispinata, a North American species occurring in Europe in anthropogenic habitats (Roithmeier et al., 2018). We found this species in compost heaps of the Moscow Region (Shakhovkaya District), and also in oat fields in Kaluga Region (Mosalsk District, agrarian holding Savinskaya Niva).

Orchesella cincta, a West European species that spread across anthropogenic habitats eastward to Kamchatka (Potapov & Janion-Scheepers, 2019). It is found on perennial grasses in the Moscow Region (Barybino, collection of L. Sukhova).

Invasive species are rare in agroecosystems, especially in arable cultivation; they rather prefer composts and other accumulations of organic residues.

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DO ALIENS IN DETRITAL FOOD WEBS REALLY NEED DISTURBED HABITATS?

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It is traditionally assumed, following a concept originating in plant ecology (Grime, 1979, etc.), that alien species primarily occupy disturbed habitats, including the most polluted and/or extremely stressful ones (plants: Lambinon, 1997; birds: Claridge, Wilson, 1981; insects: Watt, 1977, etc.), which are usually not occupied by serial communities of the zonal successional system (terminology: Clements, 1936).

Our study in the Lower Don River Basin showed that this is not the rule for macroinvertebrates: invaders can occupy the most favorable habitats, and the most aggressive ones can displace native species from resident serial communities (Son et al., 2020).

In our opinion, the invasion of alien species into native communities with detrital food webs is facilitated by the lower (compared to communities of pasture food webs, including planktonic ones) trophic competition between species under conditions of a constant surplus of resources (detritus), and by the low trophic specialization of detritus feeders. As a result, filter feeders or detritus-feeding collectors from different regions of the world are, as a rule, trophically pre-adapted to colonie a new ecosystem.

Disturbed habitats of inland waters are usually inhabited by native cenophobes (species that do not originate from the zonal or, in our case, regional (local) successional system: Razumovsky, 1981), which effectively use existing food resources. As a result, macrozoobenthic communities are more susceptible to invasions of alien species under more stable conditions, under which, during the specialization of the trophic niches of native cenophilic species (i.e., those that originate from the regional successional system: Razumovsky, 1981), detritus, which is not completely consumed by them, accumulates as a potential trophic resource.

It is especially worth noting that in anthropogenic waterbodies (canals, reservoirs, and other artificial waters associated with power stations), one can observe simultaneously both a disturbance of the natural aspect of ecosystems (decreased mosaicity and diversity of substrates and habitats, degradation of vegetation, absence of a developed floodplain, etc.) and an increased temperature stability, favorable oxygen conditions, etc. (Sousa et al., 2021). Taken together, these factors can both oppress the most specialized local biota and give no preferences to cenophobic species, as a result of which alien species colonize such ecosystems successfully.

Detrital food webs provide the formation of a gradient of communities in terms of structural organization (Protasov, 1989) from the "P (Petersen)"-type (biotopically determined without a dominant key-species) to the "M (Möbius)"-type (consortium-like, with a dominance of key-species). In the case of invasion into P-communities, aliens are able to displace natives with a similar diet (as in the most invasive amphipods). There are also many examples in the Holarctic of the formation of M-communities new to the region, with aliens as the key-species, e.g., mollusks of the genera *Dreissena*, *Sinanodonta*, *Potamopyrgus*, some Polychaeta, etc.

Thus, the mainstream view of the predominant invasion of alien species into disturbed habitats seems to us at least not applicable to macrozoobenthos communities of inland water bodies. A similar situation can possibly be observed in other communities dominated by detrital food webs. The study of the invasion process, taking into account the qualitative and functional composition, as well as the successional position of the native accepting communities, is necessary for predicting and controlling biological invasions.

In its most general form, our idea can be formulated as follows: in the presence of excessive resources, new taxa are able to integrate immediately into serial communities, bypassing the assemblages of cenophobic species.

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SPATIAL MODELING OF THE POTENTIAL DISTRIBUTION OF INVASIVE PLANT SPECIES IN THE CAUCASUS: METHODOLOGICAL ASPECTS

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Ecological niche modeling (ENM) is a powerful and widespread method for identifying the potential distribution of invasive plant species (Banerjee et al., 2019; Bowen and Stevens, 2020; etc.). There is a clear need to increase the numbers of such studies globally, however, the methodological aspects of ENM using still raise many questions. One of the most common mistakes is to include variables (environmental layers) in the modeling process without critically analyzing them (Sillero et al., 2020; etc.).

In this study, we presented the results of spatial modeling of *Conyza canadensis* (L.) Cronquist in the Caucasus, depending on the sets of variables: 1) BioClim (all 19 BIOCLIM variables); 2) BioClim+Top (combination of 19 BIOCLIM and eight topographic variables); 3) BioClim+Top+Antro (19 bioclimatic, eight topographic, and four anthropogenic variables, such as the distance to agricultural structures, railways, roads, and settlements). To create a maximum entropy model (Maxent) for *C. canadensis*, we selected a study area that included the territory from the Black Sea to the Caspian Sea and from the Kumo-Manych depression to the boundaries of Georgia. We compiled 120 presence points of the species in field studies. Environmental layers were clipped to the study area at 500 m^2 resolution. We performed the modeling settings using the ENMeval test procedure (Muscarella et al., 2018) and evaluated the model performance of candidate models based on Akaike’s information criterion and its modifications AIC, AICc, and $_{\Delta}$AIC (Burnham, Anderson, 2002; Cobos et al., 2019).

The optimal parameters for setting the model according to the information criteria for both BioClim and BioClim+Top+Antro models was LQHP (linear quadratic hinge product) feature type; for BioClim+Top model this was LQ (linear quadratic feature type). The optimal regularization multiplier in all cases: 3. The main bioclimatic variables that maximally affecting the distribution of *C. canadensis* are the precipitation parameters and the max temperature of the warmest month (Table). For these parameters, the maximum values of the percentage contribution (PC) are noted. However, PC of the bioclimatic variables significantly decreased in BioClim+Top and BioClim+Top+Antro models. PC of the main topographic variables (altitude and slope) was above 50% in BioClim+Top model but decreased sharply with the addition of anthropogenic variables, such as the distance to roads and settlements. The areas of potentially suitable and optimal habitats for *C. canadensis* are lowest when using BioClim+Top+Antro model.

Table. Contribution of variables to the formation of the distribution area of *C. canadensis* in the Caucasus

Model	Set of variables	PC, %	Variable	PC, %	Predicted area, km^2 (% of the total area)	
					$P \geq 0.5$	$P \geq 0.8$
BioClim	Bioclimatic	100	Bio19	37.8	79087 (12.6)	22309 (3.6)
			Bio18	29.3		
			Bio14	21.6		
BioClim+Top	Bioclimatic	48.2	Bio16	30.7	44811 (7.2)	20993 (3.4)
			Bio5	17.4		
	Topographic	51.8	Alt	29.7		
			Slope	10.4		
BioClim+Top+Antro	Bioclimatic	26.6	Bio18	16.6	28260 (4.5)	9820 (1.6)
			Bio5	9.2		
	Topographic	7.6	Alt	2.7		
	Anthropogenic	65.8	Dist_roads	44.4		
			Dist_settlements	16.5		

PC (%) is the percentage contribution of variable (set of variables) to construction of model; P (%) is probability of the species presence in the area; Bio14 is the precipitation of driest mo.; Bio16, Bio18, Bio19 (mm) are wettest, warmest, coldest quarters, respectively; Bio5 (°C) is the max temperature of warmest mo.; Alt (m) is the altitude; Slope is the slope of the terrain; Dist_roads and Dist_settlements (m) are the distance to roads and settlements.

Thus, when modeling the distribution of plant species in mountainous areas, it is important to use topographic variables in addition to bioclimatic ones. However, in modeling of invasive species distribution, anthropogenic factors may be most important and neutralize the influence of bioclimatic and topographic variables. The main factors that determine the distribution of *C. canadensis* in the Caucasus are the distance to roads and settlements in combination with the precipitation of the warmest quarter.

ON A POSSIBLE EXPANSION OF *OSTREA EDULIS* L.AND *FLEXOPECTEN PONTICUS* (BUCQUOY, DAUTZENBERG ET DOLLFUS) INTO THE SEA OF AZOV

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At the end of the Pleistocene, bivalve mollusks *Ostrea edulis* L. and *Flexopecten ponticus* (Bucquoy, Dautzenberg et Dollfus) inhabited the waters of the salty Karangat Sea, which extended over the territory of the present-day Black and Azov Seas (Semenenko et al., 1991). Because of the desalination of the waters and the division of the sea into two parts, the Black and the Azov, the mollusks *O. edulis* and *F. ponticus* disappeared in the latter. They continue to exist in the recent Black Sea.

In recent decades, empty valves of these mollusks are increasingly common on the shores of the Sea of Azov (Khaliman, 2002). They vary in color from light gray and orange to almost black. Some specialists believe that it is possible to recognize the expansion of these species from the Black Sea to the Sea of Azov (Anistratenko et al., 2011). However, there is no hard evidence for this. The purpose of our study is to reveal the geological age of the disputed shells *O. edulis* and *F. ponticus* from the Sea of Azov using elemental analysis methods. The study used valves of *O. edulis* and *F. ponticus* collected from littoral emissions in 2009–2013. on the coast of the Kazantip Bay of the Sea of Azov near the village Pesochnoe (Crimea Peninsula). For comparison, fossil valves (with traces of sedimentary rock) from the coast of the Arabat Gulf (Crimea Peninsula) and recent *O. edulis* from the Black Sea coast of the Maly Utrish Peninsula (Krasnodar Territory) were taken. The study was carried out independently in two stages. The first stage is the study of the shell matter for the content of the elements Fe, Cu, Cr, Mn, Al using a HANNA Instruments C100 colorimeter. At the second stage, a more detailed elemental analysis (for 54 elements) was performed using an Agilent Technologies 7900 ICP-MS mass spectrometer.

It did not identify a dependence in the concentration of the elements Al, Mn, Cu, Cr by using colorimetry. The amount of manganese in fossil and recent shells varied, but in recent shells it was much less. The content of chromium and copper in the fossil and disputed valves was slightly higher. But it was possible to reliably show only the difference in the content of iron. In the fossil and disputed valves, there was a lot of it, while in modern ones, iron was contained in insignificant quantities.

Using the mass spectrometer, it was possible to clearly distinguish the recent, disputed and fossil valves of *O. edulis* and the disputed valves of *F. ponticus* by their elemental composition. For the analysis, the most significant elements were Li, B, Na, Al, K, Mn, Fe, Zn, Rb, Hg, Pb. The recent valves had high concentrations of elements - Li (insignificantly), B, Na, Al, K, Zn (insignificantly), Rb, Hg and Pb. High concentrations of the last two elements are probably related to anthropogenic load. Sodium and potassium in living organisms are part of the cell sodium-potassium pump, so their content in recent shells is high. And vice versa, such elements as Mn and Fe in recent oysters are ten times less than in fossils. The disputed valves of oysters and *F. ponticus* differed from the recent ones in all the listed elements and coincided with the fossils of *O. edulis*.

In addition, some of the fossil valves revealed their own elemental features associated with their origin from different geological layers. *F. ponticus*, in comparison with other samples, has a high content of Co and Sr, and a low content of Zr and Cd. High concentrations of Si, V, I, Eu, Gd, Dy, Ho, Er, Yb, Lu were found in the disputed valve.

The most indicative element for determining the geological age in both analyzes is turned out the iron: the data on it coincide.

Using two methods of elemental analysis, it was possible to prove that in the Kazantip Bay of the Sea of Azov, the valves of *O. edulis* and *F. ponticus* are fossils and are washed out by the sea from the Pleistocene sediments. The invasion of these mollusks from the Black Sea into the Sea of Azov was not found.

INVASIVE COLEOPTERANS (INSECTA) - IN THE FAUNA OF STAVROPOL TERRITORY

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Many animal species have settled outside their natural ranges due to unintentional or deliberate introduction by humans. Beetles are the largest group of alien insects in Europe, many of them damage natural communities, being pests. The study of coleopteran invasions is an intensively developing area of research. The European Commission has adopted a series of regulations on biological invasion policies and has established an official European alien species information portal on its website (EASIN, 2019). In the course of our research on the territory of the Stavropol Territory for 2010-2020. 24 invasive species of Coleoptera were identified. The list of identified specie is given below.

Stegobium paniceum (Linnaeus, 1758). Possible vectors of invasion are unintentional introduction during the transport of food. *Aspidapion validum* (Germar, 1817). A species alien to Europe (EASIN, 2019). *Lyctus brunneus* (Stephens, 1830). Unintentional introduction in the transport of wood products. *Acanthoscelides obtectus* (Say, 1831). Unintentional introduction during transport of contaminated bean seeds. *Bruchus rufimanus* Boheman, 1833. Unintentional introduction during the transport of beans. *Megabruchidius dorsalis* (Fåhraeus, 1839). Unintentional introduction during the transport of honeyberry seeds. Naturalized. *Aspidapion validum* (Germar, 1817), invasion vector - unintentional introduction during transportation of infected seeds of stock-rose and marshmallow. *Rhopalapion longirostre* (Olivier, 1807). The species is considered alien for European countries (DAISIE; Sauvard et al., 2010) and for the United States (Tattershall and Davidson, 1954). *Zygogramma suturalis* (Fabricius, 1785). Intentional introduction as a biological control agent for *Ambrosia artemisiifolia.* The earliest find in the region of 1980, naturalized (Pushkin, 2008). *Harmonia axyridis* (Pallas, 1773). Unintentional introduction of adults with fruit (Korotyaev, 2013). Atomaria lewisi Reitter, 1877. Unintentional introduction in the transport of plant substrates. *Cryptophagus acutangulus* Gyllenhal, 1827. Introduction for the transport of plant substrates. *C. cellaris* (Scopoli, 1763). Introduction for the transportation of dry plant substrates. *C. distinguendus* Sturm, 1845. Introduced during the transport of dry plant substrates. *C. punctipennis* C.N.F. Brisout de Barneville, 1863. Cryptogenic species (EASIN, 2019). *Lignyodes bischoffi* Blatchley, 1916. Inhabits mainly along roads and forest plantations. *Otiorhynchus albidus* Stierlin, 1861, *O. smreczynskii* Cmoluch, 1968. Introduction during the transportation of seedlings of lilacs and other shrubs (Dedyukhin, 2014), as well as occasional delivery of individual beetles by means of transport. *Attagenus simulans* Solsky, 1876. Drift with animal and vegetable products. Stavropol Territory, 2002 (Pushkin, 2002). It is detected at bakeries and other grain processing enterprises of the Stavropol region. Naturalized. *Dermestes maculatus* DeGeer, 1774. Cryptogenic for Europe (EASIN, 2019) Naturalized (Pushkin, 2002). *Megatoma ussuriensis* Mroczkowski, 1967. Species alien to Europe (Zhantiev, 2009). Naturalized. *Cryptolestes pusillus* (Schönherr, 1817). Unintentional introduction in the transport of grain and other supplies. *Carpophilus dimidiatus* (Fabricius, 1792). Unintentional introduction during the transport of plant substrates. *Ahasverus advena* (Waltl, 1834). Unintentional introduction in the transport of food.

Thus, over the past decade, a steady tendency for the penetration of 24 Coleoptera species can be noted. Of these, four species are naturalized, two are pests. The main vectors of appearance in this case are the transport of food and plant substrates. Potential threat associated with economic damage to agricultural products is represented by 2 species: *Bruchus rufimanus*, *Attagenus simulans*. To give a more accurate description of the species, additional research is required.

THE DYNAMICS OF THE DEVELOPMENT OF PHYTOPATHOGENIC FUNGI ON SOME INVASIVE PLANT SPECIES IN KAZAKHSTAN

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The issue of biological contamination of the biosphere by alien plant species is one of the most pressing in studies of Earth's ecological systems. However, investigations of the mycobiota of invasive plant species began in Kazakhstan only in recent years, when the species composition of the mycobiota of some invasive species of vascular plants was studied in order to identify potential biocontrol agents for the development of effective methods of combating phytoinvasions. The purpose of this article is to study the dynamics of the development of phytopathogenic fungi on some invasive plant species in the southeast of Kazakhstan.

Despite the fact that there are 10 pathogenic fungal species on *Acer negundo* L., powdery mildew is most often noted. Powdery mildew (the causative agent *Sawadaea bicornis* (Wallr.: Fr.) Homma) on maple leaves is observed annually in most regions of Kazakhstan. The appearance of the first symptoms on young leaves is noted on May 20–25 in the southeast of Kazakhstan, in the northern regions and the East Kazakhstan region – much later (sometimes on July 20). The lesion spots increase until the end of July; chasmothecia appear in August. In September, there is a premature fall of heavily affected leaves.

The pathogens, characteristic for *Populus alba* L., are: agents of stem rot, rust, necrosis and leaf spots. Poplar rust which is caused by the rust fungus *Melampsora tremulae* Tul. is the most common. The first symptoms on young leaves appear in the first half of May. The lesion spots and their number gradually increase; leaf petioles and young shoots are also affected. A sharp loss of decorativeness of trees, especially young trees, is observed. The disease reaches its full development by the beginning of August, but already from July, severely affected leaves have fallen off.

Development of white rust pathogen (the causative agent *Pustula tragopogonis* (Pers.) Thines) on *Ambrosia artemisiifolia* L. is associated with the amount of atmospheric precipitation during the growing season. This disease was first noted in 2016. The first symptoms on young leaves appear in early June. The lesion was observed on leaves, tops of shoots and flowers, and in the affected flowers the fruits develop in an insignificant amount and are small in size. The widespread and intensive development of the disease was observed in 2020; the disease was not registered in the dry 2021.

On *Conyza canadensis* (L.) Cronq. three species of fungi causing powdery mildew and leaf spots are found. Powdery mildew (the causative agent *Podosphaera erigerontis-canadensis* (Lév.) U. Braun) appears rather late in the second half of July, but the disease development is rapid and reaches its maximum by the end of September. By the same date, chasmothecia form. The leaves of *Conyza canadensis* are characterized by local spots that do not cover the whole leaf. Mass fall of the affected leaves is usually not observed. There is no intensive development of the disease in the southeast of Kazakhstan.

On the leaf rosettes of *Oenothera biennis* L., powdery mildew (the causative agent *Erysiphe howeana* U. Braun) appears either in early June or in early August, depending on climatic conditions. The fungus does not form chasmothecia, but develops only in the conidial stage. By mid-September, the leaf rosettes of *Oenothera biennis* are usually completely covered with the white powdery mildew typical of this disease.

Leaves of amaranth (*Amaranthus retroflexus* L.) are usually affected by the causative agents of white rust, downy mildew and spots. The first symptoms of white rust (the causative agent *Wilsoniana bliti* (Biv.) Thines) appear on leaves in early July. With sufficient precipitation, the disease develops quite rapidly, reaching a maximum by mid-August.

Pathogenic mycobiota of drooping brome (*Anisantha tectorum* (L.) Nevski), wide spread in the territory of the Kazakhstan, numbers 6 species of fungi: agents of leaf rust, steam rust, smut, foliar blotches, powdery mildew. Among them *Puccinia recondita* Dietel & Holw. infecting leaves of host-plants, is the most harmful. The first symptoms of leaf rust appear in early May. Since *A. tectorum* is ephemeral species and ends its vegetation early, the development of the pathogen ceases in early or mid-June.

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THE EFFECTS OF OMNIVOROUS CARP (*CARASSIUS GIBELIO*) ON PLANKTON COMMUNITY AND WATER QUALITY IN SHALLOW AQUATIC ECOSYSTEM

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Different species of omnivorous fish can affect aquatic ecosystems, including water quality, by different ways. Our knowledge is limited on the effect of omnivorous Prussian carp (*Carassius auratus*), widely distributed and mass introduced invasive species in Belarus and in other European and Asian countries on competition between plankton and benthic algae. We conducted a 72-day outdoor experiment in mesocosms with and without prussian carp to examine whether this species inhibits growth of benthic algae stimulating the biomass of phytoplankton and increasing water turbidity (Figure). One-time input of nutrients had the sustained long-term effects (over 60 days) in mesocosms with Prussian carp. The presence of fish increased phytoplankton biomass and TSS and decreased light intensity and phytobentos biomass, measured as chlorophyll a, already at the beginning of our experiment. Thus the impact of omnivorous Prussian carp can shift competitive ability from benthic to plankton algae and contribute to eutrophication of water bodies.

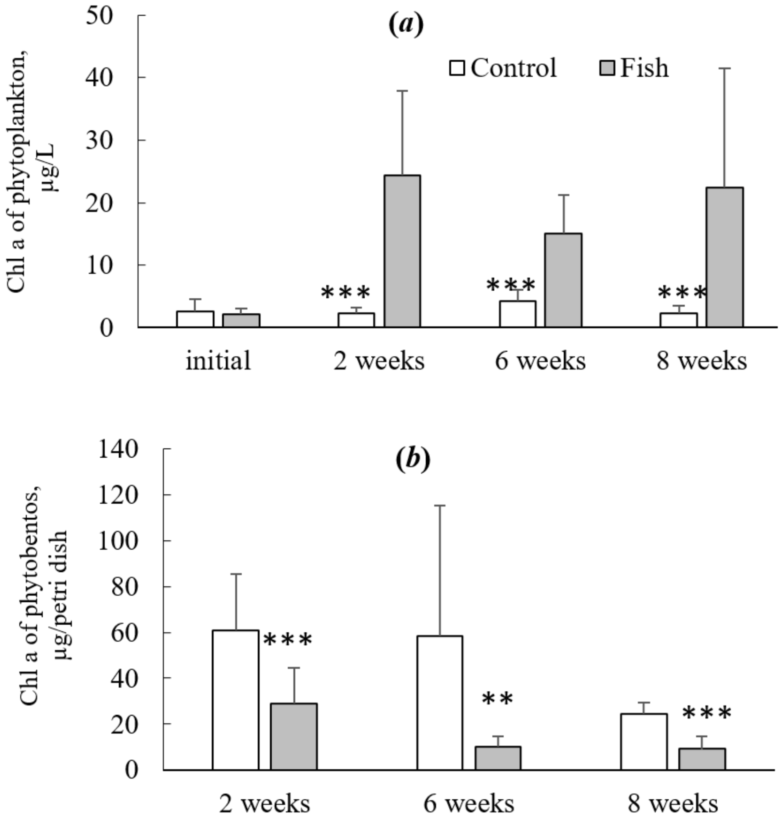

Figure. Planktonic algae (a) and benthic (b) algal biomass (chl *a*) in the control and fish treatments over time. Asterisks indicate significant differences (*p< 0.05, ** p< 0.01, ***p< 0.001). Bars indicate ±1SD.

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CURRENT DISTRIBUTION AND ECOLOGY OF THE POPULAR PET TERRAPIN (RED-EARED SLIDER, *TRACHEMYS SCRIPTA ELEGANS*) IN OUTDOOR WATER BODIES OF EURASIA

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Biological invasions are recognized as one of the global problems accompanying the development of human civilization. The red-eared slider, *Trachemys scripta elegans*, originates from North America. This freshwater terrapin is one of the most popular pet reptiles in Eurasia. Young red-eared slider individuals are small and brightly colored, making them very attractive for aquarists. However, these animals grow rapidly and large individuals require more space, are less pleasant, aggressive and prone to biting. Releasing them in a nearest water body is a common way to dispose of the annoying pet. This terrapin easily adapts to outdoor conditions, can reproduce and establish stable populations in regions with appropriate climates. Uncontrolled releases of this omnivorous animal into outdoor water bodies represents a serious conservational issue. To date, data on spatial expansion and invasion ecology of this reptile were not systemized in the most parts of Eurasia. We combined and analyzed our own original and literature data on the distribution and ecology of this terrapin throughout Eurasia in the past 50 years. The invasion of this reptile in outdoor water bodies first started in two distant locations of Eurasia and was later driven by numerous independent releases across the continent. The geographical expansion of this reptile gradually enlarged up to the present time and is continuing. For example, we recently detected this terrapin in eight "new" countries as well as several distant regions of Russia for the first time. Currently, the red-eared slider has been documented in natural water bodies in more than seventy countries of Europe and Asia. We analyzed and described differences in ecology of the red-eared slider in different parts of Eurasia and listed regions with a lack of appropriate information on the ecology for this subspecies. Records of successful reproduction coincide well with the calculated potential range based on climatic requirements in the native range. However, records with proven successful wintering have a much wider distribution. This invader provides an excellent but rare example of wide invasion without establishment of reproducing populations but rather through the recruitment of new individuals to add to the increasing pseudopopulations formed by multiple releases. Therefore, when planning measures for control of alien groups of the pond slider, the strategy against this invasive reptile must also take into account the geographical area of successful wintering even without reproduction.

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EFFECTS OF ZEBRA MUSSELS ON EFFICIENCY OF TRANSFER OF CARBON AND ESSENTIAL COMPOUNDS FROM PHYTOPLANKTON TO ZOOPLANKTON

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Efficiency of transfer of essential compounds including polyunsaturated fatty acids (PUFA), nitrogen and phosphorus from phytoplankton to zooplankton has a great impact on higher trophic levels. The bivalve *Dreissena polymorpha* (Pallas 1771) can significantly affect plankton communities (Baker et al., 1998; Karatayev et al., 2002; Wilson, 2003; Davies, Hecky, 2005; Dzialowski, Jessie, 2009; Wojtal-Frankiewicz, Frankiewicz, 2011; Sarnelle et al., 2012; Feneva et al., 2015, 2020 et al). However, the mechanisms of zebra mussels' effects are not completely understood. The goal of this work was to evaluate the effects of zebra mussels on the efficiency of transfer of carbon, total fatty acids (FAs), PUFA including eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids, nitrogen and phosphorus from phytoplankton to zooplankton. Efficiency of essential compounds' transfer was found as a ratio of secondary production to primary production.

In experimental mesocosms filled with water from a mesotrophic lake containing phyto- and zooplankton, we manipulated the presence/absence of zebra mussels. Zebra mussels increased primary production facilitating the growth of inedible large algae. As a result, zebra mussel decreased zooplankton production and biomass. Consequently, the mollusk reduced the efficiency of the transfer of carbon, total FAs, PUFA, nitrogen, and phosphorus from phytoplankton to zooplankton. Zebra mussels had different effects on the efficiencies of transfer of different essential compounds, specifically, they reduced efficiencies of transfer for carbon by 6 times, for EPA by 3 times, for DHA by 4 times, for total FAs by 3 times, for nitrogen by 6 times, and for phosphorus by 7 times relative to the control. Interestingly that zooplankton had higher contents of essential compounds relative to their contents in phytoplankton, thus mitigating the negative influence of zebra mussels on the quality of zooplankton as a biological resource for fish.

In conclusion, zebra mussels pose a more serious threat to freshwater ecosystems than it was thought before. Besides changing the taxonomic structure of phyto- and zooplankton communities, zebra mussels reduced the flow of essential compounds to higher trophic levels. We believe that the mechanism of accumulation of essential compounds by zooplankton partially alleviates the negative influence of zebra mussels on the quality of zooplankton as a resource for fish.

