

THE 37TH POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

The 37th Polish Malacological Seminar (25th–27th May 2023) was organised by The Association of Polish Malacologists and Faculty of Natural Sciences, University of Silesia. The Organising Committee consisted of ladies only: ANNA CIEPŁOK, ANETA

SPYRA, MARIOLA KRODKIEWSKA and ADRIANNA KOCZOROWSKA. The Katowice Team was planning to organise this event a few years ago, but the plans were thwarted by the pandemic. This year, we met without any problems in Chorzów in a small Skaut



Fig. 1. Almost all seminar's participants in front of Silesian Planetarium (photo: ANNA DROZD)



Fig. 2. JAROSŁAW MAĆKIEWICZ at his speech on alien species (photo: ANNA DROZD)

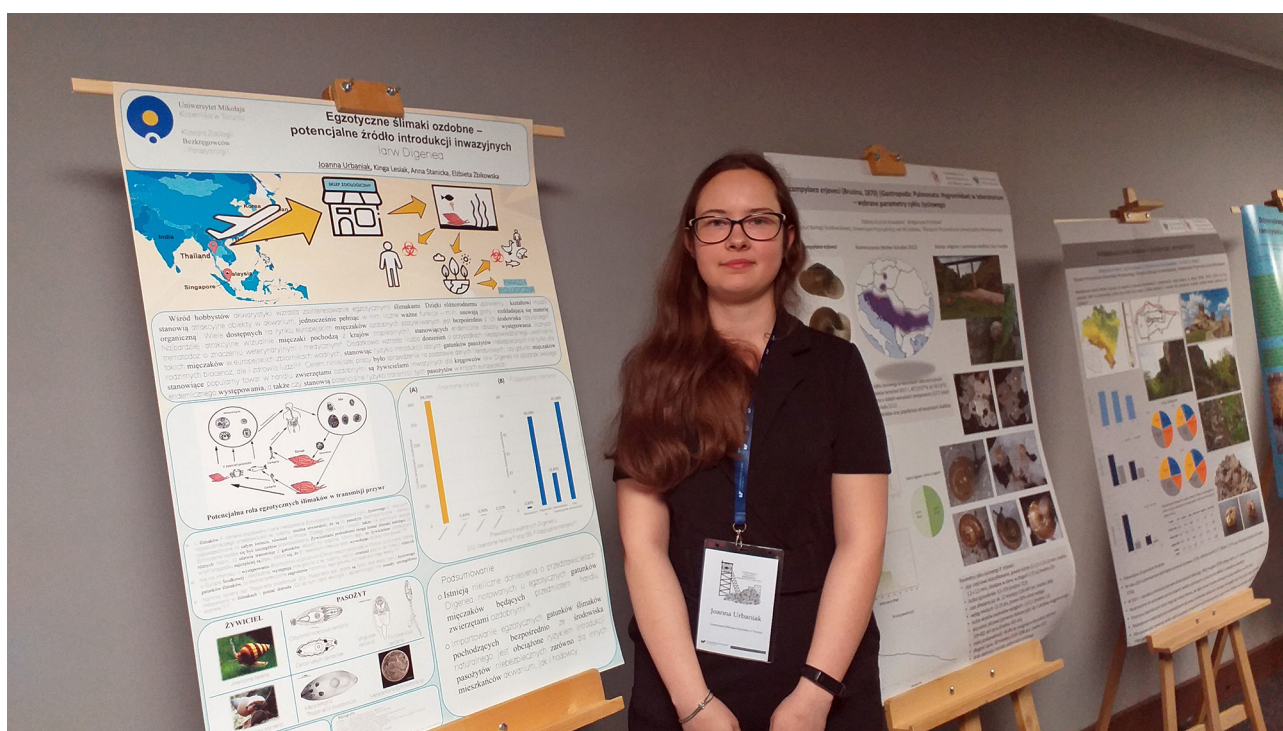


Fig. 3. JOANNA URBANIAK at her poster on alien species (photo: ANNA DROZD)

hotel located in the vicinity of Silesian Park. It is a large forest and park complex at the junction of three Silesian cities: Katowice, Chorzów, and Siemianowice Śląskie. Therefore, it is a great place for rest and recreation for the inhabitants of the Silesian agglomeration and guests like us.

The seminar was attended by 48 malacologists (Figs 1–6) who presented 40 scientific contributions. The program was divided into five oral sessions, during which 28 talks were presented, and one poster session with 12 posters. As always, the presentations were concerned with various aspects of malacology. As in the previous year, papers on gastropods dominated over papers on bivalves (ratio 2.2:1). This time aquatic taxa were the objects of study only slightly more often than terrestrial taxa (1.2:1). Most of

the papers were in the field of Biogeography and Faunistics (Table 1), which was quite unusual. The second place was taken by Ecology and Conservation, which both in the long term attracted and still attracts many researchers. It is worth noting that this year, more than a third of the studies were on alien and invasive species. There has been an increase in the interest of these taxa by Polish malacologists over many years (Fig. 7); the problem is growing, probably as a result of climate change. The upward trend has fluctuated; whether we have reached the peak of interest this year remains to be seen in the coming years.

On the first day of the seminar, the program also included a trip to the planetarium. This was a nice change from the practice of previous seminars,



Fig. 4. ŚCIBOR SZYMANIAK, winner of the prize for the best poster with his happy promotor (photo: JAROSŁAW MAĆKIEWICZ)

Table 1. Comparison of the topics discussed at this year's seminar with the previous ones

Discipline	2007–2022		2023	
	n	%	n	%
Ecology & Conservation	215	30.4	7	17.5
Applied Malacology & Parasitology	89	12.6	3	7.5
Miscellaneous: general, behaviour, archaeology, collections, history, education, methodology	77	10.9	2	5.0
Life Histories	75	10.6	2	5.0
Biogeography & Faunistics	64	9.1	13	32.5
Systematics / Phylogeny (including molecular)	56	7.9	4	10.0
Fossil Molluscs	54	7.6	3	7.5
Structure (histology, cytology, shell) & Variation	43	6.1	2	5.0
Physiology	34	4.8	4	10.0



Fig. 5. Good company or good soup is enough to have good time (photo: ANNA DROZD)



Fig. 6. The banquet (photo: ANNA DROZD)