For details see: Sakharova E.G., Karpowicz M., Gladyshev M.I., et al. 2021. Effects of *Dreissena polymorpha* on the transfer efficiency of carbon, fatty acids, nitrogen and phosphorus from phytoplankton to zooplankton // Zhurnal Obshchey Biologii. № 3. P. 188–200. https://doi.org/10.31857/S0044459621030052

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LIFE HISTORY AND MODERN STATUS OF THE INVADER – RACCOON *PROCYON LOTOR* – IN THE CAUCASUS REGION

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We present consolidated information on the history of the formation of local populations, the modern distribution and some aspects of adaptation of the invasive raccoon *Procyon lotor* over a vast territory, which includes the south of the European part of Russia (North Caucasus), Azerbaijan, Georgia (western and eastern parts), Iran (Caspian region) and Armenia (northern regions).

In the Caucasus region, the raccoon (*Procyon lotor*) appeared 80 years ago, after introduction in Azerbaijan. Invader population developed intensively, and after the WWII almost 1,200 animals were exported from Azerbaijan to many regions of the North Caucasus, to Belarus, Kyrgyzstan, Uzbekistan and the Far East of Russian Federation. A stable meta-population was formed only in the Caucasus and adjacent territories. The distribution pattern of the raccoon in the region is changing rapidly. At the initial stage, these were several local populations within Azerbaijan and Dagestan. From Azerbaijan, the raccoon widespread to Iran, Georgia and Armenia.

The modern area is represented by four isolated "spots": the largest area is located along the coast of the Azov and Black Seas and occupies a significant part of the Krasnodar Kray. The second section is located along the coast of the Caspian Sea within Dagestan and north Azerbaijan with a westward extension along the Terek River. The third focus is located narrow along the southern macroslope of the Great Caucasus within Azerbaijan, Georgia and Armenia. The fourth focus located in the extreme south of Azerbaijan and in the adjacent regions of Iran.

Natural dispersion now continues along the coast of the both Black and Caspian Seas, as well as in the northern and southern directions. The development of some local populations occurs through repeated "explosions". The expansion of the aliens is facilitated by ecological corridors – river valleys, glades of power- and gaspipelines, along which the invaders penetrate the mountains to the upper border of the forest, and on the plains – into the zone of the forest-steppe and even the steppe. The most attractive for the invader are riparian habitats and mountain forests. The leading factor in the explosive development of populations is trophic. Local features in the dietary spectrum determine the physical condition of invaders: in the regions adjacent to the Caspian Sea the average body weight of raccoons more than in the Black Sea regions.

The maximum range of habitats' altitude is very wide: the lowest border is at the coast of the Caspian Sea (28 m below sea level). On the southern macroslope of the Caucasus the raccoon does not rise above 1500 m a.s.l., also on the northern side in some localities it is recorded up to 1500 m a.s.l. In east part of Caucasian distribution range (Dagestan), raccoons don't inhabit areas above 600-800 m a.s.l., which, presumably, is associated with severe climatic conditions.

With an increase in the number of population and expansion of the distribution range, the degree of synanthropization of the invader also increases.

In the Russia (six North Caucasian regions) and Azerbaijan, the raccoon officially is a hunting species. In last country now year-round hunting of raccoon was allowed.

We predict that in a few decades the disjunctive distribution range of *Procyon lotor* will transform into a "ring" around the Greater Caucasus ridge. We also expect significant raccoon expansion in both north and south directions. In the ecosystems of the Pan-Caucasus, the invader may become the most numerous carnivore, which has already become a reality in the Sochi vicinity and in the south of Azerbaijan.

For details see: Saveljev A., et al., Raccoon (*Procyon lotor*) in the Pan-Caucasus region (Russia, Azerbaijan, Georgia, Iran, and Armenia) // Beiträge zur Jagd- und Wildforschung, 2021. Vol.46. *in press*

EXPANSION OF *HARMONIA AXYRIDIS* (PALLAS, 1773) (COLEOPTERA: COCCINELLIDAE) TO THE EUROPEAN PART OF RUSSIA

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Harlequin, multicoloured Asian, or Asian ladybeetle *Harmonia axyridis* (Pallas, 1773) is one of the most famous invasive species of ladybirds (Coleoptera: Coccinellidae). The natural habitat of *H. axyridis* covers the following territories: North-Eastern and Central China, Mongolia, Korea, Japan, Northern Vietnam, North-Eastern Kazakhstan, in Russia—the Far East (including Sakhalin, Kuril and Shantar islands) and Southern Siberia. In Europe, invasive populations of *H. axyridis* were discovered in the early 2000s (the Asian ladybeetle was sold by various biological control companies from 1995 in France, Belgium and the Netherlands). It has spread very rapidly, particularly since 2002, and is now regarded as established in thirteen European countries. In the European part of Russia, the appearance of *H. axyridis* was observed from 2004–2006 in the territory of the Belgorod Region (2004) and Adygea (2006). In 2010, mass breeding of the species was recorded in Kaliningrad. The presence and reproduction of *H. axyridis* have been observed since 2011 on the Black Sea coast of the Caucasus and since 2012–2013 in the Krasnodar Territory. In 2019, *H. axyridis* was recorded in the Volga Region.

In the present days, *H. axyridis* is widely distributed through the European Russia (Figure), and it is known from the Astrakhan', Belgorod, Bryansk, Kaliningrad, Kaluga, Kursk, Lipetsk, Moscow, Nizhny Novgorod, Orenburg (Ilek vill., 2019), Oryol, Penza, Pskov, Rostov-on-Don, Ryazan', Samara, Saratov, Smolensk (Smolensk city, 2020), Tambov, Tver' (Tver' city, 2021), Tula, Vladimir (Vladimir city, 2020), Volgograd, Voronezh and Ulyanovsk oblasts, Krasnodar and Stavropol Territories, Adygea, Bashkir, Crimea, Chechen, Chuvash, Dagestan, Kabardino-Balkaria, Karachay-Cherkess, North Ossetia–Alania, Mordovia, Tatarstan and Udmurt Republics. In the present study, *H. axyridis* is recorded from the Orenburg, Smolensk, Tver' and Vladimir oblasts for the first time.

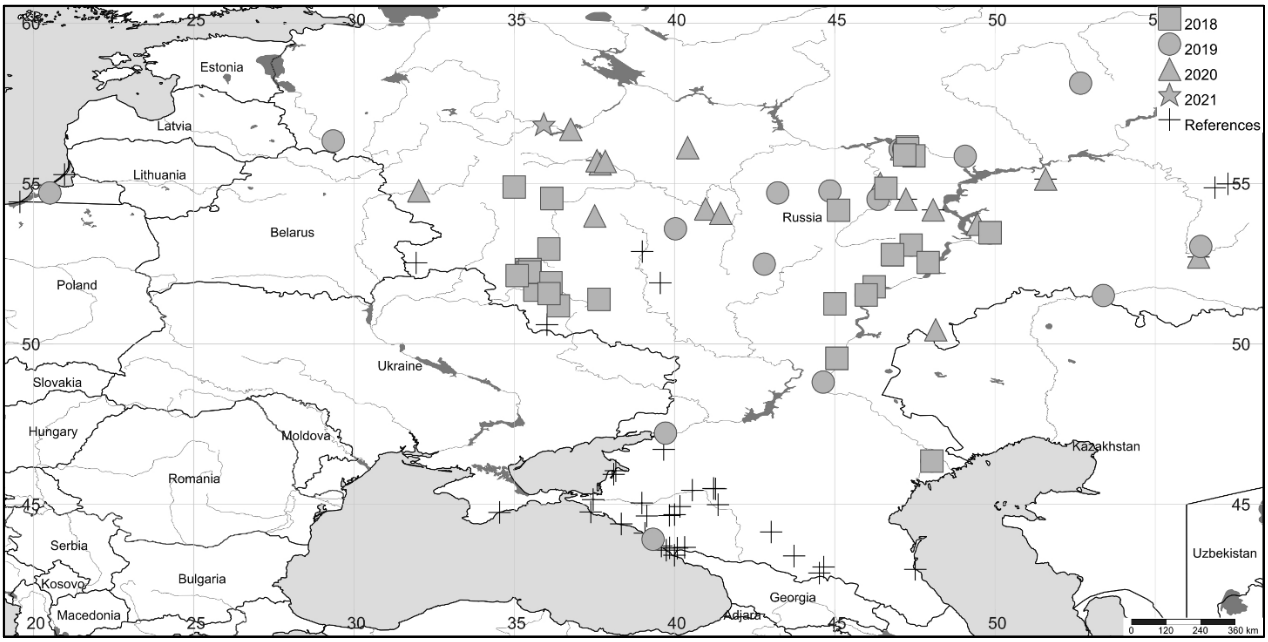

Figure. Expansion of *Harmonia axyridis* (Pallas, 1773) to the European part of Russia: squares – 2018 year, circles – 2019, triangles – 2020, star – 2021 (only new records for regions) and pluses – references data.

H. axyridis is a very polymorphic species with variations in the coloration patterns within a fairly broad range. Almost only European morphs (*succinea*, *spectabilis*, *conspicua*) were present in all the collections, the first of them numerically prevailed. The West Siberian morph *axyridis* was found only in Saransk and Kursk oblast. Apparently, the settlement of the European part of Russia is a spontaneous expansion of the species' range both from the West, which is confirmed by the findings of *axyridis* form, such morphs were previously known only from Western Europe, and from the south of Russia, where the strong point represented by local populations of *H. axyridis* introduced to the Caucasus play a significant role in the colonization of the species (primarily in the Volga Region).

ON THE DEVELOPMENT OF A PROTOCOL FOR SAMPLING AND ANALYSIS OF SHIPS' BALLAST WATER IN RUSSIA

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The transfer of water ballast by the commercial ships has negatively impact the biological resources of the Black Sea and the Sea of Azov, the health of humans, the environment and the economy. Successful introduction and establishment of organisms of phytoplankton, zooplankton and pathogenic bacteria by ballast water discharge in a new habitat is most likely to occur when such organisms are released alive and in high abundances. According to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (IMO) in the port-recipient should collection of plankton samples to assess compliance with the Regulation D-2. Therefore, monitoring of the plankton in ship's ballast water to be discharged in Russia and the establishment of protocols will be crucial for the future investigates of systems effectiveness evaluation of Ships' Ballast Water treatment in ports recipient. Currently, the protocol for sampling ballast water on territory of Russia does not have a complete description (Russian Maritime Register of Shipping, 2017). It is necessary to develop a protocol for carrying out the procedure for sampling ballast water for different types of vessels and their analysis for objects under the technical supervision of the Russian Maritime Register of Shipping.

Sampling of ships' ballast water is carried out using sounding pipes, manholes of ballast tanks and other. The protocol should note all available selection points on different types of vessels (tanker, cargo ship, etc.) and also specify additional information – the name and type of the vessel, date of construction, port of registration, total capacity and volume of ballast water, the recipient port of ballast water, location and type of access point for sampling, the capacity of the tank from which the samples were taken, volume of selected and filtered ballast water. The efforts of hydrobiological researchers should be aimed at solving the issues of adequate sampling with a representative sample and rapid determination of the viability of planktonic organisms in ballast waters. The preserved samples should be analysed after the live sample analysis was completed. Counts of biological organisms are do starting with the larger size plankton (x40 magnification). Then, plankton of a much smaller size are counted (x100–400 magnification). On board the vessel, for express analysis (microscopy) of phytoplankton and zooplankton samples from water ballast, we recommend using closed Sorokin chambers of the pencil case type of different volumes-1–5 ml (nanoplankton and protozoa), 10–20 (protozoal microplankton) and 30 ml (metazoal plankton). Regulation D-2 of the compliance standards (IMO, 2004) only requires a viability count that indicates whether there are more or less than 10 viable organisms of 10μm and 50μm minimum dimensions per cubic meter. For the express analysis of these groups of organisms in the ballast water of commercial ships, carried out by employees of the Authority port control on board the vessel, there is no need for a detailed assessment of the taxonomic composition, determination of morphometry, size and counting of the number of living hydrobionts of different taxonomic groups, as required by the IMO Convention. To our opinion, in decontaminated ballast water there should be 100% mortality of hydrobionts. The IMO documents (the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004) should include the correctness of the definitions of the number, size and taxa of viable phytoplankton and zooplankton organisms. Regulation D-2 of the Convention should include marine organisms size ranging from 2 to 10 microns, among which potentially dangerous species may occur. For effective decontamination of ballast water using Ultraviolet irradiation, it is necessary to additionally install systems of ships ' ballast water treatment on drain of the water discharge of ballast water from the ship in sea.

A formulated protocol could be used to enforce compliance to standards from the IMO as well as to enable the Russian territories to focus their resources on fewer vessels that are more likely to introduce alien, invasive species or harmful aquatic organisms and pathogens.

INVASION OF EMERALD ASH BORER IN ST. PETERSBURG AND ECONOMIC ASSESSMENT OF THE CONSEQUENCES

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The appearance of invasive species in forest and urban plantations often leads to catastrophic consequences. The problem of large-scale death of elms caused by the spread of Dutch elm disease associated with the reproduction of bark beetles (Coleoptera: Curculionidae, Scolytinae) is well known. In St. Petersburg (SPb), the city authorities responsible for landscaping and green spaces did not respond to the message made in 1995 about the appearance of this disease, and the mass death of elms began in St. Petersburg and its environs in 2000. On the territory of public green spaces 7789 dying and dead trees were cut down from 2013 to 2015 only. In total, the number of felled elms in 10 years has exceeded 20 thousand.

The death of ash trees in North America, and then in central and southern Russia due to the spreading of the Emerald Ash Borer (EAB) *Agrilus planipennis* (Coleoptera: Buprestidae) served as a signal for taking measures to limit the spread of the pest in far from all regions of Russia. Despite the real threat to the existence of ash – one of the key elements of landscape compositions in the parks of St. Petersburg, the appearance of EAB in the city in 2014-2016 (time of the appearance to be confirmed) passed unnoticed. However, when this pest was discovered in the fall of 2020, the administrations responsible for management of the city's plantations (Department of Gardening of St. Petersburg) and of the Peterhof State Museum Reserve (SMR) took prompt measures to localize the foci of the pest. Specialists from the St. Petersburg State Forestry University were involved in consultations and surveys of public plantings and plantations of the Peterhof SMR.

Several foci of EAB were found from September 2020 to April 2021 in public green spaces in the Petrodvorets and Nevsky districts of SPb located in opposite parts of the city. All the inhabited by EAB found trees (165 ash trees *Fraxinus excelsior* and *F. pennsylvanica* with a diameter of 6 to 62 cm) were cut down before the start of the vegetation season. The cost of removing one tree ranged from 3,4 to 18,0 ths rubles. The amount of compensatory landscaping by large-sized planting trees in the nursery high school excluding the cost of caring for each tree (5 ths rubles and more) varies from 15 to 40 ths rubles. The average value of the cost by large-sized planting for *F. excelsior* in SPb indicator is 27 ths rubles. The calculation of the total cost of losses, taking into account the diameters of the cut trees, showed that cutting down the municipal economy will cost 1 million 470 ths rubles, and compensatory landscaping at least 4 455 ths rubles. In total, the costs of the city will amount to at least 5 925 ths rubles or about 70 ths euros. This is a relatively small amount. However, it should be borne in mind that ash is one of the key species of urban landscaping and historical park ensembles of SPb, and EAB is a fatal pest of ash. The losses from the further spread of this pest can be comparable to the losses from the catastrophic spread of Dutch disease. The volume of economic losses due to the death of elms in St. Petersburg in 2001 - 2020 according to preliminary estimates, it exceeded 600 mln rubles or about 6.5 mln euros.

The measures taken give hope that the centers of the spread of EAB will be localized and the spread of the pest will be stopped. However, a significant number of ash trees are located in numerous parks, squares and random plantings along federal highways, on the territory of state museums-reserves, hospitals, educational institutions and other organizations not related to the management of the Department of Gardening of St. Petersburg. The control over the spread of pests in these plantations is often not carried out. The departmental fragmentation of the organizations responsible for plantation management raises serious concerns.

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INVASIONS OF PESTS OF TREES IN ST. PETERSBURG AND THE SURROUNDING AREA DUE TO CHANGES IN CLIMATE

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Invasions of dendrophagous insects and pathogenic fungi that have occurred in the last 30 years have resulted in the death of a significant part of the plantations in St. Petersburg (SPb) and its environs. The expansion of the range of elm bark beetles *Scolytus multistriatus* and *S. scolytus* found in SPb in 1997 (Mandelstam, 1998) and *S. pygmaeus* found in 2012 (Shcherbakova, Mandelstam, 2014) led to the spread of the Dutch elm disease and the almost complete death of elms in SPb. About 8 thousand trees were cut down in 2013-2015 only. *S. multistriatus* and *S. scolytus* were found even in the north of the Karelian Isthmus in Vyborg (Mandelstam and Selikhovkin, 2020). The appearance of Emerald ash borer *Agrilus planipennis* in SPb recorded in the fall of 2020 (Volkovich, Suslov, 2020), has already led to the felling of more than 160 trees of different ages. The range of the bark beetle *Ips amitinus* capable of producing outbreaks of reproduction, reached the northern border of the distribution of conifers by 2011 (Shcherbakov et al., 2013). At once three invasion species leaf mining moths from the family Gracillariidae: *Phyllonorycter issikii*, *Cameraria ohridella* and *Acrocercops brongniardella* appeared in SPb and the Leningrad region in the last two decades. These species were first recorded in SPb in 2002, 2013, and 2018 respectively. All three species are thermophilic, but nevertheless spread to the northern border of the range of their forage species, consistently expanding their ranges.

One of the key factors contributing to the expansion of the ranges of invasive species to the north may be climate warming, and in particular an increase in the sum of effective temperatures during the growing season and a decrease in the absolute value of minimum temperatures. The regression analysis of average temperatures for study of the nature of temperature changes in SPb over the past 120 years – from 1900 to 2020, was applied. Independently investigating the dynamics of the following indicators: the average annual (t_1), the average for the growing season – May-September included (t_2); minimum average annual (t_3). A simple deterministic linear model of temperature dynamics is adopted. The following model parameters were obtained: $t_1 = 0.72\ x + 5.14$; $t_2 = 0.51\ x + 14.44$; $t_3 = 0.02\ x + 0.50$.

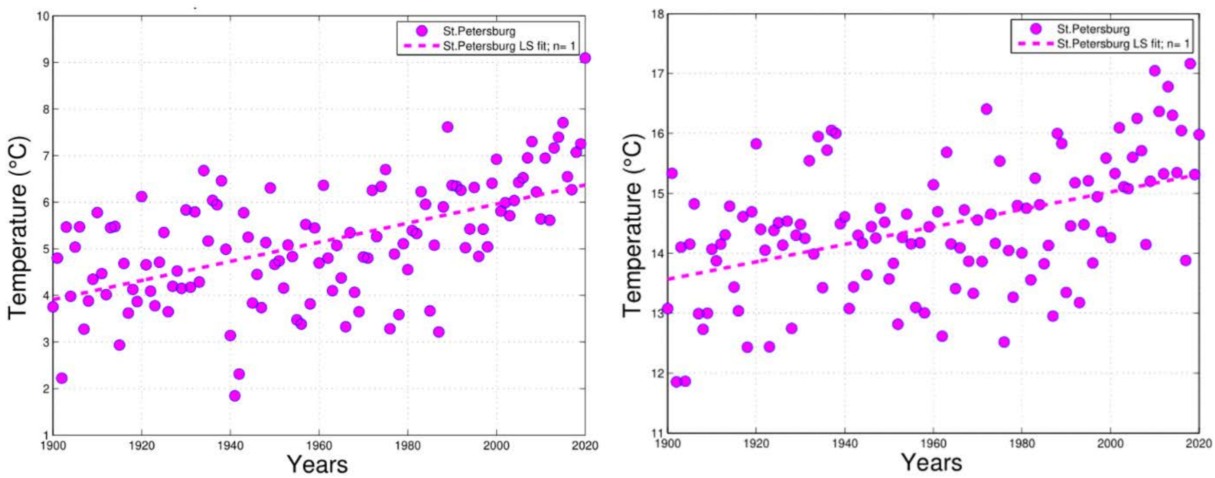

Figure. Long-term variation of the average air temperature in St. Petersburg; on the left part - for the year; on the right - for the growing season; dotted line - linear regression models

The three models show warming in St.Petersburg both in summer and in winter, reaching up to 2°C warmer than in 1900 (Figure).

The expansion of invasive ranges of dendrophagous pests to the north is an alarming trend. The results obtained suggest that climate warming is the most important factor contributing to this process.

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MAPPING INVASIVE *HERACLEUM SOSNOWSKYI* MANDEN WITH SATELLITE REMOTE SENSING FOR EUROPEAN RUSSIA: THE PRELIMINARY RESULTS

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Invasive species are of great concern globally; they reduce the quality of habitat, impact hydrological regimes, and negatively affect human well-being. Among invasive species in northern Eurasia is the *Heracleum sosnowskyi* Manden *or Sosnowskyi's hogweed (*further, *H. sosnowskyi),* which became widespread after 1990 due to reduced control of this species and which was included in the top 100 list of the most dangerous invasive species in Russia. Accurate and timely mapping of *H. sosnowskyi* is essential for successful control delineation of *H. sosnowskyi.* Unfortunately, though, there is no operational map of *H. sosnowskyi* available for such countries as Russia. At the same time, scientific literature and anecdotal evidence suggest *H. sosnowskyi* is common across as many as 40 Russian provinces (oblasts). Satellite remote sensing became a common approach to monitor vegetation, including invasive species, due to the ability of sensors to capture reflectances of vegetation in different spectras, repetitive observations, ability to cover large areas.

Here we present an approach to monitor *H. sosnowskyi* with freely available optical satellite data from Landsat-8 and Sentinel-2 A, B satellites and machine-learning classification methods. In our work, we take advantage of the distinctive phenology pattern of H. *sosnowskyi* across the year to separate *H. sosnowskyi* from other vegetation types. First, in the presented work, we introduce state-of-the-art of *H. sosnowskyi* mapping with satellite imagery and phenology of *H. sosnowskyi*. We then elaborate on mapping *H. sosnowskyi* with Landsat-8 OLI and Sentinel-2 A, B MSI satellite imagery and random forest machine-learning classifier for 2019 by bringing a case study of Moscow oblast in Russia. Also, we present our developed participatory method to collect training and validation data. Last but not least, we elaborate how the developed method can be translated to map *H. sosnowskyi* for entire Russia with cloud-processing platforms like Google Earth Engine and VEGA.

Our preliminary results on mapping *H. sosnowskyi* for Moscow oblast in Russia suggest widespread distribution of *H. sosnowskyi* with a concentration of *H. sosnowskyi* in the northern part of the oblast. Our results highlight an ability to produce *H. sosnowskyi* maps with plausible classification accuracies. This suggests about the applicability of the proposed method to map *H. sosnowskyi* with optical data like from Landsat-8 OLI and Sentinel-2 A, B MSI sensors.

ADVENTIVE FRACTION OF THE FLORA OF THE CITY OF KYZYL (REPUBLIC OF TUVA)

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The adventive fraction includes alien or invasive plant species that are unusual for the local flora, the appearance of which is due to direct or indirect human activity and is not associated with the natural course of phlorogenesis. With such a broad understanding, anthropophytes include complexes of species of different degrees of naturalization, introduced at different times (including archaeophytes), the primary range of which is located at considerable distances from the study area or is located in neighboring (contact areas, introduced accidentally or deliberately (including introduced species noted outside the culture) (Vinogradova et al., 2010).

An analysis of adventive alien species in terms of time and mode of introduction, the degree of naturalization into natural communities, taking into account life strategies and the place of their primary growth makes it possible to identify the direction of the dynamics of regional floras (Saksonov, 2005). Studying the main fragments of the history of the development of the territory of Tuva to the formation and study of the synanthropic flora, the following parameters of adventive species were identified according to the time of introduction: archaeophytes - species introduced in the period beginning in the first half of the 18th century (8 species). Hemykenophytes are species, the probable introduction of which occurred in the second half of the 18th century and continued until the beginning of the 20th century (23 species). Eukenophytes (neophytes) are species that appeared at a later time, associated with the activation of Russian foreign policy in Tuva and the beginning of the economic development of the territory (48 species). Archeophytes include the following species - *Avena sativa, Echinochloa crusgalli, Panicum miliaceum*. Hemykenophytes - these include species, *Avena fatua, Commelina communis*, etc. Eukenophytes (neophytes) - species (*Zea mays, Populus alba, Acer negundo,* etc.).

The analysis by the degree of naturalization is based on the classification of F.-G. Schroeder (1969), which has already become traditional and modernized, according to which we have identified 4 main groups: epecophytes, agriophytes, colonophytes and ephemerophytes.

In the adventive fraction of the city of Kyzyl, about half of ergasiophytes (species that have left the culture) - 40 species, xenophytes (accidentally introduced species) - 37 species. This fact is mainly associated with a wide variety of introduced species used in landscaping and in personal plots and often running wild in garbage places. According to the method of introduction, the following were distinguished: xenophytes (*Hordeum jubatum, Echinochloa crusgalli, Setaria viridis,* etc.); ergasiophytes - species introduced intentionally, mainly cultivated species, usually not found outside the culture or occasionally found in secondary habitats (*Populus alba, Lotus krylovii, Phacelia tanacetifolia,* etc.); xenoergaziophytes - the transitional group of species is represented by 4 species (*Portulaca oleracea, Melilotus officinalis, Triticum aestivum*).

Among the groups of species in terms of the degree of naturalization, the leading position is occupied by epecophytes (37 species) - alien species that actively disperse in disturbed habitats (*Axyris amaranthoides, Chenopodium album, Amaranthus albus,* etc.). Ephemerophytes (21 species) have a smaller share - fluctuating species that appear and disappear from time to time in local habitats (*Amaranthus blitoides, Zea mays, Rumex acetosella,* etc.). The third position is occupied by colonophytes (13 species) - species that are firmly entrenched in new habitats, but do not spread from them (*Armoracia rusticana, Populus alba,* etc.). Basically, these species are plants that have left the culture that form colonies in various economic territories. The most dangerous is the group of 10 agriophytes or invasive species (*Dactylis glomerata, Ulmus pumila, Humulus lupulus, Melilotus officinalis, Solidago canadensis, Xanthium strumarium, Arctium tomentosum,* etc.), which invade natural habitats and can displace native species.

DISTRIBUTION OF ALIEN FISH SPECIES IN THE ALAKOL BASIN

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In the period 1930–1990, intensive acclimatization of commercial fish species was carried out in the Alakol basin. After such events, the species composition of the ichthyofauna underwent significant changes, new species not characteristic of this basin appeared. Some acclimatized fish, as a result of the development of different reservoirs of the basin, gradually expanded their ranges and became one of the dominant species in the ichthyofauna.

As a result of studies performed in 2015-2020, it was found that the species composition of the ichthyofauna of the Alakol basin consists of 27 species from 6 families. Of these, 16 species are alien: common carp – *Cyprinus carpio* (Linnaeus, 1758), common goldfish – *Carassius auratus* (Linnaeus, 1758), silver carp – *Hypophthalmychthys molitrix* (Valenciennes, 1844), grass carp – *Ctenopharyngodon idella* (Valenciennes,1844), roach – *Rutilus rutilus* (Linnaeus, 1758), freshwater bream – *Abramis brama* (Linnaeus. 1758), white amur bream – *Parabramis pekinensis* (Basilewsky, 1855) stone moroko – *Pseudorasbora parva* (Temminck & Schlegel, 1846), sharpbelly – *Hemiculter leucisculus* (Basilewsky, 1855), rosy bitterling – *Rhodeus ocellatus* (Kner, 1866), eightbarbel loach – *Lefua costata* (Kessler, 1876), chinese false gudgeon – *Abbottina rivularis* (Basilewsky, 1855), eleotris – *Micropercops cinctus* (Dabry de Thiersant, 1872), pike-perch – *Sander lucioperca* (Linnaeus, 1758), amur goby – *Rhinogobius similis* (Gill, 1859), japanese rice fish – *Oryzias latipes* (Temminck et Schlegel, 1846).

Of the commercial alien species, freshwater bream, common goldfish, common carp, roach, and pike perch are widely distributed in all water bodies of the Alakol basin, with the exception of Zhalanashkol Lake. After acclimatization, grass carp and silver carp have become naturalised well in lakes Sasykkol and Koshkarkol and in the desalinated part of Alakol Lake. But, due to the lack of spawning grounds, these species could not form a large commercial herd and were gradually caught. In some publications, it was indicated that young individuals of these species were found singly in the eastern part of Alakol Lake.

At the moment, 9 non-commercial alien fish species have been registered in the Alakol basin: sharpbelly, chinese false gudgeon, stone moroko, eleotris, amur goby, japanese rice fish, rosy bitterling, eightbarbel loach and white amur bream. Among them, the stone moroko is a constant component of the shallow waters of the Alakol lakes and its additional system. Chinese false gudgeon, japanese rice fish and eleotris have now settled in many lakes and river channels of the delta Tentek river, but their numbers are quite small. The amur goby, according to the literature data, was recorded on the coast of the Koshkarkol Lake, in the open biotopes of Sasykkol Lake, and delta areas rivers of the Urzhar, Katynsu, and Emel. However, in our research in 2020, in the summer period, only 1 specimen of the amur goby was found in the middle reaches of the Emel River. A single example of sharpbelly was discovered within the stomach of a pike perch in 2000 within the eastern portion of Alakol Lake, after that, it was not found. Eightbarbel loach was first caught in June 2015, and white amur bream in July 2020 in the middle reaches of the Emel River. In 2016, the rosy bitterling was caught in the southern shallow part of Alakol Lake. The greatest diversity and density of juvenile alien species is observed in the Emel River originating in the People's Republic of China. Thus, for the Alakol basin, the main source of alien fish species is currently the transboundary Emel River.

The number of these non-commercial fish in the Alakol basin is small. Thus, the existing fish community prevents the introduction of new species.

DIFFERENCES IN PHYSIOLOGICAL PARAMETERS OF TWO *DREISSENA* SPECIES EXPOSED TO HAZARDOUS SUBSTANCES (Cu, TBT)

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The studying of the effects of priority organic substances included in the list of the some main indicators of HELCOM (an intergovernmental organization bridging policy and science on matters related to the environment of the Baltic Sea). The overall goal of Project ER90 HAZLESS (the Estonia-Russia Cross Border Cooperation Programme 2014-2020 for the period 2014-2020) is the adaptation and implementation of uniform biological indicators for assessing and monitoring the state of the environment in the eastern part of the Gulf of Finland. The main tasks of the Project include the measurement of priority hazardous substances (HS) from the HELCOM list and the study of the effects on the benthic invertebrates from the Baltic Sea of certain HS. The knowledge about the level of HS and application of the most advanced methods for assessing the effects of HS may provide useful tool for regional monitoring of the environmental state in the Baltic Sea and other regions. The bivalve molluscs *Dreissena polymorpha* had settled in the eastern part of the Gulf of Finland many times ago, but there is no clear information about the naturalization of *D. bugensis* (beside rare records).

This work aimed to conduct a comparative the possible effects of various hazardous substances (heavy metals and organotin) on the physiological parameters of two species of dreissenids (*D. polymorpha* and *D. bugensis*). We studied bioaccumulation and effects after short (96 h) and long-term exposures (40 days) to tributyltin (TBT, 10 - 100 ng/L) and copper (Cu, 0.05 – 5 mg/L). The several endpoints (survival, condition index, respiration and heart rates, and biochemical parameters) were estimated in exposed and control mollusks TBT bioaccumulation has been found in zebra mussel tissues up to 125 ng/kg dry weight.

Results showed differences in reaction of studied species. The survival of *D. bugensis* (70%) was lease then *D. polymorpha* (95%) at concentrations of more than 2 mg/L Cu. With the increase of TBT and Cu concentrations, oxygen respiration rate increased in *D. bugensis* and decreased in *D. polymorpha*. Oxygen consumption of *D. bugensis* was higher in comparison with *D. polymorpha*.

The recovery time of heart rate (Trec) of mollusks after stress to the background level is used to diagnose the health status of animals. Increase in water temperature and exposure to the air for 1 h was used as short-term stress. During heating, maximum heart rate (up to 50 bpm) was observed in *D. polymorpha*, while it was less than 33 bpm in *D. bugensis*. The heart rate recovery increases at a tributyltin concentration > 10 ng/L after 40 days of exposure.

D. bugensis turned out to be less resistant to the effects of pollutants in comparison with *D. polymorpha*. The different responses to environmental factors in the two species of dreissenids may be the reason for the limitation of their distribution.

Thus, short and long-term exposure to Cu and organotins were affected on the physiological characteristics of *D. polymorpha* and *D. bugensis* with changes in heart rate and a decrease in resistance to stress.

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ACTUAL STATUS OF *ARMERIA VULGARIS* L. S.L. IN THE WESTERN PART OF RUSSIA

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Western populations of *Armeria vulgaris* L. s.l. (Kaliningrad, Leningrad, Pskov, Novgorod, Smolensk, Kaluga and Bryansk regions) are included in the Red Data Book of Russian Federation. We have analyzed the places of growth and the dates of findings of this plant in the western part of European Russia and in the neighboring countries (up to Poland and Ukraine). Based on our analysis, we conclude that this species is an alien in the western part of Russia, except for the Kaliningrad region.

There were several different ways for this species to join the flora of Russia:

1) as a decorative cultivated plant (Khmara village, Pochinok district, Smolensk region; Pechory town, Pskov region; Pskov city);

2) with sand ballast of Scandinavian and German merchant sailing ships (Novaya Ladoga town, Leningrad region);

3) near the railways and highways, on which the supplies for the German army were transported in 1942–1943 (Saint Petersburg–Warsaw railway: near the stations of Varena-1, Alitus district, Republic of Lithuania; Pytalovo, Pskov region; and Tolmachevo, Luga district, Leningrad region; Bryansk–Dudorovsky railway: near the station of Tereben', Khvastovichi district, Kaluga region; Moscow–Warsaw highway: near the villages of Koski and Staroe Kurgan'e, Roslavl' district, Smolensk region);

4) on the positions occupied by the German troops in 1942–1943 or in the vicinity of these positions (on the defense line "Hagen": near the villages of Kuz'minichi, Kuybyshev district, Kaluga region; Kuyava, Lyudinovo district, Kaluga region; and Ol'shanka, Dyat'kovo district, Bryansk region; near Demyansk town, Novgorod region; near Karachev town, Bryansk region);

5) in the places of anti-partisan actions of the German army (between the villages of Vysokaya and Krasnoe, Ugra district, Kaluga region; near the village of Tereben', Khvastovichi district, Kaluga region; near the village of Kholmetsky Khutor, Brasovo district, Bryansk region).

HIBERNATION PATTERNS OF THE ALIEN OAK LACE BUG *CORYTHUCHA ARCUATA* (SAY, 1832) (HETEROPTERA, TINGIDAE) IN DIFFERENT ALTITUDINAL ZONES OF THE NORTHWESTERN CAUCASUS

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Hibernation of *Corythucha arcuata* (Say, 1832) in the Northwestern Caucasus was studied in the altitude range of 19–1950 m above sea level (farther – m). The preferred biotopes and stations, the occurrence of colonies, the ratio of ♀♀/♂♂, their mass and mortality were taken into account. In 2018–2021, 87 series of 11.6 thousand imago were collected under the bark of different tree species. In 2021, wintering features were investigated on three altitude profiles in the valleys of Kurdzhips, Belaya, Ubin, and Wulan rivers (34–1785 m). Mt Gebeus (05.03.2021): steep northern slope of the summit, 694 m, beech forest, 31% ♀♀, mortality ♀♀ 25%, ♂♂ 14%; south slope of the summit, 529 m, oak forest, 49% ♀♀, mortality ♀♀ 10%, ♂♂ 14%; south slope foot, 196 m, oak forest, 27% ♀♀, mortality ♀♀ 13%, ♂♂ 14%; valley at the southern slope, 34 m, oak forest, 69% ♀♀, mortality ♀♀ 4%, males ♂♂ 9%. Bugs prefer the trunks of *Acer trautvetteri* Medw., *Carpinus betulus* L., *Quercus* spp. Mt Sober-Oashkh (01.04.2021): edges at flat top, 711 m, oak-hornbeam forest, 43% ♀♀, mortality ♀♀ 32%, ♂♂ 24%; steep southern slope, 632 m, oak forest, 48% ♀♀, mortality ♀♀ 13%, ♂♂ 7%; steep northern slope, 560 m, oak-hornbeam-beech forest, 38% ♀♀, mortality ♀♀ 20%, ♂♂ 0%. Adults prefer *Carpinus* and *Quercus*. Belaya river valley (3–12.02.2021): Azish Pass, 1785 m, beech-fir forest, 44% ♀♀, mortality ♀♀ 60%, ♂♂ 80%; Azish-Tau Mt Range, 1460–1151 m, beech-fir forest, 17–31% ♀♀, mortality ♀♀ 53–21%, ♂♂ 60–32%; cuesta rocks, 954 m, oak, 39% ♀♀, mortality ♀♀ 23%, ♂♂ 4%; river bottomland, 431 m, oak forest, 58% ♀♀, mortality ♀♀ 0%, ♂♂ 0%; 111 m, oak forest, 57% ♀♀. Guama Mt Range, 1171 m, steep southern slope, oak, 36% ♀♀, mortality ♀♀ 6%, ♂♂ 2%; sloping northern slope, 1133 m, hornbeam-beech forest, 29% ♀♀, mortality ♀♀ 30%, ♂♂ 4%; 726 m, oak-hornbeam forest, 44% ♀♀, mortality ♀♀ 13%, ♂♂ 3%; 458 m, oak forest, 53% ♀♀, mortality ♀♀ 12%, ♂♂ 7%.

Table. Winter population structure of *Corythucha arcuata* in the Northwestern Caucasus

Altitudinal zones (m above sea level)	Medium ♀♀ portion, November–April (%)				Studied samples / adults specimens (n)
	2018	2019	2020	2021	
Mid mountains, 901–1800	–	36	–	35	17 / 622
Low mountains, 151–900	56	67	50	46	27 / 1262
Foothills, 71–150	63	87	66	58	32 / 8612
Plains, 11–70	–	65	64	72	7 / 510
Maritime biotopes, 6–100	51	–	–	79	4 / 644
Maritime biotopes, 101–400	–	–	–	67	2 / 521

In oak forests, the largest groups of bugs winter under the bark of recently dead trees of *Ulmus*, *Carpinus*, *Crataegus*, and *Castanea*. In the midlands (fir-beech forests) rare individuals prefer a lagging bark on the trunks of *Acer trautvetteri*. In the parks of the forest-steppe zone (Krasnodar) they winter under the bark scales on *Gleditsia triacanthos* L. and *Platanus orientalis* L., without forming large aggregations. In all biotopes bugs are rare on the trunks of *Fagus orientalis* Lipsky, *Salix caprea* L. and especially *Fraxinus* spp., but even in oak trees they winter in the layers of bark of *Pinus sylvestris* L. The mortality of imago in wintering places by April constitutes 3–60% in ♀♀ and 2–80% in ♂♂. In the most of the samples studied (77% for ♀♀ and 85% for ♂♂) it does not exceed 25%. Maximum mortality is recorded on the trunks of *A. trautvetteri* near the upper boundary of the forest. The ratio ♀♀/♂♂ and their mortality depend on the altitude and exposure of wintering stations. Even in the lowlands ♂♂ prevail on the mountain summits, choosing watersheds and their northern slopes. The main portion of the third and fourth ♀♀ generations (58–87%) hibernates in the lowlands of the northern macroslope, where they concentrate in forests dominated by *Quercus* and *Carpinus* as early as September (see table), preferring edges and open woodlands.

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ON THE POSSIBILITY OF USING *SOLIDAGO CANADENSIS* AS A SOURCE OF GREEN PESTISIDES

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North American species *Solidago canadensis* L. from the *Solidago* subsect. *Triplinerviae* is one of the top 100 most aggressive invasive species in Europe. *S. canadensis* is well known for its medicinal product in Europe: it is part of the so-called Herba Solidaginis. This preparation is used to treat disorders of urinary tract, prostate and kidney. However, the resource potential of this species is not limited only to phytotherapeutic use. Goldenrod leaves and flowers are known to contain essential oils (EOs). These are complex mixtures of volatile compounds and generally contain twenty to sixty individual compounds in different concentrations. They are lipophilic in nature and have density lower than water. These interfere with basic metabolic, biochemical, physiological and behavioral functions of insects. Several essential oils and its constituents have been established for their repellent, antifeedant, ovicidal, oviposition inhibitory and developmental inhibitory activities in insects. These insecticides probably interfere with the respiratory and nervous system of the insect to exert its actions. These essential oils provide an alternative source of insect control agents because they contain a range of bioactive chemicals, most of which are selective and have little or no harmful effect on the environment and the non-target organisms including human.

Analysis of the essential oil content in the generative and vegetative organs of *S. canadensis* plants showed that the leaves contain up to 0.7% of essential oil, and the inflorescences produce the maximum amount of essential oil – up to 0.9%. In the composition of essential oil 63 components were identified. Mono- and sesquiterpene hydrocarbons were dominant in all the oil samples. Among the monoterpenes dominated α- and β-pinene, β-myrcene, limonene and bornyl acetate; sesquiterpenes – germacrene D, α- and β-caryophyllene, β-elemene. The remaining components of these classes were encountered in small amounts. Within a vegetative phase (before flowering) the major components of essential oil of leaves are α-pinene – 28.1%, germacrene D – 39.2%, bornyl acetate – 7.3%, limonene – 7.0%, β-myrcene – 7.3%. The inflorescences contain 0.9% essential oil and the major component is α-pinene – 61.2%, bornyl acetate – 13.7% and limonene – 8.5%.

Germacrene D is a sesquiterpene, it is recognized as an important sexual stimulant for males of *Periplaneta americana* L. and it is recommended as a useful compound for pest control. Bornyl acetate is an ester of monoterpenoid borneol, which has a camphor smell. This compound is used by some insects, such as *Corythucha marmorata* (Uhler) (Hemiptera: Tingidae), as a source of sex pheromones. Monoterpene α-pinene has allopathic and antimicrobial properties. In addition, the presence of α-pinene, bornyl acetate, and germacrene D as the main components in the essential oil samples makes it possible to recommend these essential oils for the control of plant pathogens such as *Botrytis cinerea*, *Aspergillus niger*, and *Aspergillus tubingensis*.

The effectiveness of botanical pesticides based on essential oils depends on many factors, such as the method of application, the temperature after application, in particular, the chemical composition and the ratio of the main components, can exhibit both synergistic and antagonistic relationships. Thus, according to literature sources, the essential oils of *S. canadensis* leaves is toxic to *Culex quinquefasciatus* and adult *Musca domestica*, and the flowers of *S. canadensis* are highly toxic to *Spodoptera littoralis* (Benelli et al., 2019). In general, it is expected that essential oils *S. canadensis* are harmless to pollinators and natural predators such as honey bees and ladybug beetles, as goldenrod is an important source of nectar for honey bees. Therefore, this invasive plant can be an ideal bioresource that can be used for the production of green pesticides.

PREDICTING RANGE EXPANSION OF INVASIVE CTENOPHORE *MNEMIOPSIS LEIDYI* A. AGASSIZ 1865 UNDER CURRENT ENVIRONMENTAL CONDITIONS AND FUTURE CLIMATE CHANGE SCENARIOS

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Since the late 1990s, global warming has increased especially in Eurasia. With the temperature rising, the harmful invasive species such as «ecosystem engineer» *Mnemiopsis leidyi* spread into the seas of Eurasia and continues expanding around the world. Based on field data we defined the ranges of key environmental parameters (SST, SSS and Chl concentration) required for *M. leidyi* occurrence, reproduction and population growth in Eurasia. First, we evaluated the parameters separately and plotted global climatology of each of them for *M. leidyi* reproduction conditions. Next, we combined all parameters and determined the areas sufficient for *M. leidyi* occurrence, reproduction and sterile dispersal. Our results based on climatological data match well with field data on occurrence and reproduction and confirm the areas of its establishment in Eurasian seas. Since this climatological approach was successful, we extended it to the global scale. Results demonstrate the ability of *M. leidyi* establishment worldwide both at present and in future in the case of global warming prolongation. Model assessments predict accelerated SST rise in the Northern Hemisphere. As a result, waters previously too cold for M. leidyi reproduction could become favorable, which is especially true off the Arctic coasts of Eurasia. These areas in summer and autumn are expected to be much wider and extend closer to the North Pole. It is important to point out that all *M. leidyi* habitats including native, recipient and prospective ones are situated in shallow coastal areas and inland water bodies (semi-closed and closed seas, bays, lagoons, fjords). Equally important is that the local currents can provide only the relatively short distance of *M. leidyi* transport while shipping acts as the major vector.

CLIMATOLOGY-BASED ASSESSMENT OF CTENOPHORE *BEROE OVATA* BRUGUIÈRE, 1789 ROLE IN CONTROL OF INVADER *MNEMIOPSIS LEIDYI* AGASSIZ, 1865 POPULATION IN THE SEAS OF PONTO-CASPIAN BASIN

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In this work we intend to identify the role of B. ovata as a regulator of *M. leidyi* populations in former Ponto-Caspian region (Black, Azov and Caspian seas) and assess its ability to spread and establish further in these seas to control *M. leidyi* abundances. Based on the field data for both ctenophores, coupled with environmental climatological data, we intend to specify conditions, favorable for their reproduction and growth. Thus, the high priority goal of the paper is to obtain information on the prospective recipient areas, where *B. ovata* will be able to control *M. leidyi* population, including the situation of drastic climate changes.

The rectangular region covering the Black, the Azov and the Caspian seas was chosen for the climatology data extraction and further analysis. For this region monthly climatology of surface temperature (SST), salinity (SSS) and chlorophyll (Chl) from various observation databases have been considered for the period from the January 2003 to January 2019. Monthly average spatially gridded (L3) global NASA skin SST product maps (4km resolution) were derived from the Moderate Resolution Imaging Spectroradiometer (MODIS Aqua v2019) in the mid-infrared region (3.8-4.1 um) of wavelength channels at night-time. Total Chl data product (in mg m-3, 4km resolution), indicating the concentration of the photosynthetic pigment chlorophyll a, was generated by the NASA Ocean Biogeochemical Model (NOBM) based on data assimilation of remotely-sensed chlorophyll a fluorescence. The both SST and Chl data products have been extracted from the GIOVANNI database collection. Objectively analysed monthly climatology of SSS have been taken from World Ocean Atlas 2018 database (WOA2018) with ¼° resolution. SSS are the objectively interpolated mean fields at standard depth levels for the World Ocean.

Regridded climatology fields are considered only with respect to the key ranges favourable for *M. leidyi* and *B. ovata* reproduction conditions for SST, SSS and Chl obtained from numerous in-situ observations listed in this work. The maps of duration of reproduction conditions during a year, of annual mean Chl in areas of reproduction as well as their changes due to the various climate change scenarios will be analysed in this work.

SPREADING PECULIARITIES OF THE ALIEN SPECIES *AMORPHA FRUTICOSA* L. IN THE KUBAN RIVER DELTA

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The problem of invasions of alien organisms and a decrease in the biodiversity of natural ecosystems is currently extremely relevant. In many cases, invasive species significantly transform the structure of biocenoses, and their appearance has global ecological, economic, and sometimes social consequences.

In the North Caucasus, the basin of the river Kuban is the largest in terms of the size and capacity of the watercourse, the total length of the river is 870 km, and its catchment area is 57,900 km^2. The Kuban is experiencing a strong anthropogenic load, affecting the state of all components of ecosystems, including the vegetation cover, which is characterized by synanthropization processes.

Within the Krasnodar Territory, in the floodplain, mixed communities of tree and shrub plants are described, which are outliers of forests that occupied vast areas on the banks of the Kuban. At present, fragments of forests have been preserved mostly on the right bank of the Kuban. The transformation of large landscapes in the river basin and recurring floods have affected the composition and structure of the flora. In the riverbed part of the floodplain, there are mixed forests of willows and poplars, less often - maple. The central and near-terrace parts are characterized by mixed oak forests, as well as spontaneous tree communities formed by self-seeding of various forest reclamation species. A significant role in their formation is played by adventive elements of the flora: *Robinia pseudo-acacia* L., *Gleditsia triacanthos* L., *Acer negundo* L., *Ailanthus altissima* (Mill.) Swingle, *Amorpha fruticosa* L., etc.

A serious threat to biodiversity is posed by the dispersal of the false indigo-bush *Amorpha fruticosa* L., *Fabaceae*, whose cenopopulations were recorded in 72 % of the surveyed floodplain communities. This shrub is 2 - 5 m high, an introduced species of North American origin. It is a valuable decorative, medicinal, fodder, melliferous and phytomeliorative plant.

In the Krasnodar Territory, from the middle of the 20th century, *A. fruticosa* has been used in landscaping of settlements, forest protection cultivation, and strengthening the banks of watercourses. So, with the expansion of the rice irrigation network in the Krasnodar Territory, *A. fruticosa* was used to fix the banks of the main irrigation canals. Here, the plant, as a species with a high invasive potential, quickly occupied the territory, completely or partially displacing the moisture-loving apophytes. Along the banks of the canals, *A. fruticosa* often forms monodominant communities, its populations being fully membered, the plants bloom and bear fruit under local conditions. The spread of the species by seeds with the waste waters of the rice irrigation system ensured its “escape from culture” and its settlement along the banks of the Kuban and the Protoka rivers, as well as along the banks of watercourses connecting the estuaries of the Azov Sea. In near-water communities of the floodplain of the Kuban *A. fruticosa* prefers open and shaded habitats, in depressions it spreads to shallow water, and is also found on meander scars and spaces between them.

From the point of view of the existing classification of anthropochores, according to the time of introduction, the species belongs to neophytes (introduced in the recent past), according to the method of immigration it is an ergasiophyte (“fugitives of culture”). The following biological characteristics of the species determined its distribution from culture: a wide ecological amplitude, high competitiveness in various habitat conditions, active vegetative reproduction, high seed productivity. These characteristics ensured the introduction of *A. fruticosa* into the undergrowth of willow and poplar forests of the Kuban. In the lower reaches of the river (near the city of Temryuk), the species forms monodominant phytocenoses in shallow water and directly near the water, excluding the development of natural coastal water communities of hygro- and hydrophytes. Under these conditions, an unusual fact was also noted - a change in the life form of the plant. In addition to shrubs, the cenopopulation included *A. fruticosa* trees about 6 m and with a trunk diameter of up to 15 cm. The decrease in the species diversity of riverine communities is possibly compensated for by the high bank-fixing ability of *A. fruticosa*, which has a well-developed tap root system.

Obviously, along with the inventory of the adventive flora of the region, an important stage in the study of adventive species should be the consideration of their population ecology, which implies the identification of adaptive capabilities at the population level (self-maintenance mechanisms, age structure, vitality, ontogenesis multivariance, relationships with consorts, allelopathic manifestations, etc.).

ACER NEGUNDO L. MONITORING IN THE RIBBON PINE FORESTS OF ALTAI KRAI

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When studying the ecological consequences of invasions, it is important to study the disturbance of successional processes in the forest communities by alien species, which leads to a decrease in successional variability, loss of habitats, and species diversity. The most aggressive invasive species in terms of ecological and economic consequences, ranking first in Russia, is *Acer negundo* L. The introduction of *Acer negundo* changes the natural course of the secondary succession.

The mechanism of the species introduction into the pine forests of Altai Krai was determined for the first time in Siberia through the study of the *Acer negundo* influence on the phytocoenotic structure, phytodiversity, and the properties of ecotopes. The successional mechanism with the participation of this invasive species in the ribbon forests of the forest-steppe and steppe natural and climatic zones involves the introduction of the alien transformer ash-leaved maple species at precisely the initial stages of reforestation successions. In its turn, the species can delay the successional process and form long-term communities, which are a springboard for the invasion persistence. At the same time, the communities dominated by *Acer negundo* will be characterized by low species richness, suppression of the undergrowth, a high level of synanthropization, ranges from several square meters to several hectares, and a long lifespan (more than 10 years).

Based on the forest taxation materials within the framework of forestry management of forest districts and a number of field studies in 2019-2020, it was determined that *Acer negundo* grows throughout the Barnaulsky ribbon pine forest, but is characterized by various frequency and abundance in its different parts.

The phytocoenotic conditions for the introduction of *Acer negundo* in the Barnaulsky ribbon pine forest are predetermined by the following factors:

1) anthropogenic transformation of the ribbon forest phytocoenoses. The introduction of *Acer negundo* is facilitated by felling, littering, and mechanical destruction of the soil and vegetation cover, since the light and mineral regimes change, and the plant species typical for the initial community disappear. In some habitats, more often in the inter-ridge depressions, pure maple forests are formed;

2) a vast network of roads in the ribbon forest becomes a corridor, especially near cities and villages, along which the invasive transformer species *Acer negundo* gets from settlements and forest edges to felling sites. There, depending on the degree of the soil and vegetation cover disturbance, the degree of moistening in the habitat, it becomes a dominant or an ecosystem engineer of an invasive community or a transformed community, changing the course of natural and anthropogenic secondary successions in the ribbon pine forests of Altai Krai;

3) in the southern part of the Barnaulsky ribbon pine forest in the most unfavorable for the invasion conditions of the dry steppe, *Acer negundo* settles in deep roadside ditches where water accumulates, or on the road slopes bordering on carrs. In addition, branches subfreezing and a sprouting effect are observed here. The ash-leaved maple has the form of a multi-stem tree in the overwhelming majority of cases.

The biological and structural assessment of the *Acer negundo* populations in the Barnaulsky ribbon pine forest demonstrated high rates of variation in the *Acer negundo* populations in terms of its development degree, including the parameters of the first order branches development indicating high plasticity of the species and its adaptability to various environmental factors. It was revealed that the abundance of *Acer negundo* and its role in the formation of the forest understorey are reduced when moving from the north to the south along the Barnaulsky ribbon pine forest. The populations of *Acer negundo* are normal almost throughout the entire length of the Barnaulsky pine forest, except for the extreme south (Uglovsky district), where the population of *Acer negundo* is invasive.

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MUSCLE TREMATODE INFECTION OF ALIEN CYPRINIDS IN THE BASIN OF THE MIDDLE OB (SIBIRIA, RUSSIA)

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Natural foci of opisthorchiasis are located near the Ob, Irtysh, Ural, Volga, Kama, Don, Dnieper, Northern Dvina and Biryusa rivers. The world's largest focus of opisthorchiasis caused by *Opisthorchis felineus* Rivolta, 1884, is associated with the Ob-Irtysh basin. Almost all the territories adjacent to this basin are unfavorable for opisthorchiasis. The Tomsk region occupies one of the leading places in terms of population infection with cat fluke. In the Ob-Irtysh basin, the main carriers of cat fluke metacercariae are cyprinid fish – mainly objects of industrial and amateur fishing: ide, dace and roach. Along with this, the range of hosts-carriers of *O. felineus* metacercariae is expanding as a result of the introduction of cyprinids from other water basins of Russia, which were not previously found on the territory of Siberia. In the Middle Ob basin in different years of the XX century, three species of cyprinid fish were introduced, and later naturalized. Bream, starting from the 30s, settled throughout the Ob-Irtysh basin. Currently, it reaches a large number, in the Tomsk region one of the most important commercial species (the share in the total catch is up to 18-20 %). Bleak was first note for Western Siberia in 1973 in the lake Khoroshee (Ob River basin). It quickly became a numerous species, first recorded in the Tomsk region since the beginning of the 90s. It has no commercial significance, it is an object of amateur fishing. Sunbleak in the reservoirs of Siberia is an accidental invader. It was first noted by Krivoshchekov (1973), penetrated into the rivers of the Ob basin during the descent of carp ponds. Currently, sunbleak is widely distributed in the Ob River basin, mainly in floodplain lakes, where it reaches a high number.

Studies on fish infestation with *O. felineus* metacercariae in the Middle Ob basin were started by S.D. Titova from 1936 (publications 1946-1965), then continued by B.C. Myasoedov (1953-1960) and T.A. Bocharova (1971-2005). According to T.A. Bocharova (2007), larvae of cat fluke were found only in ide, common dace and roach, and were not observed in the muscles of the pike, sunbleak, common bleak, bream, gudgeon, lake minnow, Prussian carp, perch and zander. We have been studying the infestation of fish since 2016, including alien species. We examined 554 fish specimens, including bream - 145 specimens (Ob River), common bleaks - 274 specimens (river Tom), sunbleak - 135 specimens (110 from a floodplain lake, 25 specimens from a continental lake, the Tom river basin). Our studies expanded the range of hosts of metacercariae to include all three alien species. Extensiveness and intensity of infestation of bream and common bleak from 2016 to 2018 was low, but in 2020 there was a sharp increase in both the extensiveness and the intensity of infection (common bleak). Infection of sunbleak from the floodplain lake is high. The infection rate in 2020 is significantly higher than in 2021 (Table). Larvae of trematodes were not found in the muscle tissue of the sunbleak caught in the mainland lake. Thus, we have identified the infestation of alien cyprinid fish species in the basin of the Middle Ob. In different years, the infestation can vary significantly, especially for short-cycle fish species. Infection rates may be local, especially in isolated water.

Table. Indicators of infestation of alien cyprinid fish species, Middle Ob basin

Species	Year	PI, %	II, ind.	IA, ind.	Infected number	Total number
Abramis brama	2016	8.69	1.50 ± 0.5 (1–2)	0.13	2	23
	2017	14.28	1	0.14	1	7
	2018	0.00	0	0.00	0	115
Alburnus alburnus	2016	2.56	1	0.03	5	195
	2017	0.00	0	0.00	0	18
	2018	2.38	1	0.02	1	42
	2020	52.63	13.10 ± 9.17 (1–95)	6.89	10	19
*Leucaspius delineates**	2020	73.33	8.27 ± 2.67 (1–61)	6.07	22	30
	2021	42.50	1.65 ± 0.19 (1–6)	0.70	34	80

Note: PI – prevalence of infection, II – intensity of infection: mean ± standard error (min–max); IA – index of abundance; * – from mainland lake.

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DISTRIBUTION OF *ARGIOPE BRUENNICHI* (SCOPOLI, 1772) IN VITEBSK REGION (BELARUS)

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The wasp spider *Argiope bruennichi* (Scopoli, 1772) entered Belarus presumably at the end of the XX century by natural expansion. To date, the wasp spider has been recorded in a significant part of the territory of Belarus. However, the geographical distribution of this species remains poorly understood until now.

As a result of the research carried out in August 2020, we identified the northernmost points of registration of the wasp spider on the territory of Belarus: 10.08. 2020, Vitebsk region, Braslavsky district, Slobodka village, near Potekh Lake, 55°40'51.6" N 27°10'24.0" E (N.V. Sinchuk, A.V. Sinchuk), 1 female; 16.08.2020, Vitebsk region, Polotsk district, Gorodishche village, near the Western Dvina River, 55°20'49.8" N 28°59'50.2" E (A.V. Sinchuk, N.V. Sinchuk), 1 female. Only isolated finds were noted. It is assumed that the expansion of this wasp spider species in Belarus has not yet been completed.

BIVALVE TRANSMISSIBLE NEOPLASIAS IN RUSSIAN FAR EAST POPULATIONS OF *MYTILUS TROSSULUS*

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Clonally transmissible cancer (CTC) is a neoplastic disease passed from individual to individual by physical transfer of cancer cells. The first inkling of a transmissible cancer came from a study of canine transmissible venereal tumor, CTVT, dating back to 1876. Since then CTC has been confirmed for CTVT and the facial tumor of Tasmanian devil *Sarcophilus harrisii* and, more recently, for several lineages of disseminated neoplasia (DN) of eight marine bivalve mollusks.

A straightforward method of CTC diagnostics is DNA genotyping. The genotype of CTC cancer cells is different from that of the host cells. The result is genetic chimerism, when an individual possesses cells with different genotypes. At the same time, cancer cells of the same lineage have the same genotype in different infected individuals. Such lineage-specific genotypes are thought to derive from the "patient zero", the host individual in which the cancer originated.

Blue mussels *Mytilus* suffer from two transmissible cancers known as BTN1 and BTN2; both cancers derived from the Pacific mussel *M. trossulus* (i.e. has the genotype of this species). BTN1 was hitherto founded in *M. trossulus* from British Columbia only while BTN2 - in multiple populations of four different mussel species worldwide.

The widespread, in particular bipolar distribution of BTN2 indicates that it is spread by the sea traffic together with infected mussels fouling ships. BTN2 could be treated as a successful invasive species of a parasitic cell lineage (an unicellular parasitic *Mytilus*) with the host range potentially encompassing all representatives of the genus.

Recently, we were the first to discover the disease it Russian waters, in *M. trossulus* from the Far Eastern Seas. In our presentation we briefly summarize current knowledge on bivalve transmissible neoplasia and present the methodology of transmissible cancer diagnostics tried-and-tested on transmissible neoplasia of mussels.

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CONSEQUENCES OF *DREISSENA POLYMORPHA* PALLAS, 1771 (BIVALVIA) INTRODUCTION FOR THE FISH COMMUNITY OF LAKE PLESHCHEYEVO

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The introduction of alien organisms into new habitats can entail both predictable as well as some unknown impacts (Nalepa, Schloesser, 2013; Jernelöv, 2017; Dgebuadze et al., 2018). Zebra mussel has appeared in Lake Pleshcheevo in the 1980s, having successfully occupied a niche on the bottom ecosystem over several years. The increased levels of filtration contributed to changes in the trophic structure of the lake. This study examines structural changes in the ichthyofauna of Lake Pleshcheevo, following the introduction of the zebra mussel, *Dreissena polymorpha* Pallas, 1771 (Mollusca: Bivalvia).

Presented own and literary material allows us to conclude that the occurrence of a sustainable biocenosis of *D. polymorpha* in Lake Plescheevo involved processes that directly and indirectly determine the structure and spatial distribution of the fish community. According to our estimates, the role of benthophagous fish has significantly increased in the lake, which was a direct consequence of the change in the food value of macrozoobenthos and the environment-forming activity of this mollusk. Similar processes were previously discussed in detail by Mayer et al. (2013) using a series of lakes of North America and Europe located in the temperate climate zone. The term “benthification” they proposed reflects the essence of the changes occurring in lake ecosystems. Size and age characteristics have noticeably improved in populations of certain lake species (roach, silver bream), while deteriorating for other (bream). Data from this study showed that changes noticeably affected the pelagial of the lake (Figure). Thus, small roach, earlier numerous in pelagic aggregations, is now practically completely absent. Apparently, this event is due to an improvement in the feeding conditions for the species in the littoral and sublittoral zones of the lake on the one hand, and an increase in food competition with aboriginal pelagic species (vendace, bleak) on the other. In addition, according to our assumptions, large bream individuals are forced to stay on the shellfree parts of the bottom, during the feeding season because the high environment-forming activity of *D. polymorpha* associated with the creation of druse conglomerates changes the availability of other benthic organisms for fish. Further observations would allow for a more detailed study of the trends discussed in the present work on the transformation of the lake ecosystem and can help preserve this unique landscape object in the European part of Russia.

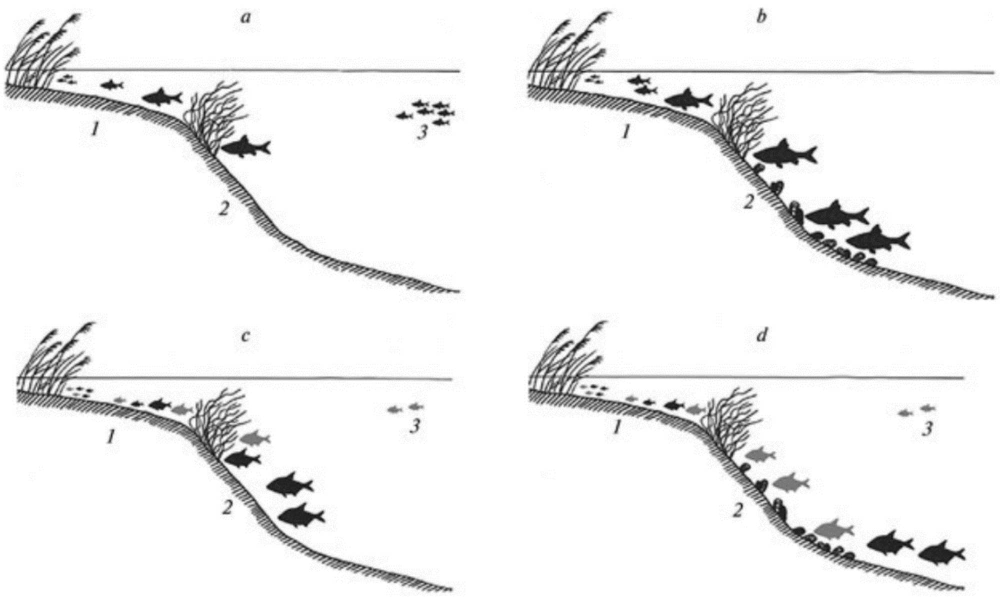

Figure. Changes in the spatial distribution of some fish species in the littoral (1), sublittoral (2) and pelagic (3) zones of Lake Plescheyevo after the introduction of zebra mussel: a – roach in 1978–1981, b – the same in 2014–2016, c – bream (black) and silver bream (gray) in 1978–1981, d – the same in 2014–2015.

For details see: Smirnov A.K., et al., Impact of zebra mussel *Dreissena polymorpha* Pallas 1771 (Bivalvia) appearance on fish populations in lake Pleshcheevo, European Russia // Zoologicheskii Zhurnal. 2020. Vol. 99. No. 12. P. 1363-1374. https://doi.org/10.31857/S0044513420110070

MAPPING OF INVASIVE PLANT SPECIES BELARUSIAN-LITHUANIAN BORDERLANDS

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In 2019, within the framework of the international project ENI-LLB-1-207, a total inventory of the eight most dangerous invasive plant species (AIPS) of the Belarusian-Lithuanian borderland (Grodno and Shchuchin regions of Belarus, Alytus and Vilnius counties of Lithuania) was carried out: *Acer negundo*, *Asclepias syriaca*, *Echinocystis lobata*, *Heracleum sosnowskyi*, *Heracleum mantegazzianum*, *Impatiens grandulifera*, *Solidago canadensis*, *Solidago gigantea*.

The area of the Belarusian territory covered by research is 1,771 km, and includes the territories of the landscape reserves «Ozyory» and «Kotra» and partly « Pushcha Grodno ». The basis of field research is the grid method. In each rectangle with a unique coding, field surveys carried out. For each finding of an invasive plant species, a special form drawn up, which included data on the location, habitat, and other necessary information. On the printed map, special marker indicating the type of cartographic (vector) unit marked the location: point, line or area. All completed forms and maps were scanned and subsequent placement in the GIS. A special application for a smartphone was developed and used also. It allows you to enter descriptions of AIPS populations with automatic fixation of location coordinates and a photographic image of the growing habitat (biotope).

The implementation of the cartographic and analytical part carried on the ArcGIS geoinformation platform. This brought together the collection of field data (manually and via a mobile device), the analysis of the data on a desktop computer, and the publication of the results on the Internet as a web application. It also later made it possible to link the inventory data of alien invasive plant species for the entire border area of Belarus and Lithuania. The collected field data are combined into a joint Belarusian-Lithuanian geodatabase, which will allow you to store and manage both spatial (points, lines and polygons) data and attributive data. Sample for the Belarusian part: area – 241, 518 questionnaires were filled in, information on 658 habitats of the target species was entered: 234 points, 140 lines, 284 areas. The real area occupied by invasive species (excluding duplication – when several invasive species grow in the same biotope) was ~ 1131.9 ha, which is 0.7 % of the project area. The fact that several invasive species coexist must be taken into account when assessing the total area occupied by several plant species.

The digital map served as the basis for an interactive web application developed within the framework of the project, available to all interested organizations and citizens for further filling with information about the places where alien plant species grow and the activities are carried out to deal with them (https://arcg.is/0r5Pfm, https://bit.ly/2S1UxLa).

When performing field works, for operational reconnaissance on the ground, a special Internet questionnaire for the population, developed within the framework of the project, helped. The questionnaire designed to collect data on the distribution of eight target and 12 associated invasive plant species in the Lithuania and Belarus border region (https://arcg.is/0Drb1u).

Analysis of the invasive species abundance in the Belarusian part of the project in the identified habitats showed, that the most abundant of the target species – *Acer negundo* (324 localities) – occupies the largest areas (~ 43 % of the total area) with an abundance of 10–20 % coverage with the maximum number of habitats (87 units) with an abundance of up to 10 %. *Heracleum sosnowskyi* occupies relatively small areas (0.5 hectares) with an abundance of up to 1 % in three localities, which indicates the effectiveness of systematic control of this species in the Belarus border regions.

The largest area and number of localities of invasive species in settlements were found (> 100 localities covering an area of ~ 300 hectares). This defines human settlements as the most dangerous source of AIPS invasion into natural biotopes.

Results of the ENI-LLB-1-207 project: https://clck.ru/UAsK2.

ENI-LLB-1-207 project funded by the European Union.

THE ROLE OF BIOLOGICAL INVASIONS IN THE VORONEZH RESERVE FLORA FORMATION

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For the first time, the inventory of the Voronezh Reserve flora was carried out in 1946-1947 by S.V. Golitsyn, he identified 923 species of vascular plants. By that time, the territory had the reserve status during 12 years. Based on the analysis of this list of plants, as well as materials on the history of the Voronezh Reserve flora formation, data on the economic activities of the reserve in 1936-1947, and information on the history of adventive flora formation in the Voronezh Region, 113 species were classified as alien. At the same time, it was found that 65 alien species appeared on the territory in the period preceding the reserve regime establishing. In the first 12 years of conservation, the flora was supplemented with 48 alien species; the rate of introduction of alien species was 4 species per year. In the subsequent period (1948-2020) the rate of biological invasions of plants decreased to 1.05 species per year; flora was supplemented by 77 alien species (Figure).

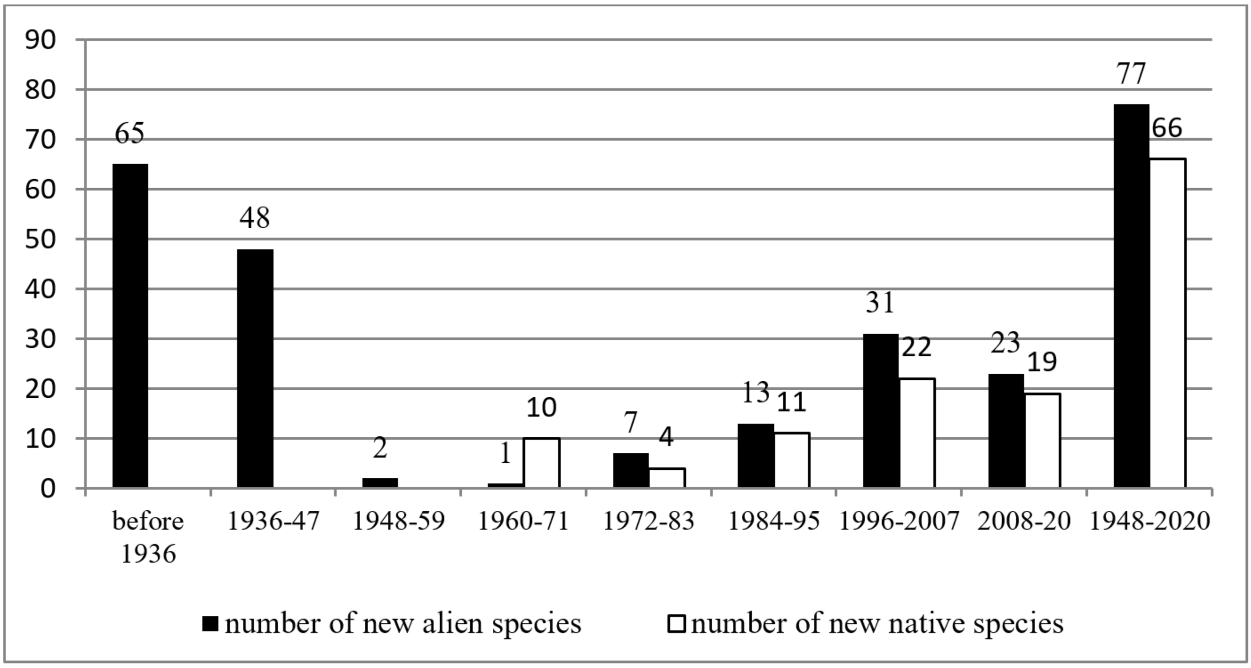

Figure. Dynamics of new species registration in the Voronezh reserve territory. On the abscissa – time periods (12 years each)

To reveal the temporal dynamics of flora formation, the entire conservation period was divided into 12-year periods. The small number of new finds of species in the period 1948-1983 is explained by the lack of florists in the reserve staff. In subsequent periods, with regular monitoring of the flora, the number of new alien species always exceeded the number of new native taxa. To date, the share of alien species is 17.8% of the total vascular plants list (190 alien species out of 1066 identified taxa).

Analysis of the vectors of invasion shows that 39.3% of alien species appeared spontaneously; 33.5% left the culture; 20.9% were purposefully planted on the territory and 6.3% of species have a mixed or unidentified type of invasion. In general, the share of alien species that appeared in the protected area as a result of the deliberate introduction of exotic plants (60.7% of all alien flora) significantly exceeds the contribution of unintentional introduction (39.3%). 40 exotics were planted directly in the forest, of which 30 species during the reserve existence. Thus, human activities for the introduction of plants play a leading role in the formation of alien flora in the protected area.

The share of stable elements of alien flora (reproducing and spreading over the territory) is 12.4% of the total flora in the protected area, the share of invasive species is 4.2%. In addition to 35 species included in the Black Book of the Flora of Middle Russia (Vinogradova et al., 2010), the territory of the Voronezh Reserve contains such invasive species as *Robinia pseudoacacia* L., *Sambucus racemosa* L., as well as potentially invasive species: *Cerasus vulgaris* Mill., *Lonicera caprifolium* L., *Padus serotina* (Ehrh.) Borkh., *Phedimus spurius* (Bieb.) 't Hart, *Prunus cerasifera* Ehrh., *Ulmus pumila* L.).

DISTRIBUTION OF ALIEN DECAPOD SPECIES OFF THE COAST OF SOUTH-WESTERN CRIMEA

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The introduction and spread of alien species are now recognized as one of the most significant modifiers of biodiversity. The Black Sea is one of the world's hotspots for marine bio-invasions. Over the past decades, the number of records of alien aquatic species has increased in the Black Sea. Among decapods noteworthy are the records of blue crab (*Callinectes sapidus*), Chinese mitten crab (*Eriocheir sinensis*), Say's mud crab (*Dyspanopeus sayi*), estuarine shrimp (*Palaemon longirostris*), asian prawn (*Palaemon macrodactylus*), and green tiger prawn (*Penaeus semisulcatus*).

The significant amount of new species was recorded near the Black Sea coast of Crimea. On the basis of original and published data, during the past 10 years, the findings of 5 alien species of decapoda was found near Crimea: *Rhithropanopeus harrisii* (Gould, 1841)*, Callinectes sapidus* Rathbun, 1896, *Eriocheir sinensis* H. Milne Edwards, 1853, *Pilumnus cf. vespertilio* (Fabricius, 1793) and *Palaemon longirostris* H. Milne Edwards, 1837.

The estuarine mud crab *R. harrisii*, is a prime example of one of the most successful invasions into water ecosystems of the 20th century. The native distribution area of *R. harrisii* comprises fresh and brackish water bodies of the Atlantic coast of North America. In 1874, this species was for the first time discovered outside its native range, in Zuiderzee, Holland. In the 1930s–1950s, it actively spread over all European coasts, including inner seas (Baltic, Black, Caspian seas and the Sea of Azov), and lower reaches of rivers (Slynko et al., 2017). Currently, this species is widespread among the fauna into coastal water bodies of the Crimean Peninsula.

The blue crab *C. sapidus* is a euryhaline and eurythermal species that inhabits estuaries and shallow coastal areas to depths of 90 m along much of the east coast of North and South America, including the Gulf of Mexico. In Europe it is considered an Invasive Alien Species. The first record of the blue crab in the coastal waters of Crimea was made in 2007 (Khvorov et al., 2006).

Moreover, two individuals of blue crab *C. sapidus* (one female and one male) were captured on 26 July 2011 and 22 December 2011 to 18 m depths in the coastal zone Sevastopol. The carapace width and weight were measured as 15.2 cm and 232.04 g for the female, and 15.0 cm and 298.5 g for male the specimens. In January 2018, another find of this species was recorded off the coast of Sevastopol. The caught specimen is a female with a carapace width of 18.3 cm, weighing 305.1 g.

The only find of Chinese crab *E. sinensis* – the exotic invader to the Black Sea basin, was found in march 2005 near Sevastopol coast (Lozovskii, 2005).

In July 2018, a crab of the family Pilumnidae was found in the coastal zone of the south-western Crimea, during the collection of samples of Black Sea aquatic organisms. According to morphological characteristics, specimen we found was identified as the hairy crab *P. vespertilio*, representative of the Indo-Pacific region.

In addition, in July 2018, a new for the Russian sector of the Black Sea species of shrimp Palaemonidae family, *P. longirostris*, was registered in the Sevastopol Bay (Sevastopol) (Statkevich, 2019).

An increase in the species composition of fauna decapoda off the Black Sea coasts of the Crimea results from the on-going process of mediterranization – species self-distribution from the Mediterranean Sea via the Bosphorus Straitthe. Other important vectors of introduction of alien species are shipping, namely, the transfer of aquatic organisms in ballast water or on the hulls of fouling communities.

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INVASIONS OF ALIEN SUCKERMOUTH-ARMORED CATFISHES (SILURIFORMES: LORICARIIDAE) INTO INLAND WATERS OF VIETNAM

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At present, there is an urgent need for studies of the process of invasion of "successful" alien species (Dgebuadze et al., 2002; Pavlov et al., 2003), which include armored catfishes (Siluriformes: Loricariidae), which pose the most serious threat to tropical and subtropical freshwater ecosystems (Armbruster 1998; Le Thanh Luu, Nguyen Van Thanh, 2005; Orfinger, Goodding, 2018; and many others).

Studies on the distribution of alien American armored catfishes *Pterygoplichthys* spp. in different types of water bodies in the central and southern Vietnam have shown that they inhabit the basins of virtually all main river systems of the country (Stolbunov et al., 2017; Gusakov et al., 2018; Stolbunov et al., 2020; Stolbunov et al., 2021). Their dispersal in the hydrological network of the country is of unidirectional character, as a rule: from the lotic systems to the limnic systems, and not vice versa. Within the river basins, the dispersal of loricarids occurs in the direction from the upper reaches to the lower ones (Stolbunov et al., 2017; Gusakov et al., 2018; Stolbunov et al., 2021) of Central and Southern Vietnam. The data obtained through morphological and molecular-genetic analyzes, as well as the assessment of the color patterns of fish, has shown that the studied reservoirs and streams are inhabited by armored catfishes of two species: *Pterygoplichthys pardalis* (Castelnau, 1855) and *P. disjunctivus* (Weber, 1991), as well as an interspecific hybrid *P. pardalis* x *P. disjunctivus*. It is obvious that the numerous populations of invaders – armored catfish come into close competitive relationships with native fish species, including competition for food resources. It has been established that armored catfish behave like typical detritus-gatherers in new habitats – reservoirs and watercourses of Vietnam (Stolbunov et al., 2021), similar to what is observed in their natural (primary) habitat – in South and Central America, where they are called «Janitor fish» (Lujan et al., 2012; Froese and Pauly, 2012). In Vietnam, the diet of alien armored catfish (*Pterygoplichthys* spp.) consists of plant and animal food, as well as organic detritus (Stolbunov et al., 2021). Single specimens of catfish were found to consume high percentage of animal food. It was noted that when a high population size is reached, alien armored catfish are able to provide significant food competition for local fish species – detritivores and, possibly, benthophages (Stolbunov et al., 2021).

Alien fish species currently dominate in terms of quantity and compete with native species for ecological niches and environmental resources in a number of freshwater water bodies and watercourses in Vietnam, which can ultimately lead to a decrease in the diversity and transformation of native fish communities (Stolbunov et al., 2017; Stolbunov, Tran Duc Dien, 2019). Invasions, as well as deliberate and/or accidental introduction of alien fish species, in most cases, can impose negative consequences for the biodiversity of aquatic ecosystems in Vietnam (Stolbunov, Tran Duc Dien, Armbruster, 2020). Therefore, it is necessary to monitor the invasive process, as well as to continue research on the biological characteristics of "successful" invasive species.

For details see: Stolbunov I.A., Tran Duc Dien, Armbruster J.W. Suckermouth-armored Catfish (Siluriformes: Loricariidae) of Central and Southern Vietnam. Inland Water Biol. (2020) 13, 627–639, https://doi.org/10.1134/S1995082920040100; Stolbunov I.A., Tran Duc Dien, Karabanov, D.P. Taxonomic Composition and Distribution of Alien Suckermouth Armored Catfish (Siluriformes: Loricariidae) in Southern Vietnam. Inland Water Biol. (2021) 14, 263–273, https://doi.org/10.1134/S1995082921030123.

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THE CURRENT STATE OF THE *EURYTEMORA* GENUS DISTRIBUTION IN HOLARCTIC

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The genus *Eurytemora* Giesbrecht, 1881 currently includes 21 species (Sukhikh, Alekseev, 2020). Almost all species of the genus, with a few exceptions, are inhabitants of the fresh or brackish waters of the Holarctic. According to various sources, at least 5 of them were noted as actively spreading: *Eurytemora americana* Williams, 1906, *Eurytemora gracilicauda* Akatova, 1949, *Eurytemora velox* (Lilljeborg, 1853), *Eurytemora caspica* Sukhikh & Alekseev, 2013 and *Eurytemora carolleeae* Alekseev & Souissi, 2011.

It is supposed that the active dispersal of these species is facilitated by perfect self-regulation processes, a short life cycle, and the presence of a diapause stage in the life cycle (Lee, 2000). Modern ranges of dispersing species, pathways and possible ways of distribution, supported by preliminary studies on molecular genetics, will be presented in the report.

The work was performed in accordance with the national research initiatives AAAA-A19-119020690091-0, and was also supported by RFBR grants 20-34-70020, 20-04-00035 and 19-04-00217. The Federal Zoological Collection of Zoological Institute RAS was used for the study.

IS *ACANTHOSPERMUM HISPIDUM* DC. (ASTERACEAE) THE DISAPPEARED EPHEMERAL OR ERADICATED INVASIVE SPECIES OF RUSSIAN FAR EAST?

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Acanthospermum hispidum DC. is a fast-spreading annual plant from South America, an aggressive weed of the pastures and more than 25 crops. During last 200 years it has spread very widely in North America, Australia, Africa and Asia and now occurs in over 60 countries. *A. hispidum* is a quarantine organism in many countries (for example, Mexico, Iran, Yemen, Uzbekistan et. al.). *A. hispidum* was proposed for inclusion in the Unified List of Quarantine Objects of the Eurasian Economic Union in 2017. Earlier the pest was discovered twice on the territory of Russia. However, it is not still clearly, whether grow this species and where exactly at present time. This is important for determining the its status (present/ absent). Besides the main pathways of entry as well as morphological and biological features are insufficiently studied for this species.

Field studies were carried out in Far East (Primorsky territory) in September of 2020. Previously all available herbarium specimens of *Acanthospermum hispidum* were investigated in the Russian herbariums: LE, MW, MHA, VLA. 31 carpological samples were selected from herbarium specimens by origin from Argentina, Brazil, Bolivia, Cuba and Cape Verde for detailed morphological analysis.

Mann–Whitney U-test was used to compare of samples. Macro photography of fruit was carried out using a Canon EOS 5D MkIV camera, a Carl Zeiss SteREO Discovery stereo microscope V20. The images were processed in the Zen pro and Zerene Stacker programs.

Initially *A. hispidum* was detected in Ussuriysk in 1980. The cenopopulation of pest was already completely eradicated in 1983. But a new finding of the species was found in Ussuriysky district (Novo-Nikolskoye village) in 1984. According to T.G. Butch and V.D. Shvydkaya (1989) *A. hispidum* was entered like as contaminant of imported soybeans from the United States, Mexico or Argentina. These findings are discussed in scientific works of different authors - T.G. Butch and V.D. Shvydkaya (1989); N.S. Probatova, A.E. Kozhevnikov, V.YU. Barkalov et al. (2006); A.E. Kozhevnikov, Z.V. Kozhevnikova (2011); A.E. Kozhevnikov, Z.V. Kozhevnikova, M. Kwak, B.Y. Lee (2019).

In recent years there are no references about new findings of *A. hispidum* on the territory of Far East and Russian Federation in general. *A. hispidum* is absent in the Checklist of invasive plants in flora of the Russian Far East (Vinogradova, Aistova, Antonova et al., 2020). During our surveys of cultivated fields and ruderal lands of the Ussuriysk district, roadsides and railways around the Vladivostok, industrial lands near of oil processing factory in Ussuriysk, *A. hispidum* was not found also.

A. hispidum is a highly pubescent erect plant. Fruit is cuneate compressed achene in the involucre 6.82±0.1 mm in length (Figure). Width of fruit is varied from 2.18 mm to 2.87 mm. Fruit thickness is also varied from 0.84 mm to 1.19 mm. Variation of the fruit width and thickness are true and can be explained differences in environmental conditions. Fruits have many prickles. Quantity of prickles varies from 52 to 87. Two largest prickles are located on the top of the fruit. They are covered with spikes. All fruit surface is dotted with glands. These fruit peculiarities and other biological features allow of this species to become successful invasive species. Despite all of that, *A. hispidum* is rather ephemeral species for Russian Far East. Last findings were found only 36 years ago and then the pest was no longer found. Thus, we suppose a viewpoint that the species as absent in the territory of the Russian Federation nowadays. But the risk of entry and further spread of *A. hispidum* are still high due to the import of various types of commodities with potential of weed contamination.

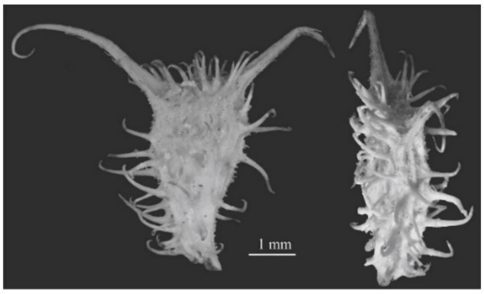

Figure. Different sides of fruit of *Acanthospermum hispidum* DC.

NEW DATA ON THE STATE OF INVASIVE LAND SNAILS POPULATIONS OF THE CENTRAL RUSSIAN UPLAND

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In recent years, there has been an expansion of the invasive species areas of land snails in the Central Russian Upland, caused by changes in climatic conditions, intensification of economic activity, and increased human mobility (Snegin et al., 2015; Adamova, 2018; Artemchuk, 2019). The identification and description of new alien snails populations, their ecology and morphogenetic variability are important tasks in assessing the potential for further expansion of invasive molluscs.

The xerophilic snail *Xeropicta derbentina*, widely distributed in the Caucasus and Crimea, has also been actively moving north in recent years. We found a previously undetected population of this species on the territory of the Belgorod region in the Rovenki township on the slope of a ravine with chalk outcrops (N 49.914716, E 38.891985). The average size of the shell (*N*=23): width (*WS*) 14.2±0.3 mm, height (*HS*) 8.2±0.3 mm, volume (*Vs*) 827.1±50.1 mm^3. It is noteworthy that the *HS/WS* index (0.57±0.02) was lower than in other populations of the Belgorod region. The state of the gene pool of this population was estimated based on the variability of nine isoenzyme loci. All markers were polymorphic, the average Shannon diversity index (*I*) is 0.58±0.06, the effective number of alleles (*Ao*) is 1.60±0.10, the observed heterozygosity (*Ho*)is 0.39±0.07, and the inbreeding coefficient (*F*) is -0.10±0.10. The obtained data indicate a high level of genetic diversity of the studied group, and higher than in some natural populations of this species in the Crimea and the Caucasus (Adamova, 2018).

The snail *Chondrula tridens* var. *major* is known from Belgorod, where it was presumably introduced with soil from the North Caucasus (Rogozha and Snegin, 2007). We found a population of this snail in the vicinity of the Solyanka park in a meadow near the side of a dirt roadin the Kursk city (N 51.700385, E 36.111565). The population is characterized by similar shell parameters to the populations from Belgorod (Snegin, 2011): *HS* =15.5±0.3 mm, *HWS* (height of the shell whorl)/*HS*=0.40±0.01, the notch index of the mouth is 1.63±0.03, with the exception of significantly ($p<0.05$) higher values of the *WS* (7.0±0.01 mm), as well as the height (6.0±0.1 mm) and width (5.1±0.1 mm) of the shell mouth. Nevertheless, the range of variability of the shell morphometric characteristics in the studied population is included in the normal response of the Belgorod group populations. It is noteworthy that on the basis of isoenzyme loci, the detected population has significantly greater genetic variability than the previously studied groups: *Ae*=1.22±0.11, *I*=0.22±0.09, *Ho*=0.14±0.06, *F*=0.02±0.06.

In 2020, we found a population of the invasive species *Helix pomatia* in the Rzhavets village of the of the Belgorod region (N 50.573258, E 36.559501). The population lives in a meadow and the forest edge along the railway in the Seversky Donets floodplain. Snail shells are on average larger than those observed for most other populations of the Central Russian Upland: *WS*=41.0±0.6 mm, *HS*=40.6±0.4 mm, *Vs*=34046.7±1304.0 mm^3, mouth area (*Sm*) 572.8±46.0 mm^2, which brings this group closer to such invasive populations as "Shopino", "Kursk", as well as to the "Zhytomyr" population of central Ukraine (Artemchuk, 2019). The "Rzhavets" population has the following values of genetic variability indicators: *Ae*=1.41±0.17, *I*=0.41±0.14, *Ho*=0.27±0.12, *F*= -0.07±0.18. These indicators bring this group closer to other populations of *H. pomatia* of the Central Russian upland, having high viability. According to our observations, *H. pomatia* has been actively spreading in the Central Russian Upland in recent years. In addition to the population of "Rzhavets", in 2020-2021 we found other populations of this snail: 1) Belgorod, "Archiereiskaya Roshcha" (N 50.573258, E 36.559501), the edge of the oak grove; 2) Kursk, "Solyanka Park" (N 51.705990, E 36.129136), the edge of the forest of oak, maple and pine; 3) Surrounding area of Near Chesnochnoe in the Belgorod region (N 50.700614, E 38.816932), the edge of the forest of oak and maple. All this indicates an active distribution of the studied mollusk and a potential threat to natural communities due to the unpredictable nature of the biotic connections formation.

Thus, the condition of the detected invasive land snails populations is estimated by us as good, with a high potential for further settlement along the territory of the Central Russian Upland in the presence of favorable environmental conditions.

THE INVASIVE SPECIES OF HYDROBIONTS (INVERTEBRATE AND ALGAE) IN THE UKRAINE NPP AND TPP TECHNOECOSYSTEMS

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The process of invasion of species outside of native areas currently has significantly intensified. The invasive process has its own characteristics in different types of water bodies. Long-term studies of the Ukraine techno-ecosystems have shown that cooling ponds (CP) of power plants are objects in which various adventive hydrobionts invade often. Most of them naturalized, some ones were registered for a short time.

Almost all cooling ponds in Ukraine was infested by mollusks Dreissenidae (*Dreissena polymorpha* Pall., *D. bugensis* Andr.) at various times. Herewith, these molluscs, as «ecosystem engineers», have significantly changed the habitat of native species, structure and functioning of ecosystems of CP, forming the communities of the consortium type. In many cases the massive development of Dreissenidae led to the emergence of bio-hindrances in the operation of equipment and was of cause of contuorisation processes.

The greatest number of invaders was recorded in CP of Khmelnytskyi NPP (KhNPP). Among filamentous algae, *Chaetomorpha henningsii* P. Richt. (Chlorophyta) was noted in the intake channel. In phytoplankton, invasive species were represented mainly by diatoms: *Pleurosira laevis* (Ehrenberg) Compère, *Cyclotella marina* (Tanimura Nagumo & Kato) Aké-Castillo, Okolodkov & Ector, *Aulacoseira tenella* (Nygaard) Simonsen, and also *Raphidiopsis raciborskii* (Woloszynska) Aguilera, Berrendero Gómez, Kastovsky, Echenique & Salerno (Cyanobacteria). Only *R. raciborskii* and *A. tenella* are freshwater, the others are either brackish water or marine. Everything was represented by single exemplar. *R. raciborskii* was also registered singly in the CP of Zujeskaya TPP and in the CP of Zaporizhzhya NPP, where it caused «water bloom». In the CP of Zujeskaya TPP along with *R. raciborskii*, other freshwater cyanobacteria of tropical origin: *Sphaerospermopsis aphanizomenoides* (Forti) Zapomelová, Jezberová, Hrouzek, Hisem, Reháková & Komárková and *Cuspidothrix ussaczevii* (Proshkina-Lavrenko) P.Rajaniem, J.Komárek, R.Willame, P.Hrouzek, K.Kastovská, L.Hoffmann & K.Sivonen were found. The last one caused «flowering». All the invaders met for a short time.

In CP of KhNPP *Eunapius carteri* (Bowerbank,) (Porifera, Spongillidae), *Craspedacusta sowerbii* (Lankester) (Coelenterata), *Bratislavia dadayi* (Michaelsen) (Naididae), *Tyrrhenocythere amnicola donetziensis* (Dubowsky), *Stenocypris* sp. (Ostracoda), *Theodoxus euxinus* (Clessin), *Ferrissia* sp., *Planorbella* sp. (Gastropoda) were recorded among invertebrates, and *Najas marina* L., *Typha laxmannii* Lepech among vascular aquatic plants.

The invasive process continues nowadays. *Thalassiosira incerta* Makar. – marine species of diatoms was found in phytoplankton in 2019. In 2015 *Diaphanosoma mongolianum* Ueno (Cladocera: Sididae) was recorded in zooplankton. It was the first find in Ukraine.

Since 2012, *Limnomysis benedeni* Czerniavsky which did not reach significant abundance has been constantly recorded in the zoobenthos of the KhNPP CP. *Corophium robustum* G.O.S. was first discovered in 2019. These crustaceans were recorded earlier in all CPs of Ukraine, they are mainly associated with the settlements of the Dreissenidae. On soft bottom, some hydraulic structures corofiids can form massive settlements. In the CP of the Krivoy Rog TPP, the abundance of Corophiidae reached 1.7 million ind/m^2, and biomass was 300 g/m^2. With such abundance, these crustaceans can cause bio-hindrances.

Tropical gastropods *Melanoides tuberculata* (Müller) and *Tarebia granifera* (Lamarck) are inhabited in CP of Zaporizhzhya and South-Ukraine NPPs (S-UNPP). In periphyton of S-UNPP CP in 2018 the populations of these species on the dam and on the stone dump of the reservoir were represented by individuals of different sizes, which may indicate the naturalization of species in the reservoir. The biomass of mollusks reached some kilograms (locally up to 5.8 kg/m^2). Tropical species tilapia *Oreochromis mossambicus* Peters it met in large quantities at the area near the dam in 2018 in this CP. It should also be noted the short invasion of *Cercorages pengoi* (Ostroumov) in the S-UNPP CP.

A significant threat for techno-ecosystems is invasive species that can cause bio-hindrances. The most significant bio-hindrances were caused by Dreissenidae and Gastropoda. At power plants, measures are being taken to the fight against molluscs, mainly by mechanical methods.

DISTRIBUTION OF POLYCHETA OF THE GENUS *LAONOME* (SABELLIDAE, POLYCHAETA) IN LUGA BAY AND GULF OF VYBORG (GULF OF FINLAND)

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New species of polychaetes *Laonome xeprovala* Bick & Bastrop, 2018 was found in of the Luga Bay and Gulf of Vyborg (part of Gulf of Finland) during hydrobiological studies in 2018-2020.

In the Luga Bay this polychaeta was registred at five stations in the mouthes of the Khabolovka and Luga rivers. The abundance of *L. xeprovala* here ranged from 80 to 2200 ind./m^2, biomass was follows: 0.01 – 4.88 g/m^2 (Tamulyonis et al., 2020).

In 2019 the of polychaetes were found at three stations in the water area of Bolshaya Pikhtovaya Bay the Gulf of Vyborg. In 2020 they were discovered at four stations in Bolshaya Pikhtovaya Bay (Tamulyonis, et.al., 2020). The abundance of *L. xeprovala* in Gulf of Vyborg ranged from 20 to 500 ind./m^2 in 2019, and from 20 to 280 ind./m^2 in 2020. The biomass varied from 0.02 to 0.55 g/m^2 (in 2019) and from 0.02 to 0.61 g/m^2 (in 2020).

All findings in 2018-2020 were located in the areas of sea ports, where in the last twenty years dredging and dumping of soil were actively carried out (Zuyev, Tamulyonis, 2017; Maximova et al., 2018). It might be supposed that this alien species (*L. xeprovala*) has inhabited biotopes modified during hydraulic engineering, located in shallow bays with low salinity.

DYNAMICS OF INVASIONS OF DENDROPATHOGENIC ORGANISMS ON THE TERRITORY OF BELARUS

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People have been aware of the biological invasions of phytopathogenic organisms since the dawn of crop production, however they are especially acute in recent times, spurred on by climate change and increasing world trade. The aim of the work was to study invasions of various phytopathogenic species dangerous for tree plantations in Belarus as well as neighboring countries.

As a result of this monitoring of invasive species within Belarus, scientists record one new dendropathogenic organism every year on average. Moreover, it has been discovered that there is an increasing trend in the frequency of their detection (Figure).

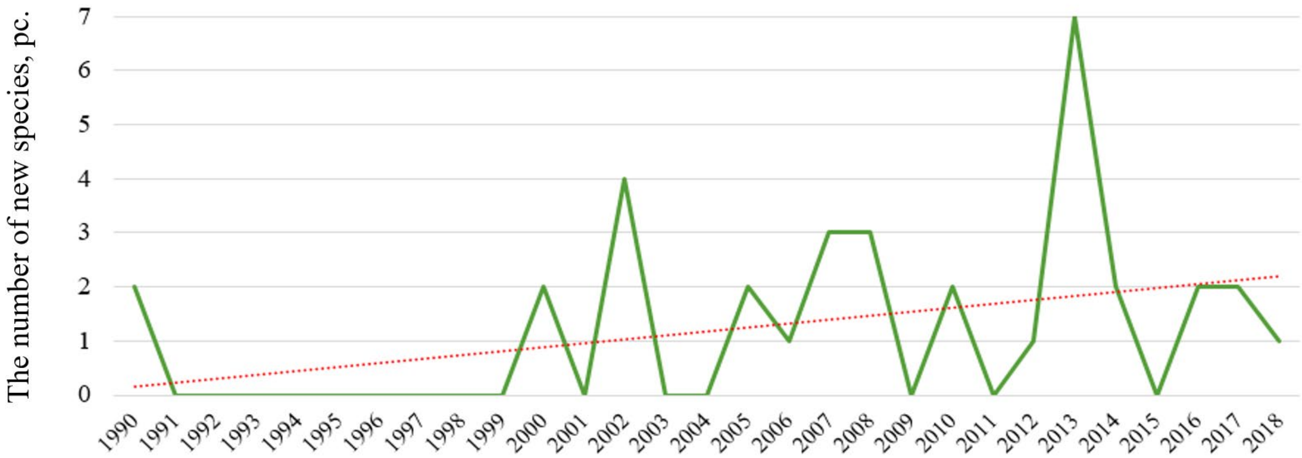

Figure. Dynamics of the number of invasive species of dendropathogens by years of penetration into the territory of Belarus.

The harmfulness of certain pathologies caused by some invaders is staggering. For example, *Hymenoscyphus fraxineus* Baral, Queloz & Hosoya, which first appeared in the Republic less than 2 decades ago, has since caused the death of more than two thirds of all ash forests within Belarus. Clearly, the utmost attention must be paid to the prevention of potentially dangerous invasive species.

From the list of quarantined objects that are somewhat common within the territory of the EAEU, 18 types of pests were identified that pose a potential danger to the forest plantations, nurseries, and arboretums of the country. Of these, 12 species are of American origin, 3 species are East Asian and 3 species are European. These data confirm the fact that invaders are moving along the vectors of the most active trade ties to zones of other continents with similar climatic conditions. It is also possible to trace the expansion of the ranges of southern European species to the north, which is probably related to global warming.

Analysis of phytosanitary risks, monitoring and forecasting of distribution, as well as measures to localize and eliminate foci of quarantine organisms in the forests of the republic are not carried out or do not have a systematic basis, which contradict the requirements of national or international norms.

The monitoring and effective control of recent phenomena is often hampered by the incompleteness of the symptomatology of pathologies in the regions of introduction, the imperfection of the methods used to diagnose adventive pathogen species, the lack of methods for predicting their spread, as well as regulations for the localization and elimination of foci. This poses a significant threat to sustainable forest management, hinders its productivity, and poses a risk towards the biodiversity of forest ecosystems.

ALIEN PLANT SPECIES IN THE RUSSIAN ARCTIC: SYNTHESIS OF THE FIRST RESULTS

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The territory of the Arctic is one of the least susceptible to biological pollution due to the harsh natural conditions and, until recently, the relatively low migratory activity of humans in these latitudes [Russian Arctic..., 1996; Daniëls et al., 2013; Alsos et al., 2015]. The aim of this work is to synthesize and refine modern data on the species richness and regularities of the spatial distribution of alien plant species in the Russian part of the Arctic (RA).

For the RA, the diversity of native species of vascular plants, as well as the number and proportion of alien species in the flora of the region were estimated according to the summary by N.A. Secretareva (2004) with additions. The analysis does not include species whose presence is doubtful, as well as species that are found only in the forest-tundra and northern taiga regions of a particular region. Additionally, we used information about the findings of alien and native species from the tundra regions in later publications [Kozhin, 2014; Pismarkina, 2014; Pospelova, Pospelov, 2014, 2016; Kozhin et al., 2016, 2018, 2020; Lavrinenko et al., 2016; Bobrov et al., 2017; Byalt et al., 2017; Pospelova et al., 2017; Byalt, Egorov, 2019a, b; Koroleva et al., 2019; Pismarkina, Bystrushkin, 2019; Pismarkina et al., 2019; Flora of Taimyr, http://byrranga.ru/], and for the north of the Murmansk region are also represented in GBIF [GBIF, http://gbif.org/]. For analysis, the territory of the RA is divided into 10 large regions in accordance with the map of the circumpolar Arctic [CAVM Team, 2003] and the division proposed in [Sekretareva, 2004].

According to the results of the generalization of the data, 333 alien plant species were recorded in the RA, 63 (18.9%) of them are native for one of its regions and introduced to other regions. Alien species are represented in all regions of the RA, but their shares are generally less than in the regions of more southern biomes, they are unevenly distributed and are relatively small over a significant length of the territory of the RA: from 1-2% in the north of Yakutia and in the continental part of Chukotka to 22-27% on the Kola Peninsula and in the Bolshezemelskaya tundra. In general, the low species richness of alien species in the Arctic regions is associated with two groups of factors. The first of them includes socio-economic indicators and, first of all, reduced human migration activity in the Arctic [Alsos et al., 2015], and for the RA also a relatively low transport development of the territory. The second unites natural factors, among which the climate is of paramount importance.

Mainly, plurizonal species are introduced into the Arctic with the northern border of their ranges in the boreal zone. The question of the biogeographic specifics of the distribution of alien species in the RA, the role of zonal gradients and the mechanisms of transfer of alien species from the neighboring boreal zone remains unclear, since the direct donor regions during their introduction are often not known. However, such species are clearly better adapted to a wide range of conditions, which allows them to survive at least for a short time in a harsh climate, and against the background of a long warming cycle to bear fruit and spread. There are no invasive species in the RA, they are generally few in the Arctic and mainly because most of them are poorly adapted or have no pronounced adaptations to Arctic environmental conditions at all.

The introduction and distribution of alien species in the RA is mainly associated with disturbed territories as a result of settlements, industrial centers, developed mineral deposits, as well as transport highways. Distribution of disturbances has a "focal" character, and it is in such places that the main findings of alien species in the RA are located. The main vectors for the introduction of alien species in the regions of the Russian Arctic are the movement of transport, people and related objects during the economic development of territories and Arctic tourism, and transport corridors connecting the northern regions and the "mainland" are the main route for the introduction of alien species.

There is no single trend in the change in the proportion of alien species in the flora of RA on the longitudinal gradient, and there is also no relationship between the number of native species and the number of alien species in the region (spearman's correlation coefficient $r_{sp} = -0.061$, $p = 0.868$). The zonal features of the distribution of alien species and their biogeographic effects, as well as the synthesis of data on the impact of climate change on invasions of alien plant species in the Arctic, have yet to be investigated.

This work was supported by the RFBR grant № 18-05-60057 and the theme of the state assignment of the Institute of Geography of the Russian Academy of Sciences № 0148-2019-0007 (organization and maintenance of the database).

POSSIBILITY OF ACCLIMATION IN UKRAINE OF PINK ODD SILKWORM *LYMANTRIA MATHURA* MOORE

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The main task of plant quarantine is to protect plant resources of the state from absent harmful (quarantine) organisms: pests, pathogens of plant diseases, alien plant species. Recently, the processes of biological invasions are accelerating in the world - the invasion of alien species into new territories, leading to negative consequences for local species and ecosystems. The main reasons for this phenomenon are anthropogenic factors: the development of trade and tourism, an increase in traffic, the transformation of natural ecosystems (deforestation or unjustified afforestation of the steppes, artificial drainage and watering of territories), climatic changes. Timely identification of adventive pests in regulated products, preventing their penetration and further spread on the territory of the country is of great importance in the preservation of plant resources. The measures taken to prevent the penetration and spread of absent pests are based on the Lists of national organizations, depend on the belonging of the pest in the A1 or A2 Lists, which are formed based on the results of the Pest Risk Analysis. (PRA).

The most important component of PRA is to assess the possibility of acclimatization of adventive species in territories free from them, which is determined by the availability of food resources (host plants) and the appropriate climatic conditions. The pink odd silkworm is currently common in eastern Asia (Bangladesh, Hong Kong, India, the Korean Peninsula, China, Nepal, Japan, part of the Russian Far East). As a polyphagous pest, it can damage trees of various deciduous species to varying degrees. The high risks of *L. mathura* introduction, the ability to quickly passive and active spread and expansion of the range, a wide range of forage plants, high reproductive and adaptive potential, the ability to cause serious economic losses necessitated determining the possibility of the existence of the pest in Ukraine.

The information on the expansion of the range of the pink gypsy moth and an increase in the number of cases of pest detection in the course of international trade served as the basis for conducting research on the compliance of the above conditions in Ukraine. Currently, the range of *L. mathura* is broad-leaved and mixed forests, temperate-coniferous forests, tropical and subtopic dry broad-leaved forests; tropical and subtropical moist broadleaf forests. Of these biomes, only tropical dry deciduous forests are not found in Ukraine. Thus, the plant resources of almost the entire territory of Ukraine will meet the forage requirements of the pink odd silkworm. The main types of host plants occupy large areas and are of great importance in Ukraine for industrial production of fruit products, greening of cities, forests, national parks, forest shelter belts.

The analysis of the suitability of the territory of Ukraine for the acclimatization of the unpaired pink silkworm and the construction of electronic vector maps of the potential area of the pest was carried out using the MapInfo Pro 15.0 (Pitney Bowes) and Idrisi Selva (Clarklabs) software, which makes it possible to construct compositions from raster and vector layers. This made it possible to determine climatic predictors in the pest's area, quantitative amplitudes of each of the limiting factors and to establish the presence of appropriate conditions in Ukraine.

The long-term indicators of the mean monthly temperature of the coldest month, the long-term mean annual temperature and the mean monthly temperature of the warmest month were used as climatic predictors. The unification of ecologically suitable territories into a single map for each of all sets of conditions for the existence of a species in the range made it possible to determine the potential range of the pest in Ukraine. Thus, the probability of *L. mathura* acclimatization in Ukraine is due to the presence of forage host plants and favorable climatic conditions. The potential area of *Lymantria mathura* in Ukraine can be almost the entire territory of Ukraine, except for a small part of the Carpathian highlands in the Transcarpathian, Ivano-Frankivsk and Lviv regions.

SOME FEATURES OF THE INVASIVE COMPONENT OF THE FLORA OF VOLGOGRAD REGION IN COMPARISON WITH THE FLORA OF CENTRAL RUSSIA

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Over the past 20 years, many authors have turned to the study of the adventive component of the flora of the Volgograd region. If we analyze these works, we can identify the composition of invasive plant species. Besides, it is of great interest to study the invasive lists of plant species of any adjacent regions. Some of them can become such on the territory of our region. For this reason, we have studied the work by Dmitry Vladimirov on the invasive fraction of the flora of the Voronezh region, where 120 plant species were mentioned, among which 50 are found on the territory of the Volgograd region as adventive. Thus, after analyzing some works, we came to the conclusion that 295 plant species can be adventive for the territory of the Volgograd region. Among them, 53 are invasive. This list may be changed and expanded over time.

A very strong heterogeneity of the soil and climate conditions accounts for a considerable disparity in the list of alien species between the Volgograd region and the Central part of Russia. Nevertheless, we compared our blacklist with the data given in the "Black Book of the Central Russia flora…". 19 species are simultaneously invasive for the Central part of Russia and the Volgograd region: *Acer negundo*, *Amaranthus albus*, *Amaranthus retroflexus*, *Ambrosia artemisiifolia*, *Bidens frondosa*, *Conyza canadensis*, *Cyclachaena xanthiifolia*, *Echinocystis lobata*, *Elaeagnus angustifolia*, *Elodea canadensis*, *Erigeron annuus*, *Erucastrum gallicum*, *Fraxinu spennsylvanica*, *Galinsoga parviflora*, *Galinsog aquadriradiata*, *Juncus tenuis*, *Lepidium densiflorum*, *Oenothera biennis*, *Xanthium albinum*. Potentially invasive for the entire territory of Central Russia, and invasive for the Volgograd region, are 14 species: *Amaranthus blitoides*, *Ambrosia trifida*, *Amorpha fruticosa*, *Artemisia dubia*, *Artemisia sieversiana*, *Caragana arborescens*, *Cuscuta campestris*, *Lonicera tatarica*, *Ribes aureum*, *Robinia pseudoacacia*, *Rosa rugosa*, *Sambucus racemosa*, *Ulmus pumila*, *Zizania latifolia*. That's a total of 33 species match for these territories.

From the above list, *A. fruticosa* and *U. pumila* are rapidly settling on the territory of the Volgograd region. For a long time, these species were used as components windbreaker forest, and now, they are becoming part of both natural and disturbed communities. *U. pumila* is often found within floodplain forests, breeding probably by self-seeding. *A. fruticosa* successfully propagates not only by seeds, but also vegetatively, displacing native species not only in floodplains, but also in the bayrachny forests and on steppe areas.

Another 20 plant species are invasive for the Volgograd region. 6 species often found in undisturbed communities: *Ambrosia psilostachya* (north-west part of the region), *Ligustrum vulgare*, *Morus alba*, *Oenothera suaveolens*, *Oenothera villosa*, *Pinus sylvestris* (previously, pine was introduced in the region), *Sporobolus cryptandrus*. The other 14 species are found in disturbed and semi-natural areas: *Acroptilon repens*, *Aegilops cylindrica*, *Alcea rosea*, *Anisantha sterilis*, *Armoracia rusticana*, *Bromus japonicas*, *Cenchrus pauciflorus*, *Cotinus coggygria*, *Datura stramoniu*, *Hesperis matronalis*, *Lolium perenne*, *Malus domestica*, *Mentha spicata*.

Every year the population of *S. cryptandrus* and *O. villosa* increases in the Volgograd region, so their study is of particular interest. *S. cryptandrus* is known in Russia in a number of localities in the steppe part of the Don, Volga basins and Kalmykia. Sporobol was first discovered in 1988 in the Volgograd region by V.A. Sagalaev; somewhat later in the Rostov region, Kalmykia. *S. cryptandrus* settles in psammophytic steppe communities of different composition, but under similar conditions – on sandy river terraces and riverine sands, on steppe pastures, in disturbed roadside groupings, mainly on sandy soils. *S. cryptandrus* is the only herbaceous perennial among the adventive plants of the Volgograd region, which is a xerophytic, while the vast majority of the other refers to the mesophytae, xeromesophyte and mesoxerophytes.

Another interesting xeromesophyte potentially invasive species is *O. villosa* which is common on light, sandy soils where there is constant or repeated violation of the substrate (the shores of ponds, roadsides). Probably, it also settles on them.

Thus, despite the aridity of the climate of the Volgograd region, only a few of the species of adventive flora are xerophytes that can be introduced into stable steppe communities.

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FEATURES OF THE TRANS-SIBERIAN RAILWAY FLORA FORMATION AND ALIEN PLANT MIGRATION WITHIN DIFFERENT REGIONS

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Biological invasions are now recognized as a major cause of the loss of natural biodiversity and a threat to ecosystem services. Transport corridors are one of the main vectors of invasion both during long-distance plant dispersal and as foci from which unintentionally introduced species spread to the surrounding landscape and beyond. However, large-scale studies of invasion vectors and their role in the formation of modern floras are still insufficient. And we consider the Trans-Siberian Railway, which connects two continents with a different set of native species, to be a unique object of research for analyzing the distribution of alien plants on a global scale.

Inventory of alien and native plants was carried out on the segments of the Trans-Siberian Railway, passing through the territory of the East European Plain, including the Central and the Northern Branch of the Railway were conducted. Some studies were also fullfilled on the railway plots of the Siberian regions (Irkutsk region and Buryatia). We studied 30 railway stations located in six natural biomes. At each site three different ecotopes were studied: on the railroad bed, on slopes and in the railroad embankment. A total of 112 geobotanical descriptions were compiled. 469 species of vascular plants were detected within the territories studied: 57 woody plants, 275 polycarpic herbs and 137 species of monocarpic herbs. Among the species there are 132 invasive plants.

Factor analysis has been carried out to assess the presence of invasive species in various regions along the Trans-Siberian Railway made it possible to visualize differences in the nature of their distribution at different regions and biomes.

In result of our study we revealed a correlation between the characteristics of natural biomes and the main floristic indices. Plant’s number in the Trans-Siberian Railway positively correlates with the total number of vascular plant species recorded in the biomes: the highest number of both woody and herbaceous species, and both on the railroad bed and on the slopes, is noted in segments passing through the Smolensk-Privolzhsky biome. In terms of reducing the number of plant species, the ecotopes of the railway located in the following range: slopes of the railway → railroad bed → infiltration ditch. According to the Sørensen's similarity coefficient, the highest similarity is observed between the flora of slopes (53%), similarity of local flora of the railway bed is lower (44%), and very low (20%) similarity of flora is noted for infiltration ditch. Only 2 species are found in all six biomes, all of them being alien invasive species (*Acer negundo, Amaranthus retroflexus*) are among the TOP-100 the most dangerous invasive species in Russia. The Trans-Siberian Railway serves both as a recipient of alien species "escaping" from settlements and as a main vector for their further dispersal along the transport corridor.

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SPAWNING SEASON, FECUNDITY AND SIZE AT FIRST MATURITY OF ALIEN SUCKERMOUTH-AMORED CATFISHES (*PTERYGOPLICHTHYS* SPP., LORICARIIDAE) IN KHANH HOA PROVINCE, SOUTHERN VIETNAM

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Pterygoplichthys spp. has been reported as an invasive species which distributed mostly in all major water bodies in southern Vietnam. This study investigated reproductive biology of *Pterygoplichthys* spp. to control their invasion. Total 389 females were collected in two typical types of water bodies including lotic (Dinh river: 12°29.740' N, 109°7.686' E) and limnic (Suoitrau reservoir: 12°30.302' N, 109°2.694' E) habitats in southern Vietnam from March 2019 to February 2020. The histological examination of gonad and gonadal somatic index (GSI) indicated that these fish can breed all year round. The main reproductive season prolonged from April to October with a peak from July to August. The greatest GSIs of the fish populations at Dinh river and Suoitrau reservoir were 14.94 % and 8.48 %, respectively. The length at 50 % maturity of females from Suoitrau reservoir was 188.3 mm and these from Dinh river was 249.9 mm total length. Fecundity in the biggest individual up to 10000 oocytes/individual (TL = 450 mm, W = 943 g and w_{gonad} = 134.26 g) and the smallest individual at first maturity was only 167 mm in length and 40 g in weight. Results of this study showed that *Pterygoplichthys* spp. in southern Vietnam has high reproductive capacity. Also, the length at first maturity of these fish was smaller than that of indigenous species, indicating that they have ability to grow rapidly and dominate their habitats. This study suggested that these fish could be eliminated by removing them from their habitats during their breeding season, July-August, at which the ambient temperature is highest and the water levels in most water bodies are usually the lowest. Additional measures such as raising public awareness about the harmful effects of these fish or supporting from local governments are also important to eradicate this alien species.

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ENDEMIC AND COSMOPLITE SPECIES OF THERMOACIDOPHILIC RED MICROALGAE *GALDIERIA* FROM KAMCHATKA PENINSULA AND KURIL ISLANDS

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Extremophiles can be defined as organisms thriving in uncommon habitats. Cyanidiales are unicellular polyextremophilic red algae that inhabit acidic (pH = 1-2) and high temperature (55 ^{0}C) sites around hot sulphur springs. The firstly described member of this group, *Cyanidium caldarium* was find as well as in the middle of the 19th century in Italy. It has been classified variously as a blue-green alga, a green alga, a coccoid cryptomonad, or a symbiotic association between a blue-green alga and a colorless chlorophyte. Only in the early 1980s morphological, physiological and ultrastructural data were used to invalidate the previous descriptions, and made a definitive revision of the taxonomy of this species as a red microalga. Two additional species of Cyanidiales were formally recognized: *Galdieria sulphuraria,* and *Cyanidioschyzon merolae*. Ten years later, O.Yu. Sentsova isolated three new species of *Galdieria* in Russia: *Galdieria partita* Sentsova, together with *Galdieria daedala* Sentsova from Kamchatka peninsula and *Galdieria maxima* Sentsova from Kunashir Island. These regions form a part of the well-known volcanic Pacific Ring of Fire. In the last years, only one additional species named *Galdieria pflegrea* was described. *G. partita* and *G. daedala* are endemics while *G. maxima* was found later in some other volcanic regions. In summary, of five known *Galdieria* species three were found in Russia. All *Galdieria* species described by O.Yu. Sentsova are included in microalgae collections of Faculty of Biology Moscow Lomonosov State University (Russia) and of Timiryasev Institute of Plant Physiology RAS (Russia). In time of several years, our research group has determined chromosome number equal to two of all *Galdieiria* species. Besides, we have described a new form of highly branched glycogen and a new type of chlorophyll biosynthesis inhibition at thelevel of protoporphyrin IX formation in *G. maxima*.

Fugure. Discontinuous distribution of *Galdieria* species in natural habitats of Russian Far East

All data collected to date suggest that thermoacidic volcanic environments throughout the world are inhabited by communities of species of Cyanidiales. *Galdieria* species are acido-thermophilic and can grow autotrophically, mixotrophically, and heterotrophically in the dark on over 50 different carbon sources. They can also tolerate high concentrations of metal ions. All these characteristics make *Galdieria* species ideal organisms for genome sequencing and understanding the process of adaptation to extreme conditions and also genome evolution. Many genes that contribute to Galdieria's adaptations were determined not to be inherited from ancestor red algae but were acquired from bacteria or archaebacteria. *Galdieria* and other members of Cyanidiales are the only one known organism with a nucleus (called a eukaryote) that have adapted to extreme environments. Microalgae possess a high potential for producing pigments, antioxidants, and lipophilic compounds for industrial applications promoting the concept that *Galdieria* might have biotechnological utility.

RISKS OF DISPERSAL OF ALIEN VASCULAR PLANT SPECIES IN CONNECTION WITH DEVELOPMENT OF THE TRANSPORT AND RECREATIONAL INFRASTRUCTURE IN THE VALDAI NATIONAL PARK

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The territory of the Valdai National Park is an area of ancient economic development. In the first years of its foundation in 1990, the forest-meadow-field structure of the vegetation cover and the species composition turned out to be rather conservative to the penetration of alien species. However, in recent decades, there has been an increase in the process of dispersal of alien plants throughout the park. The expansion and reconstruction of transport infrastructure, as well as the growth of recreational loads facilitate this.

Within the park, there are 151 settlements taking in account Valdai town. The population is about 36 thousands. During summer time, the population increase in more than twice for account of tourists and recreants.

On the territory of the Novgorod region and, therefore, in the national park area, the bulk of freight transport falls on the rail and road transport. From west to east in the center the Moscow - St. Petersburg highway and the branch of the Oktyabrskaya railway to Pskov cross it. In addition, the territory of the park is penetrated in latitudinal and meridional directions by roads, both covered and unpaved, through which the communication between settlements is carried out.

The flora of the National park includes 746 species of vascular plants from 96 families (Morozova et al., 2010); adventive species account for 18% (133 species from 42 families).

46 species of adventive flora of the park are found along roads of different levels. Among them, almost half are annuals. Herbaceous plants predominate and only 4 species are woody. Xenophytes - introduced accidentally, unintentionally (26) and ergasiophytes (18) - deliberately introduced or introduced, but more or less feral, are approximately equally represented. By the degree of naturalization, ephemerophytes predominate; colonophytes and agriophytes are represented in approximately equal shares.

Among the feral introduced species, the most dangerous is *Heracleum sosnovskyi,* which distributes actively along the territory of the park.

The possibilities and risks of the dispersal of alien plant species were significantly expanded by the fact that in a relatively short period of time (since 2005), new and modernization of existing linear structures and the active development of the recreational infrastructure were carried out within the boundaries of the park. Such objects, which entailed the risks of invasions, include: (1) the Valdai-Uglovka highway (43 km), the modernization of which (expansion, asphalting, etc.) and the construction of the Dolgie Borody-Uglovka section were completed in 2005; (2) a modernized "circle" road around lakes Valdai and Uzhin (Valdai - Dolgie Borody village - Uzhin village - Shuya village - turn to the Iversky Monastery - Zimogorye village - Valdai town) with a section of a dirt road between villages Uzhin and Shuya; (3) a section of the Moscow - St. Petersburg high-speed highway (points 408 - 434 km) in close proximity to the northern borders of the National park (preparation and construction 2010-2014); (4) a new power transmission line (2014) and reconstruction of a branch from the main gas pipeline to Dolgie Borody village through the Kopka channel, which connects lakes Valdayskoye and Uzhin (2018); (5) construction of a "non-public" railway from the old section Valdai - Kresttsy (1916) to the village of Dolgie Borody in quarters 43-46, 56.57, 72 of the Valdai National Park (2018); (6) arrangement of the Great Ecological Trail (59 km, 2019-2020), ecological trails, cordons and lakeside sites (more than 20 in total on the lakes Valdayskoe, Uzhin, Vel'yo, etc.).

Research prospects are associated with the study of the adventive component of the flora of these new structures. The entire system of protected areas in Russia needs strict regulations for the development of transport and recreational infrastructure. This will reduce the risks of invasions of alien species of vascular plants and preserve their unique aboriginal floristic complex.

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ALIEN SPECIES IN THE ZOOPLANKTON OF THE KAMA AND VOTKINSK RESERVOIRS

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Since 2012, the North American rotifer species *Kellicottia bostoniensis* (Rousselet, 1908) has been recorded in the zooplankton of the Kama Reservoir. The new species lives together with the native species *K. longispina* (Kellicott, 1879). The average number of rotifers is 94 ± 40 ind./m^3; it is found mainly in the upper and central parts of the Kama reservoir. This species was not recorded in the Votkinsk reservoir.

In both reservoirs, southern thermophilic species of invaders are noted - cladocera *Cercopagis pengoi* (Ostroumov, 1891), copepods *Heterocope caspia* G.O. Sars, 1897 and *Eurytemora caspica* Sukhikh & Alekseev, 2013, these species are brackish-water Caspian forms.

Cercopagis pengoi has been observed since 2016, it is more common in the lower region of the Kama reservoir, Chusovsky Bay and the upper region of the Votkinsk reservoir. Its abundance at different sites varied from 1326 ind./m^3 to 6 ind./m^3. The highest rates are noted in 2020 in the Sylven Bay of the Kama Reservoir.

Since 2016, the copepod *Heterocope caspia* has been recorded; this species is found in reservoirs everywhere. The maximum values of the abundance were 28294 ind./m^3; they were recorded in the lower region of the Votkinsk reservoir. The smallest indices of abundance - 14 ind./m^3, were recorded in the central region of the Votkinsk reservoir.

Eurytemora caspica has been found since 2012 in the Kama and Votkinsk reservoirs. The maximum values of the abundance were recorded in the central region of the Kama reservoir and amounted to 7516 ind./m^3. The minimum values, 13 ind./m^3, were recorded in the upper area of the Votkinsk reservoir.

INVASIVE SPECIES IN GRASSY PLANT COMMUNITIES OF THE KABARDINO-BALKARIA REPUBLIC (CENTRAL CAUCASUS)

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Among invasive plants, we can distinguish two groups of species. The first group includes plants that grow only within urbanized areas. According to our observations, in the Kabardino-Balkaria Republic, this group of species includes *Acalypha australis* L., *Galinsoga parviflora* Cav., *G. quadriradiata* Ruiz et Pav., *Duchesnea indica* (Jacks.) Focke, *Oxalis stricta* L., *O. corniculata* L. *Phytolacca americana* L., *Reynoutria japonica* Houtt., *Solidago canadensis* L., *Vinca minor* L., *Elsholtzia ciliata* (Thunb.) Hylander, *Allium ramosum* L., *Portulaca oleracea* L., *Sigesbeckia orientalis* L., *Bidens frondosa* L., *Commelina communis* L., *Ipomoea purpurea* (L.) Roth., *Cosmos bipinnatus* Cav., *Symphyotrichum novae-angliae* (L.) G.L. Neson, *Amaranthus albus* L., *A. cruentus* L., *Digitaria sanguinalis* (L.) Scop., *Cuscuta campestris* Yunck., *Anethum graveolens* L., *Lepidium densiflorum* Schrad., *Paspalum thunbergii* Kunth ex Steud., *Mercurialis annua* L., Eleusine indica (L.) Gaertn., *Euphorbia davidii* Subils, *E. nutans* Lag. These species spread easily along the walls of houses, fences, in unkempt lawns, flower beds, and in other anthropogenic modified habitats.

The second group includes species that occur not only in urbanized areas, but also as part of natural plant communities. The species of this group are *Ambrosia artemisiifolia* L., *Matricaria matricarioides* (Less.) Porter (=*Chamomilla suaveolens* (Pursh) Rydb.), *Erigeron canadensis* L. (=*Conyza canadensis* (L.) Cronquist), *Echinochloa crus-galli* (L.) P.Beauv., *Echinocystis lobata* (Michx.) Torr. & A.Gray, *Erigeron annuus* (L.) Pers. (=*Phalacroloma annuum* (L.) Dumort.), *Sorghum halepense* (L.) Pers., *Amaranthus retroflexus* L., *Juncus tenuis* Willd., *Anthemis coluta* L., *Hemerocallis fulva* L., *Helianthus tuberosus* L., *Cuscuta europaea* L., *Oenothera biennis* L., *Bellis perennis* L., *Helianthus annuus* L., *Oplismenus undulatifolius* (Ard.) P. Beauv., *Lycopersicon esculentum* Mill., *Xanthium spinosum* L., *X. albinum* (Widd.) Scholz & Sukopp Some of these species grow in post-forest meadows, usually used as hayfields, while others grow in pastures.

Erigeron annuus spreads mainly in the foothills of the Kabardino-Balkaria Republic (400-900 m above sea level), where it takes a significant participation in the vegetation cover of hayfields. Based on the descriptions of meadows in the vicinity of the villages Yerokko and Urukh (Leskensky district), we identified a derivative community *Erigeron annuus* [Molinio-Arrhenatheretea/Artemisietea vulgaris]. Two classes were most fully expressed here – *Molinio-Arrhenatheretea* R.Tx. 1937 (united communities of post-forest meadows) with species *Poa pratensis* L., *Festuca pratensis* Huds., *Trifolium pratense* L., *Achillea millefolium* L., *Trifolium repens* L., *Dactylis glomerata* L., *Plantago lanceolata* L., *Prunella vulgaris* L., *Lathyrus pratensis* L., *Lotus corniculatus* L., and *Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951 (united synanthropic communities) with species *Artemisia vulgaris* L., *Berteroa incana* (L.) DC., *Cichorium intybus* L., *Convolvulus arvensis* L., and *Erigeron canadensis.* The abundance of *Erigeron annuus* in most communities was 16-25%. The vegetation cover of such hayfields was 85-95% with a species richness of 23-34. In recent years, we observed single plants and groups of *Erigeron annuus* plants in the highlands of the region.

Matricaria matricarioides is a North American species that was first recorded in the Kabardino-Balkaria Republic in 1959. Characterized by high resistance to trampling, the species successfully spread throughout the region on the roadsides, along the cattle runs, and penetrated into pastures. *Matricaria matricarioides* is the diagnostic species of class *Plantaginetea majoris* R. Tx. et Preising in R. Tx. 1950 along with species adapted to trampling (*Trifolium repens*, *Capsella bursa-pastoris* (L.) Medik., *Plantago major* L., *Poa annua* L., *Polygonum aviculare* L., *Taraxacum officinale* F.H. Wigg.). Within this class, we identified the association *Plantagini-Polygonetum avicularis* (Knapp 1945) Pass. 1964, the communities of which are distributed in the Cherek-Bezengi, Khaznidon, Adyr-su, Adyl-su, Terskol gorges. The communities were low-species (6-17 species), low-grass (2-15 cm), vegetation cover was from 45 to 100%, the abundance of *Matricaria matricarioides* was 1-15%.

Investigation of the surroundings of villages in the plain territories (Deyskoye, Planovskoye, Verkhny Kurp, Dalnoye, Priblizhnoye, Urvan, Chegem villages) revealed the penetration of *Ambrosia artemisiifolia*, *Erigeron canadensis, Echinochloa crus-galli*, *Sorghum halepense*, *Xanthium spinosum*, *X. albinum* into the plain pastures. Employees of the Laboratory for Geobotanical research of the Tembotov Institute of ecology of mountain territories RAS monitor invasive and quarantine plants that are dangerous for Kabardino-Balkaria Republic.

PARASITES OF NONINDIGENOUS AQUATIC SPECIES IN THE UPPER VOLGA RESERVOIRS

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Our approaches are based on the concept that some parasites of invasive fish and mollusks can function as great ecological factors in a fresh water ecosystem. In the resent years, climate change is the main reason for changes in parasite communities in the Upper Volga basin (Tyutin and Slynko, 2010; Tyutin et al., 2013; Tyutin and Izvekova, 2013; Perova et al., 2018). Climate warming has created favorable conditions for the range expansion of many southern Ponto-Caspian freshwater fish and mollusks through the Caspian-Volga-Baltic "invasion corridor". Usually, the absence of specific parasites and resistance to native parasites give the advantage for southern species of fish invading into Volga reservoirs in comparison with aboriginal fish species. For example, only a few cases of a significant increase in prevalence (up to 80–100%) of ectoparasitic ciliate *Ambiphrya ameiuri* Thompson, Kirkegaard, Jahn, 1947, the monogenean flatworm *Gyrodactylus proterorhini* Ergens, 1967 and aboriginal metacercariae were registered in the samples of the tubenose goby *Proterorhinus semilunaris* (Heckel, 1837) from the Rybinsk Reservoir. On the contrary, in the populations of North European vendace *Coregonus albula* Linnaeus, 1758, two specific cestodes such as *Triaenophorus crassus* Forel, 1868 and *Proteocephalus longicollis* (Zeder, 1800) were observed.

Most successful alien helminths were associated with southern invasive mollusks. For example, in populations of *Dreissena polymorpha* (Bivalvia, Dreissenidae) in the Upper Volga the trematodes *Neoacanthoparyphium echinatoides* (de Filippi, 1854), *Echinoparyphium recurvatum* (Linstow, 1873), *Aspidogaster limacoides* Diesing, 1834, *Phyllodistomum macrocotyle* (Lühe, 1909) (Olfers, 1926), *Bucephalus polymorphus* Baer, 1827 were found. Also, in the colonies of *Lithoglyphus naticoides* (C. Pfeiffer, 1828) (Gastropoda, Hydrobiidae) high prevalence of parthenitae of *Apophallus muehlingi* (Jagerskiold, 1898), *Apophallus* (=*Rossicotrema*) *donicus* (Skrjabin et Lindtrop, 1919), *Parasymphylodora markewitschi* Kulakowskaja, 1947, *Nicolla skrjabini* (Iwanitzky, 1928), *Sanguinicola volgensis* (Razin, 1929) was recorded. Some metacercariae or maritae of these alien trematodes can be pathogenic for invertebrates, fish, birds and mammals. It is found that the formation of the first permanent colony of *Lithoglyphus naticoides* took place in 2005–2010 in coastal shallow waters in the lower part of the Volga reach of the Rybinsk reservoir. There was no rapid spread of the mollusk throughout the entire water area of the reservoir outside the Volga reach zone with a relatively high mineral content of water. However, in 2011–2019, the formation of a new large settlement of *Lithoglyphus naticoides* was recorded in the upper part of the Volga reach characterized by faster flow. The prevalence of parthenitae of certain species depends on the reservoir water level regime but the overall infection of *L. naticoides* can exceed 90%. The slow-flowing lower part of the Volga reach is characterized by the dominance of *Parasymphylodora markewitschi* and trematodes of the genus *Apophallus*, but *Nicolla skrjabini* and *Sanguinicola volgensis* dominate in the upper section, which is close to the river type. A few cases of mixed infection with parthenitae (*Apophallus*+*Parasymphylodora*) were recorded in the slow-flowing lower part of the Volga reach of the Rybinsk reservoir. In the upper section of the Rybinsk reservoir mixed infection with two species of trematodes is more common (*Sanguinicola*+*Nicolla*, *Nicolla*+*Parasymphylodora*). It is found that in the Upper Volga colonies of *Lithoglyphus naticoides* the species composition of trematodes is similar. Abundance of *L. naticoides* varies from 30 to 50 ind./m^2 in the shallows of the Rybinsk reservoir and from 50 до 520 ind./m^2 in the Uglich reservoir where the mollusk is found at a depth of 2–9 m. Due to the high occurrence of trematodes *L. naticoides* is able to have a significant impact on the ecosystems of reservoirs even with a relatively low size of its populations. The aboriginal isopod *Asellus aquaticus* (Linnaeus, 1758) and the Baikalian amphipod *Gmelinoides fasciatus* (Stebbing, 1899) were described as second intermediate hosts of *Nicolla skrjabini*. Many cases of apophallosis and rossicotremosis (black spot diseases) in the native fish population were registered (mainly in the Rybinsk and Gorky reservoirs).

For details see: Tyutin A.V., Verbitsky V.B., Verbitskaya T.I., Medyantseva E.N. Parasites of alien aquatic animals in the Upper Volga basin // Russian Journal of Biological Invasions. 2013. Vol. 4. No. 1. P. 54–59. https://doi.org/10.1134/S2075111713010098

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CURRENT STATE OF THE INVASIVE TUBENOSE GOBY (GENUS *PROTERORHINUS*) POPULATION IN THE EASTERN GULF OF FINLAND

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Annual coastal fish community monitoring was conducted on shallow water biotopes of the eastern part of the Gulf of Finland in 2010-2020. Coastal shoals were investigated using of the beach seine. Thirty-six fish species recorded in samples include five invasive species among them. Two Gobiidae species are the most abundant and widely distributed invaders – tubenose goby *Proterorhinus marmoratus* (Pallas, 1814) and round goby *Neogobius melanostomus* (Pallas, 1814).

The first record of tubenose goby in the lower Neva River occurred in 2006, and in 2007 a few specimens were caught in the Neva Bay (Antsulevich, 2007). In the period of our investigation tubenose goby was recorded annually since 2011. Nowadays tubenose goby is widely distributed on shallow water vegetated biotopes of the Neva Bay and below the northern coast to the eastern part of the Vyborg Bay and along the southern coast of the Gulf. Goby shows preference both to sandy or stony bottoms with well-developed underwater vegetation primarily consisting of filamentous algae (Uspenskiy, 2020). The max salinity for goby occurrence in samples till 2017 was rated no higher than 3 ‰; and the distribution area was restricted the western coast of the Koporye Bay. Late in 2019-2020 species was recorded in high numbers within the salinity up to 3.9‰; it's distribution area along the southern coast extend the mouth of Narva river. In the 2020 tubenose goby was caught by the fishing trap in the Luga river around 12 km above estuary. Along the north coast of the gulf species distribution reach the eastern part of the Vyborg Bay from 2013 till now. Anyway, tubenose goby wasn't been recorded beyond the oligohaline zone.

In general, the species is not abundant on shallows in the first half of summer, but in August and September it may be numerous in samples. Tubenose goby was mainly observed in the Inner Neva Estuary (49.5 % of goby samples) and in the Neva Bay (19% of goby samples), and the less in the Vyborg and Luga Bays (4 and 5 %, respectively). The highest mean density (Figure) was observed in the Inner Estuary (11.5±4.16 ind./100m^2), and the less was in Vyborg Bay (0.9±0.30 ind./100m^2). The max value (162 ind./100m^2) of goby abundance was estimated in the Inner Estuary in 2016.

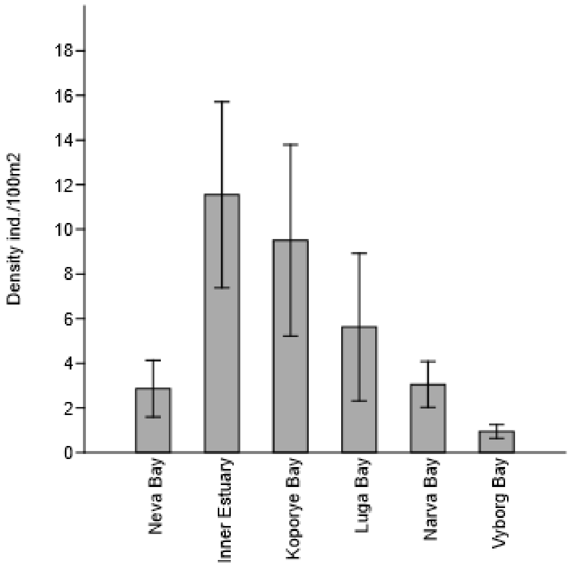

Figure. Mean values of the tubenose goby densities in the different areas of the eastern Gulf of Finland between 2010−2020

In samples tubenose goby was presented by numerous juveniles and adults up to 64 mm length (Sl). Two age groups were observed in the tubenose goby samples after the otolites examination: young-of-the-year (0+) and one-year old (1 and 1+) gobies. The spawning of the tubenose goby starts in June and continues until the end of summer. All spawning specimens were aged 1+.

During the last decade we observe intense and successful naturalization of the tubenose goby in the eastern Gulf of Finland. The further increase of abundance and colonized area may be apparent.

WHICH IMPATIENS IS EATEN MORE? COMPARISON OF LEAF DAMAGE AREA OF TWO INVASIVE IMPATIENS (*IMPATIENS GLANDULIFERA* AND *I. PARVIFLORA*) BY LEAF MINERS

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Invasive plants in the secondary range, as a rule, are free from the pressure of herbivores (the enemy release hypothesis). However, over time, native herbivores adapt to feeding on an invasive species. Understanding of the mechanism of the native herbivores' adaptation to invasive plants is very important for the biological control of invasive species.

Impatiens glandulifera Royle and *Impatiens parviflora* DC. are two invasive species of the family Balsaminaceae. Both species were introduced to Russia at the end of the 19th century, but began to expand their range in the 1960-1970s. In recent years, the leaves of invasive impatienses have been severely damaged by leaf miners. We compared the preferences of leaf miners for two invasive impatiens to investigate host shift mechanism of native insects to invasive plants.

Impatiens leaves with feeding tunnels of leaf miners were collected in September 2020, when the miners have already left the leaves. The leaves were press dried and then scanned in black and white. The number of pixels was measured using the Adobe Photoshop program, and then the area of the feeding tunnels, as well as the total leaf area, was calculated.

The collected leaves of the *I. parviflora* were significantly larger than the *I. glandulifera* leaves (Table). However, *I. glandulifera* leaves were significantly more damaged by leaf miners when measuring both the absolute area of damage and the ratio of the damaged area to the leaf area (Table).

Table. Comparison of the leaf damage area of two invasive touch-sensitives. Mean and standard deviations are indicated.

	Impatiens glandulifera (N = 85)	*Impatiens parviflora* (N = 69)	p-value in Mann-Whitney test
Leaf area (cm^2)	26.96±12.86	45.26±17.32	<0.001
Damage area (cm^2)	2.29±1.08	1.76±1.22	0.003
The ratio of the damaged area to the leaf area	0.11±0.08	0.06±0.04	<0.001

No correlations were revealed between the leaf area and the feeding tunnel area for either the *I. glandulifera* (Rs = -0.05; p = 0.657) or *I. parviflora* (Rs = 0.09; p = 0.440). Of the 69 damaged leaves of *I. parviflora*, 14 had more than one mine, and *I. glandulifera* had more than one mine on 7 of the 85 damaged leaves. However, Fisher's exact test showed that these differences have only marginal significance (p = 0.067).

Thus, in spite of the fact that both species belong to the same genus and were introduced at about the same time, the miners prefer the *I. glandulifera*. This may be due to the different nutritional value of the leaves, the different content of defensive metabolites, or with the different habitats of these species.

The study was carried out within the framework of the scientific project of the state assignment of Moscow State University No. 121031600198-2.

ALIEN SPECIES IN THE ZOOPLANKTON OF AQUATIC ECOSYSTEMS IN BELARUS

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In the water bodies of Belarus, the penetration of alien species is better studied for benthic communities. By now, only two species are known among plankton organisms: the rotifer *Kellicottia bostoniensis* (Rousselet, 1908) and the copepod *Eurytemora velox* (Lilljeborg, 1853).

We found *K. bostoniensis* on 15 August 2013 in the plankton of the Sozh old river bed closely to the Ippolitovka village, upstream from the city of Chechersk in the amount of 6 specimens (Vezhnovets, Litvinova, 2013). The presence of this species was confirmed here on 17 June 2020 when 8 specimens were found; there were 3 ovigerous females among them. It hasn't yet been found in other similar habitats of this river basin because of its lower density about 20 ind./m^3 with a relative density only 0,008 % of the total number of the zooplankton community. The total length of the measured animals ranged from 328 to 380 micrometers with an average value of 361 micrometer. The body length was constant – 112 micrometers. Thorns sizes varied significantly: the anterior thorn from 124 to 148 micrometers with an average 138, the posterior thorn from 92 to 120 (an average – 108). Determined sizes do not differ from those of animals in European and North American populations (Zhdanova, Dobrynin 2011).

The ways and means of penetration to the territory of Belarus haven't yet been investigated. Among Belarus neighboring countries, it is known only from Russia. In the Russian Federation, this species is found only in the European part and known from two lakes of the Leningrad Region (Ivanova and Telesh, 2004); it is often found in the Nizhny Novgorod region (Bayanov, 2014). In general, in the European part of Russia, *K. bostoniensis* is found in the zooplankton of 13 different lakes and 9 rivers of the Central region (Ryazan, Vladimir and Tver regions) and 4 lakes of the North-Western region (Novgorod region). Its distribution is expected along transboundary rivers from neighbor Russia (Zhdanova, Dobrynin 2008, 2011, Zhdanova et all., 2015).

By now, *E. velox* inhabited the main rivers of southern Belarus, belonging to both the Black Sea and Baltic Sea basins. Small rivers and inflows are less susceptible to the introduction of this species. The occurrence along the central European invasive corridor indicates the most probable way to the water bodies of Belarus from the lower reaches of the Ukrainian part of the Dnieper River.

The number in lakes and rivers ranged widely (from single specimens to thousands per m^3). Population density was higher in water bodies of the Baltic basin compared to the rivers of the Black Sea basin. The relative number of this species in plankton, including the nauplial stages of development, does not exceed 1 %. Compared to the current zone and a pelagic zone, the number is higher in the coastal area.

The body sizes of the alien copepod *Eurytemora velox* at all development stages were established. The size characteristics in the acquired region are lower than those, given in the literature for brackish-water habitats of an original region and some freshwater habitats of Western Europe. The breeding season of the crustacean is lasted from June to October with maximum in July-August. It has been determined that there is the presence of some generations in the Eurytemora population development, most probably 3-4, based on seasonal changes in the total number and its younger age groups. By winter, the population comes with the copepodit stages and the breeding processes are stopped. The determined fertility of *E. velox* in the water bodies of Belarus is the same as in the other freshwater habitats in the area according to the literature data.

THE "BLACK BOOK" OF THE RUSSIAN FAR EAST FLORA

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The checklist of the species invading the natural plant communities of the Far Eastern Federal District of Russia (FEFD) was made. The territory of FEFD covers an area of 6 952 555 km^2, which is 40.6 % of the total area of the Russia. The work is based on the original data on the distribution and the invasiveness of alien plant species provided by the researchers working in 11 territorial subjects of the FEFD: the Amur Region, the Republic of Buryatia, the Jewish Autonomous Region, the Trans-Baikal Territory, the Kamchatka Territory, the Magadan Region, the Primorsky Territory, the Republic of Sakha (Yakutia), the Sakhalin Region, the Khabarovsk Territory, and the Chukotka Autonomous District (Figure).

The "Black Book" of the FEFD includes 117 invasive alien species belonging to 99 genera from 32 families. 19 species are only beginning to invade natural plant communities; 76 species intensively invade natural plant communities; the most aggressive invasive species (=transformers) are represented by 22 species, of which *Ambrosia artemisiifolia, Bidens frondosa, Solidago canadensis, Impatiens glandulifera* and *Hordeum jubatum* are more widely distributed.

Four historical stages of invasive species penetration into the region have been identified. 47 invasive plant species were registered for the first time before the construction of the Transsib, i.e. before the beginning of the XXth century, 30 - from 1900 to World War II, 29 - from 1940 to 1980, i.e. before the start of the detail study of the alien component of the flora, and 11 species - from 1980 to the present time. There is a positive correlation between the period of formation of the secondary distribution range of an alien species and its representation in 11 regions of the FEFD and a negative correlation between the period of formation of the secondary distribution range and invasiveness of the species.

The labels of herbaria specimens of all the first findings are quoted in the book summarizing data of the largest Herbarium repositories: MHA, MW, LE, MIMB, VBGI, VLA, VGEO, MAG, SASY, KHA, KAM, Herbarium of the Sikhote-Alin Nature Reserve.

Because of a very strong heterogeneity of ecology there is considerable disparity in the list of alien species between various FEFD territorial subjects. Many species that actively colonize southern districts do not occur in the north, or only individual plants not capable to reproduction are noted.

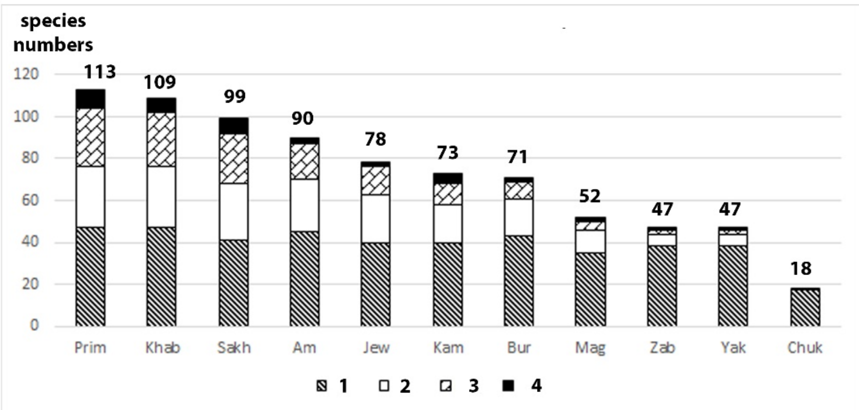

Figure Number of invasive species in administrative subjects of FEED. 1-4: historical stages of species invasion.

In general, the problem of the spread of invasive species in the Far East is not yet as urgent as in European part of Russia. However, one must take measures to control invasive species not when they have transformed the plant community, but when alien species only begin spreading actively. That is why, the authors included in the Black Book of the Far East ALL species, which tend to naturalize more than in one region, irrespectively of the area of their invasive range. This will help take concrete measures to prevent and mitigate the invasion of alien species.

The Black Book of the Russian Far East flora is the basis for making decision on prevention the economic and environmental damage of the natural biodiversity of the region.

For details see: Vinogradova Yu.K., et al. Invasive plants in flora of the Russian Far East: the checklist and comments. Botanica Pacifica. 2019. https://doi.org/10.17581/bp.2020.09107

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IDENTIFICATION OF THE QUARANTINE WEED SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM* CAV.), PECULIARITIES OF PUBESCENCE AND DEVELOPMENT OF DNA MARKERS BASED ON CHLOROPLASTIC INTERGENE SPACERS

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The nightshade (*Solanum* L.) is the largest genus of flowering plants. Plants of the genus can be found on all continents; they grow in both temperate and warm climates. It consolidates together well-known cultivated as well as invasive and weedy species. One of the invasive weed species is silverleaf nightshade (*S. elaeagnifolium* Cav.). It occurs in both North and South America, and is a harmful invasive weed in dry areas worldwide. It has become adventive on almost all continents and has received the quarantine status in Australia, Canada, Georgia, Moldova, Ukraine, Azerbaijan, EPPO and EAEU countries. In the Russian Federation, this species is absent, but there is a risk of penetration with imported seed and food materials. Silverleaf nightshade characterizes by highly variable morphological traits (shape of leaf, pubescence, etc.), and this variability has led to much synonymy, so in recent years, most researchers have adopted a broad interpretation of the species. The pubescence of the leaves of *Solanum* is represented by multicellular covering trichomes of various sizes. Trichomes perform many functions to provide protection against adverse biotic and abiotic environmental factors. They are also able to serve as a reliable morphological trait for the species identification of representatives of the genus *Solanum*. The study was aimed to estimate of the type of pubescence of *Solanum elaeagnifolium* Cav. and other quarantine species of this genus for the Russian Federation. Our investigation deals with the problem of using on the chloroplast DNA and design DNA markers for distinguish this species from another harmful nightshades.

In research were analyzed such characteristics of pubescence as: intensity (density) of pubescence, type and size of trichomes, number of lateral rays of stellate trichomes. The identified species-specific features of *Solanum* trichomes can be used to distinguish this polymorphic species. The nightshade revealed species-specific features of pubescence, which can serve as a reliable taxonomic trait for identifying individual species of Solanaceae. The phenotypic plasticity of the silverleaf nightshade does not affect such a morphological trait as pubescence, which retains its conservatism in different populations. The study revealed high intraspecific and interspecific variations in some regions of the chloroplast genome and identified SNPs unique to *S. elaeagnifolium* Cav. Based on the *trnL-trnT* chloroplast DNA intergenic spacer, DNA markers have been developed to identify this polymorphic species. Also, in the course of the study, intraspecific polymorphism of *S. elaeagnifolium* was revealed. Samples from the United States and northern Mexico are characterized by a 24 bp deletion. Samples from southern Mexico, Argentina and the Old World did not show this deletion. Further study of this polymorphism may, perhaps, better understand the ways of distribution of the quarantine species and / or its intraspecific polymorphism in different parts of the range. The data obtained can be used to identify this polymorphic species.

DOES THE NATURAL HYBRIDIZATION OF *DREISSENA POLYMORPHA* (PALL., 1771) AND *DREISSENA ROSTRIFORMIS BUGENSIS* (ANDR., 1897) OFTEN OCCUR?

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The zebra mussel (*Dreissena polymorpha*) and the quagga mussel *(Dreissena rostriformis bugensis*) are successful invasive species. These species are cause of significant ecological and economic problems in many countries. The zebra mussel and quagga mussel are characterized by overlapping habitats and similar reproductive behavior, and the introgressive hybridization may have a high possibility for them. Since the hybrids of these species can be more resistant to new environmental conditions in invasive area than the parental species, the question about hybridization frequency of these species is actual.

D. r. bugensis and *D. polymorpha* are the members of different subgenera. According to data of allozyme loci polymorphism, they are characterized by considerable genetic distance (Spidle et al., 1994). The nucleotide sequences of the 619 base pair in length COI gene fragment of the quagga and zebra mussels differ by 16–17% (Baldwin et al., 1996).

Data of previous genetic studies of hybridization of the zebra and quagga mussels are contradictory. In our analysis of polymorphism of species-specific allozyme loci of *D. r. bugensis* and *D. polymorpha*, we found an adult hybrid specimen (Voroshilova et al., 2010). However, in others investigations hybridization events were not revealed. The experiment of hybridization of *D. r. bugensis* and *D. polymorpha* in laboratory conditions has shown ambiguous results. Obtained hybrid larvae died, and it was not clear, if the conditions in those experiments have not been optimal for producing viable hybrid offspring, or high hybrids' mortality was resulted from the genetic incompatibility of these species (Nichols, Black, 1994).

In this study 273 individuals from seven reservoirs of the Volga River basin were investigated. Firstly, we analyzed polymorphism of allozyme locus *MDH-2**. The results of allozyme analysis were used to select of specimens for analysis of polymorphism of mitochondrial COI gene fragment and nuclear 18S and 28S rRNA. We did not identify any hybrids of first generation in our study. Taking into consideration our results and results of other authors, we conclude that hybridization between *D. r. bugensis* and *D. polymorpha* in natural conditions occurs very rarely.

RAPID ASSESSMENT OF CERAMBYCID BEETLE BIODIVERSITY IN A TROPICAL RAINFOREST IN YUNNAN PROVINCE, CHINA, USING A MULTICOMPONENT PHEROMONE LURE

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The Cerambycidae, commonly known as longhorned beetles, comprise a large family of woodborers with >35,000 described species in eight subfamilies. The endophytic larvae develop in woody plants, and while some species have become globally important as invasive forest pests, they generally perform valuable ecosystem services by initiating the degradation of woody plants and can be indicators of forest ecosystem health. The purpose of this study was to examine the effectiveness of a generic lure as a potential monitoring tool for both biodiversity assessment and potential invasive species. Working in a subtropical forest in southwest China, we set traps baited with generic lures at ground level (1 m) and canopy height (~18 m) across 22 randomly located forest plots (12 regenerating forest, 10 mature forest). Three stations were established per plot and each plot was trapped for 7 days in May–June 2013. In total, 4541 beetles of 71 species were caught, including 26 species with 10 or more individuals. We used Hierarchical Modeling of Species Communities (HMSC) to analyze the data and produced informative models for 18 species, showing that trap height, slope, elevation, and leaf-area index were important determinants of cerambycid distribution. Our results demonstrate the potential for using generic lures to detect and monitor cerambycid populations, both for regulatory purposes and for the study of cerambycid beetle ecology. Further research should focus on refining lure blends, and on repeated sampling to determine temporal and spatial dynamics of cerambycid communities.

DISTRIBUTION OF ALIEN FISH SPECIES IN THE FOOTHILL RIVERS OF THE WESTERN SALAIR (UPPER OB' BASIN)

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In order to study the current state of the ichthyofauna of the rivers of the Salair mountain system in 2017-2018 and 2020, survey of a large right-bank tributary of the Upper Ob' - the Berd' River (Western Siberia) was carried out. The upper part of the river basin is characterized as foothill, and the lower part acquires a low-lying type. The species composition of fish of the upper, middle and lower reaches of the river, which differ in hydrological regime, has been studied. In total, 20 sections of the main channel from the source to the river mouth were examined. The collection funds of the Institute of Systematics and Ecology of Animals of the Siberian Branch of the Russian Academy of Sciences were also used.

The results show that 20 species are inhabitants of the river.

Two species are representing of Cephalaspidomorphy (*Lethenteron camtchaticum* and *L. kessleri)*, and 18 species from Actinopterygii (bream *Abramis brama*, bleak *Alburnus alburnus*, crucian *Carassius auratus,* gudgeon *Gobio gobio*, verkhovka *Leucaspius delineatus*, ide *Leuciscus idus*, dace *L. leuciscus*, minnow *Phoxinus* sp., roach *Rutilus rutilus*, siberian barbel char *Barbatula toni*, chipped fish *Cobitis melanoleuca*, pike *Esox lucius*, grayling *Thymallus arcticus*, burbot *Lota lota*, siberian sculpin *Cottus sibiricus*, ruff *Gimnocephalus cernuus*, perch *Perca fluviatilis*, pikeperch *Sander lucioperca*). Alien complex include 25% of Actinopterigii, they are *A. brama*, *A.alburnus*, *C. auratus, L. delineates, S. lucioperca*.

Fish community from upper stream of the river includes 11 species (*A. alburnus*, *G. gobio*, *L. delineates*, *L. leuciscus*, *Phoxinus* sp., *R. rutilus*, *B. toni*, *C. melanoleuca*, *E. lucius*, *Thymallus arcticus, C. sibiricus*). The share of alien fish species is 8% of the total number and less than 5% of biomass.

12 fish species are widespread in the middle section of the river (*A. alburnus*, *G. gobio*, *C. auratus*, *L. delineates*, *L. leuciscus*, *Phoxinus* sp., *R. rutilus*, *B. toni*, *C. melanoleuca*, *E. lucius*, *P. fluviatilis, C. sibiricus*). The fish community is dominated by gudgeon, it accounts for 48% of the total fish population. Alien species part is about 25% of the total number and 20% of the biomass.

15 fish species distribute in the low river section (*A. brama*, *A. alburnus*, *G. gobio*, *L. delineates*, *L. idus*, *L. leuciscus*, *Phoxinus* sp., *R. rutilus*, *B. toni*, *C. melanoleuca*, *E. lucius*, *L. lota*, *G. cernuus, P. fluviatilis*, *S. lucioperca*). Roach and bleak predominate in abundance and biomass of fish. The portion of alien species (bleak and verkhovka*)* exceeds 45% of the total number and 35% of the fish biomass.

Assessing the species diversity of different parts of the river, it should be noted that in the upper section of the river the number of gudgeon and minnow (native species) is 85%. In the middle reaches, more than 70% are gudgeon (48%) and bleak (23%); in the lower reaches, the share of bleak exceeds 50% of the total fish abundance, which reflects an increase in the role of alien species in the fish community in the lower stream of the river.

The predominance of the abundance of two species relative to all the others indicates a low level of taxonomic diversity of fish in the Berd River. Shannon Species Diversity Index is 2.54 for upper section of the river, 2.15 for its middle section and 2.27 for low part.

Indicators of taxonomic similarity of fish communities in different parts of the river reflect significant differences between them. Comparing of the species composition of the lower and middle reaches of the river, 62% of similar species were revealed (Jaccard index = 0.56), it is 83% between middle and upper reaches (Jaccard index = 0.77), there is the least similarity between the upper and lower reaches (56%, Jaccard index = 0.50).

On the general results of the ichthyofauna study of this foothill river, it should be noted that the relative number of alien species in the fish community tends to increase as the stream speed decreases.

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DETECTION OF TWO MYXOSPOREAN SPECIES OF THE GENUS *KUDOA* (MYXOSPOREA: KUDOIDAE) IN TWO SPECIES OF INVASIVE GOBIES (ACTINOPTERYGII: GOBIIDAE) IN THE BLACK SEA

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When we studied the fauna of myxosporeans of the Black Sea fishes in the Sevastopol region, we investigated two species of invading gobies, in the muscles of which two species of the genus *Kudoa* were first found.

In July 2012, at the mouth of the river Chernaya in a chameleon goby *Tridentiger trigonocephalus* Gill, 1859, whose native range is the Pacific Ocean - Japan, Yellow and South China Seas, was found by *Kudoa nova* Naidenova, 1975. The average prevalence of invasion by this parasite was 13%. It was found in 1 of 8 specimens of fish, studied in 2010-2013 at the mouth of the river Chernaya, with the intensity - thousands of spores in the smear. *K. nova* was previously known in 26 host species - in 15 aboriginal fish species (family Gobiidae) in the Azov and Black Seas basin and in 10 fish species of other families (Sparidae, Scombridae, Carangidae, Pomatomidae) in the Mediterranean Sea and the Atlantic Ocean, and in the native range *K. nova* was found in *Myoxocephalus brandtii* (Steindachner, 1867) (family Cottidae) from the Sea of Japan. We believe that *Kudoa nova* was acquired by the invader *T. trigonocephalus* from aboriginal gobies, among which it has lived for many years, and which are also infected with this parasite. The fact that the chameleon goby is a new host for *K. nova* was stated by us in 2014. The size of the parasite's spores varied within the limits previously known from the Azov-Black Sea goby species; the shape of the spores corresponded to the original description. Spore length 3.8 μm (here and further, all measurements are in micrometers), spore thickness 5.39±0.21 (5.10–5.85), their width 6.62±0.25 (6.32–7.30), length of polar capsules 2.02±0.04 (1.94–2.15), width of polar capsules 1.12±0.03 (1.05–1.19).

In July 2018, *Kudoa niluferi* Özer, Okkay, Gürkanli, Çiftçi and Yurakhno, 2018 was found in the RBC Bay (radiobiological corps of IBSS) in the red-mouthed goby *Gobius cruentatus* Gmelin, 1789, whose native range is the East Atlantic and the Mediterranean Sea. The average prevalence by this parasite was 13%. *K. niluferi* was found in 1 of 8 specimens of fish, studied in 2016-2019 in the bays of RBC and Karantinnaya, as well as in the area of Cape Fiolent (region of Avtobat), with the intensity - units of spores in a smear. Previously, this Black Sea parasite was described from a round goby *Neogobius melanostomus* off the coast of Turkey. *K. niluferi* is first recorded in the fauna of Crimea and Russia as a whole. The red- mouthed goby is the new host for this parasite. The spores had a slightly altered shape with slightly "crumpled" valve edges and much smaller sizes, which may indicate parasitization in an unusual host, with which parasite-host relations arose relatively recently. Spore length 3.89, spore thickness 4.39 ± 0.29 (3.92–4.79), their width 5.98 ± 0.45 (5.48–6.85), length of the larger polar capsule 2.03 ± 0.08 (1.89–2.14), length medium polar capsules 1.72 ± 0.11 (1.53–1.88), length of the smaller polar capsule 1.38 ± 0.18 (1.04–1.58), width of the larger polar capsule 1.26 ± 0.05 (1.2–1.31), medium - 1.17 ± 0.02 (1.15–1.19), smaller - 0.94 ± 0.04 (0.9–0.98). Identification of this species on the basis of morphological characters, the most characteristic of which are the unequal sizes of polar capsules with a spore form similar to *K. nova*, was confirmed by molecular biological research. In the course of molecular genetic analysis in order to clarify the species belonging of this member of the Kudoidae family, we analyzed spores from the muscles of *G. cruentatus* for the ribosomal 18S-rRNA gene. A phylogenetic tree with the calculation of bootstrap supports for branching nodes (1000 replications) was built in the MEGA 6.0 program using the "nearest neighbor" method (Neighbor Joining, NJ). Samples of myxosporeans from the red- mouthed goby (one specimen) were identified as *K. niluferi*.

The work was carried out within the framework of the state assignment_№ 121030100028-0 "Regularities of the formation and bioresources of the Azov-Black Sea basin and other parts of the World Ocean", as well as under the RFBR project № 18-44-920004 "Taxonomic and molecular genetic diversity of helminths and myxosporeans of common species of invaders in the coastal area of the Sevastopol region."

SOME DATA ON *AMORPHA FRUTICOSA* L. (FABACEAE) IN THE TERRITORY OF KAMYSHIN (VOLGOGRAD REGION)

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The North American species *Amorpha fruticosa* L. (the nomenclature of taxa corresponds to the International Plant Names Index), a dangerous invasive plant (ergaziophyte, agriophyte), is one of the representatives of alien flora included in the Black list of invasive plants in Russia.

For the Volgograd region it is included in the group of species of the 1st invasion status - "species-transformers" - which are actively introduced into natural and semi-natural communities displacing species of aboriginal flora. These species require special attention.

Amorpha fruticosa L. is found during our long-term studies of flora and vegetation in the Kamyshinskiy district of the Volgograd region and its administrative center - the city Kamyshin (its population - about 110 thousand people). The species is marked at 2 points within the city boundaries and in both cases, it has appeared there due to its use for landscaping.

One of the evidences of the species "aggressiveness" and successful naturalization near cultivation site is found on the northern sandy beach of the Kamyshinka-river (eastwards the Borodinskiy bridge) in 2017 (June).

Initially *Amorpha fruticosa* was used in landscaping the territory of one of the organizations located on the river bank. Later the species began to occupy actively the adjacent beach for about 50-60 m in length. Now in some places *Amorpha fruticosa* forms quite dense narrow (up to 1 m wide) "mini-thickets" the height of which can reach 0.5 m and more.

The species actively occupies the beach areas devoid of vegetation competing there mainly with *Phragmites australis* (Cav.) Trin. ex Steud. or sedges (*Carex melanostachya* M. Bieb. ex Willd. and *C. riparia* Curtis). On the beach sites where the vegetation cover has been formed to a certain extent it can compete with the species growing there (including mentioned above) among which we can find also alien representatives of the flora, including rather aggressive species (*Acer negundo* L., *Anthemis ruthenica* M. Bieb., *Cynanchum acutum* L., *Fraxinus lanceolata* Borkh., *Ipomoea purpurea* L. Roth, *Iris pseudacorus* L., *Lycopus europaeus* L., *Mulgedium tataricum* (L.) DC., *Plantago uliginosa* F. W. Schmidt, *Populus nigra* L., *Ranunculus repens* L., *Salix alba* L., *Ulmus pumila* L., *Xanthium albinum* (Widd.) H. Scholz et al.).

Despite the fact that *Amorpha fruticosa* is considered as the species non-demanding to soils and moisture, our findings allow to suggest that in arid climate with high (about 30 degrees and more) long-term (during several spring-summer-autumn months) temperatures observed in the Volgograd region last years, nevertheless, availability of water (moisture) helps successful naturalization and distribution of this species.

This becomes obvious if to compare the *Amorpha fruticosa* state in both points of its finding. On the Kamyshinka-river bank - where the plants are provided with enough water - the species has active development and wide distribution. But at another location (in the central part of the New City - Jubileinaya Street, 4a) where several specimens of *Amorpha fruticosa* have been planted, despite their good state, active distribution of the species on the surrounding territory is not observed. Most likely, perhaps, it is restrained by insufficient watering in very hot months.

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THE KARA SEA – SINK OR SOURCE OF THE SNOW CRAB OPILIO (*CHIONOECETES OPILIO*) POPULATION?

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Snow crab opilio (*Chionoecetes opilio*) originates from the Northwest Atlantic and North Pacific. It was observed for the first time in the Barents Sea in 1990s. Since then, it grew in numbers and spread throughout the north of the sea to such a degree that commercial fishery of this crab begun in 2016. The population also spread eastwards and reached Kara Strait and the northern tip of the Novaya Zemlya Archipelago soon after its discovery in the Barents Sea. However, it was first observed in the western part of the Kara Sea only in 2012, even though there were numerous expeditions to the sea previous to that.

In 2014, we mostly found just settled crabs in our trawl samples throughout the western part of the sea. Since then, we observed the growth and distribution of these crabs during our yearly expeditions to the Kara Sea using benthic trawl “Sigsbee” and an uninhabited, towed, submerged, inert vehicle (UTSI) “Video Module”. The population size structure and density is heterogeneous across the sea. Areas with strong Barents Sea water influence are inhabited by all size and age groups and contain reproducing specimens. Other areas, such as central west sea and bays of Novaya Zemlya are inhabited by crabs that seem to have settled in 2014 and/or around that time, developed to reproducing age, although at a much smaller size than in their native range. However, in most of these areas no young specimens were observed in recent years.

The size and development structure of larva in the Kara Sea suggests that there is an ongoing vector of introduction from the Barents Sea, as well as locally produced larvae. However, based on recent observations the larva does not settle, or does not survive early benthic stages. The reproduction and survival of these crabs is affected by temperature, salinity and ice free period that is needed for the development of its larvae, which has a long (couple of months) pelagic stage. Understanding the reasons for the absence of youngsters in the central Kara Sea is fundamental to understanding the dynamics of this species invasion process and predicting its survival and further spread in Russian Siberian seas.

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ALIEN AND RARE ZOOPLANKTON SPECIES IN MOUTH AREAS OF TRIBUTARIES OF THE MIDDLE VOLGA LOWLAND RESERVOIRS

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Research of aquatic alien species mainly focuses on large organisms, most typically mollusks and fish. Much less attention is paid to smaller taxa, such as zooplankton organisms. Moreover, findings of alien zooplankton species are still poorly documented due to issues with their identification and inadequate sampling techniques, especially in case of rotifers. Therefore, it is easy to miss an introduction of a new species, which can cause difficulties in future ecological studies and complicate the development of effective management and monitoring schemes. In addition, frequent discussions about the spread of certain zooplankton species have formed a pool of so-called rare species – species that, for one reason or another, are not often found in the study area, regionally and continentally.

Field studies were carried out in 2010–2020 in mouth areas of tributaries of three lowland reservoirs of Middle Volga: Gorky, Cheboksary and Kuybyshev. In total, over 30 river mouths of different types were examined over the study period. Such detailed studies, spanning several years in some of the rivers, allowed to identify 5 alien and 3 rare species.

In 11 river mouths of two reservoirs, a North American rotifer *Kellicottia bostoniensis* (Rousselet, 1908), which has spread widely in European Russia and generally in Europe, was found. The rotifer was found in tributaries of the Cheboksary Reservoir: rivers Pyra, Chernaya, Vezloma, Oka, Vatoma, Kerzhenets, Sundovik, Sura and Vetluga, and of the Kuybyshev Reservoir: rivers Kazanka and Kama. The alien rotifer has therefore apparently spread to the river mouths of almost all major tributaries of the Cheboksary Reservoir. In two river mouths in the Cheboksary Reservoir (Vetluga River and Sura River), an Asian copepod *Thermocyclops taihokuensis* Harada, 1931 was found. The spread of this species in the Volga basin is still limited, with records of its findings made only in the lower Volga and in the Oka basin. In 2018, this species was found in the mouth area of the Sura River, and by 2019 and 2020 *T. taihokuensis* has spread to the next tributary – the Vetluga River – and to the reservoir itself. During the studies in mouth areas of the Kazanka and Kama Rivers (tributaries of the Kuybyshev Reservoir), a complex of alien Ponto-Caspian species, which have been widely spread in Lower Volga for a long time and have reached upper parts of the Kuybyshev Reservoir, was found. These species include, in particular, *Heterocope caspia* Sars G.O., 1897, *Eurytemora caspica* Sukhikh et Alekseev, 2013 and *Calanipeda aquaedulcis* Kritschagin, 1873. In mouths of the Oka, Kudma, Sura and Vetluga rivers (tributaries of the Cheboksary Reservoir), a tropical rotifer *Keratella tropica* (Apstein, 1907) was found. This species mostly spreads to temperate areas during summer. It was previously thought that *K. tropica* does not spread to latitudes beyond 45°N, but research on the Volga River before its impoundment with the Cheboksary Dam and recent studies in mouth areas of the Cheboksary Reservoir's tributaries show that its modern species range includes temperate regions at least to the 56°N latitude. During the expedition of 2020, a rare cladoceran *Pleuroxus denticulatus* Birge, 1879 was found in the estuary of the Shacha River (tributary of the Gorky Reservoir). This species belongs to the southern tropical faunal complex. According to some reports, *P. denticulatus* may be an American species introduced into Eurasia. An unexpected and very interesting discovery was made with a finding of a copepod *Leptodiaptomus angustilobus* (Sars G.O., 1898) – a Nearctic species extremely rarely found in European Russia and the rest of Europe. Its presence was recorded in the mouth of the Kerzhenets River (tributary of the Cheboksary Reservoir) in 2019. *L. angustilobus* is common in eastern Eurasia and northwestern North America.

Mouth areas of rivers, especially tributaries of lowland reservoirs, have unique hydrology and act as natural faunal refugium. The vide variety of biotopes allows rare and alien species to successfully find and fill an ecological niche. River mouths therefore act as sites for establishment of many alien species. According to our studies, 70% of rare and alien zooplankton records in the last 10 years are related to mouth areas or lower reaches of rivers flowing into lowland reservoirs of Middle Volga, and particularly the Cheboksary Reservoir.

For details see: Zhikharev V.S. et al. A record of the tropical species *Thermocyclops taihokuensis* Harada, 1931 (Copepoda: Cyclopoida) in European Russia. Biology Bulletin. (2020). https://doi.org/10.1134/S106235902010026X; Shurganova G.V. et al. New information on the findings of alien rotifer *Kellicottia bostoniensis* (Rousselet, 1908) (Rotifera: Monogononta: Brachionidae) in Nizhny Novgorod oblast. Russian Journal of Biological Invasions. (2019). https://doi.org/10.1134/S2075111719030111

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NEW DATA ON THE DISTRIBUTION OF THE ALIAN SPECIES *PLEUROXUS DENTICULATUS* BIRGE, 1879 (CLADOCERA: CHYDORIDAE) IN EUROPEAN RUSSIA

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During our research of the biodiversity of the Volga River reservoirs and rivers feeding into them, an invasive crustacean *Pleuroxus denticulatus* Birge, 1879 was detected. The species was found in the mouth area of the Shacha River (57°27′52″ N, 41°11′42″ E) – a tributary of the riverine part of the Gorky Reservoir. The Shacha is a small river with total length of 58 km and watershed area of 631 km^2, and its lower reaches are significantly anthropogenically transformed to accommodate the needs of navigation and the Kostroma Power Station.

P. denticulatus was described from Wisconsin state, USA. It is one of most common and abundant species of Chydoridae in Canada and USA, species penetrate South to Central America. *P. denticulatus* was also recorded in Old World, but only few of such records were accompanied by reliable descriptions. The first reliable record is from Germany, morphological analysis revealed no significant differences between German and American populations. Later, *P. denticulatus* was found in Ter River basin in Spain, Danube River basin in Slovakia and several regions of Italy. *P. denticulatus* can be easily recognized from all European congeners, but it was never recorded in European Russia during XX century. In Russia the species was recently spotted in small rivers of the Kologrivsky Forest Reserve – a state nature reserve and UNESCO biosphere reserve in Kostroma Oblast.

Subtropical and tropical regions of Asia and Africa south of Sahara are inhabited by abundant sibling-species, *Pleuroxus quasidenticulatus* Smirnov, 1996, and records of *P. denticulatus* from China, India and Africa are probably all refers to the former species. For example, Kotov et al. (2011) reported *P.* cf. *denticulatus* from the Zea River basin, but this record was later attributed to *P. quasidenticulatus*. Descriptions of *P. denticulatus* from Cameroon and from India is also clearly refers to *P. quasidenticulatus*. The only reliable record of *P. denticulatus* from Asia is that of Kotov et al. (2017) from South Korea.

P. denticulatus belongs to the faunistic complex of southern thermophilic species. Its biology and ecology are poorly studied. *P. denticulatus* is usually found among vegetation in the littoral zone or in organic-rich sediment of eutrophic lakes, ponds, reservoirs, floodplain lakes and rivers.

Over the period of our study (August 2020), only adult female specimens were found. Total amount and biomass of *P. denticulatus* were extremely low: 18.00±3.46 ind./l (but no more than 24 ind./l) and 0.29±0.05 mg/l (but no more than 0.35 mg/l), respectively. The role of *P. denticulatus* in the aquatic biocenisis was insignificant. Its contribution to the total number of crustacean zooplankton and particularly cladocerans did not exceed 1%, thus it does not act as a dominant species. According to literature sources, the body length of *P. denticulatus* varies between 390 and 440 µm. The specimens found in the mouth area of the Shacha River were quite large and had an average body length of 430±9 µm.

The record of *P. denticulatus* in the mouth area of the Shacha River is the second ever record of this species' presence in European Russia and the entire country as well. Both findings were made in the Kostroma Oblast. The species were most likely unintentionally introduced to the Shacha River, and the population was apparently sustained by high water temperature due to heat input from the Kostroma power plant. The prior finding in European Russia was made in 2013–2017 to the north of this study's area, and it is likely that *P. denticulatus* was brought there from the Shacha River's mouth by circularly migrating water birds. Thus, the species' distribution in the Volga basin is limited to its northern boundaries. Despite extensive research of zooplankton fauna in the Middle Volga region, no specimens were found below 57°N. The mouth area of the Shacha River may serve as a starting point for their invasion into other lakes and streams of the Volga basin, and the Volga reservoirs in particular. It should be noted that some tropical mollusks and aquatic macrophytes were also found in the study area, which may indicate an invasion of an entire complex of tropical flora and fauna. Heat pollution from the power plant could have created a buffer zone with environmental conditions that favor thermophilic tropical species. Transformed aquatic ecosystems of this kind are unique habitats for non-local flora and fauna.

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INVASION OF THE POLYCHAETA *MARENZELLERIA NEGLECTA* SIKORSKI & BICK, 2004 (POLYCHAETA: SPIONIDAE) IN THE AZOV SEA BASIN

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In March 2014, researchers of the Institute of Arid Zones, Southern Scientific Center RAS found for the first time polychaetes of the Spionidae family (genus *Marenzelleria* Mesnil, 1896), alien to the fauna of the Azov Sea and the river Don, at the dam site of the Donskoy hamlet. At the same time, there were found larvae in the net plankton sampled in the Taganrog Bay of the Sea of Azov, they were also assigned to this genus.

Initially, two morphotypes were described, whose morphological characters corresponded to the characteristics of two species: *M. arctia* (Chamberlin, 1920) and *M. neglecta* Sikorski & Bick, 2004. Further studies by genetic analysis methods showed that only one species is present in the Azov Sea basin, namely, *M. neglecta*.

In the collections of the Azov-Black Sea branch of VNIRO («AzNIIRKH»), representatives of this family Spionidae, unknown for the Sea of Azov were first found in 2010. Subsequent comparison of the materials showed that the found polychaetes corresponded to one of the described morphotypes. Thus, the available materials of annual hydrobiological surveys of AzNIIRKH have allowed one to trace the invasion of *M. neglecta* in the Sea of Azov since 2010.

In the Sea of Azov, zoobenthos was sampled in summer and autumn seasons of 2010-2020, in 2010-2015 the work was also carried out in the spring. In the delta of the river Don, studies were conducted every season in 2016-2020. From 64 to 97 stations were monitored per year in the Sea of Azov, and from 15 to 18 ones in the Don delta. A bottom grab with a capture area of 0.025 m^2 and 0.1 m^2 was used as a sampling tool.

In 2010, *M. neglecta* was recorded at several stations in the eastern Sea of Azov and in the western region of the Taganrog Bay. At that time, the average number of polychaetes amounted to 2468 individuals / m^2, and the biomass was 2.45 g / m^2.

In 2011, no invaders were registered in the sea area. The next period (2012-2015) can be characterized as the first wave of expansion of *M. neglecta* in the Sea of Azov. During those years, an increase in quantitative indicators was observed for the invader population, with their maximum values reaching 4591 ind./m^2 and 10.60 g/m^2. The habitat of the invader included the northeastern part of the sea and the entire Taganrog Bay.

In 2016, *M. neglecta* was not observed in the Sea of Azov, while for the first time we recorded the species in the Mokraya Kalancha channel (the delta of the River Don), where its abundance and the biomass were 80 ind./m^2 and 0.44 g/m^2, respectively. In 2017, polychaete was again recorded in the Sea of Azov, but its abundance and biomass were low - 197 ind./m^2 and 2.42 g/m^2. Simultaneously with a decrease in the abundance and biomass, a change in the habitat of the invader was observed – in the Taganrog Bay the polychaete worms concentrated in its central and eastern parts. In 2017 in the delta of the river Don, polychaete continued to be recorded in the Mokraya Kalancha channel, with the abundance being 30 ind./m^2 and the biomass 0.59 g/m^2.

In 2018 and 2019 in the Sea of Azov, an increase in the population of *M. neglecta* was observed. By 2019, this indicator reached the level of the first wave of expansion and amounted to 4055 ind./m^2. The maximum biomass was 8.56 g/m^2 in 2018. In 2018 and 2019 the invader was not found in the Don delta.

According to the preliminary data, in 2020 the abundance and biomass of *M. neglecta* were 80 ind./m^2 and 0.75 g/m^2 in the Sea of Azov. The habitat of the invader was limited only to the central and eastern parts of the Taganrog Bay.

It should be noted that polychaetes of the genus *Marenzelleria* are known to be invasive in other regions. In the Gulf of Finland of the Baltic Sea, their invasion was accompanied by significant changes in the hydrochemistry of bottom waters and caused the restructuring of the entire ecosystem. The environment-forming activity of these polychaetes is associated with mixing, loosening and aeration of the soil in the process of their life. Considering the growth rate of the population in the Sea of Azov, it is possible to assume the development of similar processes in the Taganrog Bay.

THE STATUS OF SHRIMP WHITE SPOT SYNDROME VIRUS IN IRAN AND WAYS TO MONITORING AND PREVENTION

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The production of cultured shrimp has the highest growth among aquatic species and due to its high price and position in the international market, it has become an economic commodity in Southeast Asian countries. Along with this growth and development, pathogens cause a lot of damage to this important industry annually. The first serious threat to shrimp farming in the world is white spot syndrome virus (WSSV) which is a notifiable pathogen of The World Organization for Animal Health (OIE) and causes a dangerous infectious disease. Considering that shrimp production in Iran is one of the most important sectors of aquaculture with an export perspective, attention to this valuable industry can be followed up. So, the present article has been obtained by collecting and studying reliable internal sources. In 2002, the Iranian shrimp industry was exposed to WSSV for the first time, and in the following years it was reported in several coastline provinces of country. Due to Iran's potential in shrimp farming, more susceptibility of Penaeidae family shrimp to WSSV, proof of horizontal and vertical transmission of the virus, as well as the lack of vaccines or special treatment, the attention of officials of relevant organizations to this valuable industry has increased. In addition, in the prevalence of WSSV in the world, the only way to combat the disease is biosecurity measures to prevent pathogens from entering the farms and reduce environmental stress. As a result, familiarity with the nature of the virus and how to monitor and detect it early is critical to preventing irreparable damage.

IS THE INVASION OF THE EUROPEAN RIVER LAMPREY, *LAMPETRA FLUVIATILIS*, (PETROMYZONTIDAE) TO THE VOLGA BASIN A RESULT OF HUMAN ACTIVITY IN THE 18–20 CENTURIES?

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The Baltic, North, Mediterranean seas and their watersheds are the historical area of the European river lamprey *Lampetra fluviatilis*. Numerous catches of the European river lamprey (= European brook lamprey, *Lampetra planeri*) in the system of the Volga River within its upper reach and midstream indicate its invasion into a new for the species watershed, i.e. Caspian Basin. At the present the fact of habitation of the European river lamprey in the Volga is not considered by researchers as invasion, and the data on the paths and terms of it are absent.

Lamprey belongs to the boreal submountain faunistic complex, which representatives appeared in the Caspian Basin (area of the Ponto-caspian complex) as a result of advances and retreats of glaciers 70–10 thousand years ago. Thence the idea of the global climatic changes, the European river lamprey inhabits the territory of the Caspian basin ~10 thousand years, since the retreat of the Valdai glacier.

Our data on distribution, morphology, genetic of the European river lamprey in the watersheds of the Upper Volga contradict this theory of such a long-term habitation of this species in the Caspian Basin. Diversity in morphology of mature adults of the populations from Vysochinsky stream, Saragozha River, Kamenka River (which are the noth-western 2–5 order tributaries of the Rybinsk Reservoir) achieves in some features the level of subspecies, although these streams are located not far from each other, un-separated by physical barriers and have similar environmental conditions. This would appear to reflect the resent settlement of the streams and retention of the founder effect in features of the specimens from the investigated populations. Analysis of the gene Cyt-b fragment of the mtDNA of freshwater populations of the lamprey from Bolshaya Sestra and Yakhroma rivers (2–3 order tributaries of the Ivankovskoe and Uglich Reservoirs) and Linda River (Levin et al., 2016) designate that the found haplotypes differ from the most abundant known haplotype of the *Lampetra fluviatilis-planeri* complex on the area with the only replacement (Cyt-b125 g > a), which is 99.9% identity. This also points to the recent invasion of the European river lamprey into the Caspian Basin.

We therefore consider that the idea of the invasion as a result of the glacier activity is insufficiently justified, and accept as the main version an invasion of the lamprey into Caspian Basin through the man-made shipways. During 18–19 centuries there were built three systems of canals, which united Baltic Basin and Upper Volga: Vyshnii Volochek, Tikhvin, and Mariinskaya. During next 300 years these waterways were used for both-ways dispersion of various water organisms, including fishes and cyclostomes. Invasion of the lamprey throughout the Upper Volga could last up to 1843–1937, thereafter the ways of its migration were destroyed with the construction of the first dam on Volga and the establishment of the Volga HPPC.

Due to the peculiarities of the lamprey life cycle, introduction through the man-made water ways into the Caspian Basin happened relatively quickly. The mature adults migrated upstream to the spawning areas in the upper reaches of streams, this is how the border from the Baltic Basin could be achieved and overcame. Preliminary dispersion of larvae from nests and redistribution of the older larvae in river happened in form of the downstream migration, this was the beginning of distribution process of the lamprey in Caspian Basin. Further distribution of the lamprey in a new part of the range was a combination of up- and downstream migrations.

Thus, for the last ~300 year the range of the European river lamprey was significantly expanded through the invasion in watersheds of the Caspian Basin. The most probable path was the man-made ship ways, which turned the Volga River into one of the Europe's main invasion corridors.

For details see: Zvezdin A.O., Kucheryavyy A.V., Kolotei A.V., et al. 2021. Invasion of the European river lamprey *Lampetra fluviatilis* in the Upper Volga // Water. 13 (1825). https://doi.org/10.3390/w13131825

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GENETIC VARIABILITY OF *BUNIAS ORIENTALIS* WITHIN ITS NATIVE AND INTRODUCED RANGES

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Warty cabbage (*Bunias orientalis*) (Brassicaceae) is widely spread across Europe (except the southern part), western Asia, Siberia, Russian Far East, and North America. In some parts of central and northern Europe, this species is considered an invasive species where it penetrates in seminatural ecosystems. *B. orientalis* is also well adapted to occupy anthropogenized habitats. We evaluated genetic diversity patterns of *B. orientalis* (Brassicaceae) in three geographically distant areas. Using inter-simple sequence repeat fingerprinting, we studied warty cabbages, including non-native populations, from the eastern Baltic and western Siberian (Tomsk) regions and native populations from southwestern Russia. The genetic structures of the native and non-native *B. orientalis* populations were assessed through analysis of molecular variance (AMOVA) and the Bayesian clustering method and by determining the main measures of genetic diversity. We studied 8 Baltic populations (including populations from Lithuania, Latvia, Poland and Russia), 8 populations from the native region in southwestern Russia, and 7 Siberian populations. The inter-population component was high and constituted 49% of the total genetic diversity. Principal coordinate analysis clustered the 23 populations into two groups that generally corresponded to the native and non-native ranges of *B. orientalis*. The larger group mostly included non-native populations. The smaller, native population group, showed relatedness only between native populations. Differences between the populations from the native and non-native groups were found in both cases, despite the locations of the non-native populations. In contrast, no statistically significant difference in diversity parameters was detected between the groups of populations from the two different nonnative regions (Baltic and Siberian, Tomsk). Our study did not reveal a decrease in genetic diversity due to genetic drift in the non-native populations of *B. orientalis*. This phenomenon can be explained by multiple species germplasm introductions into non-native area.

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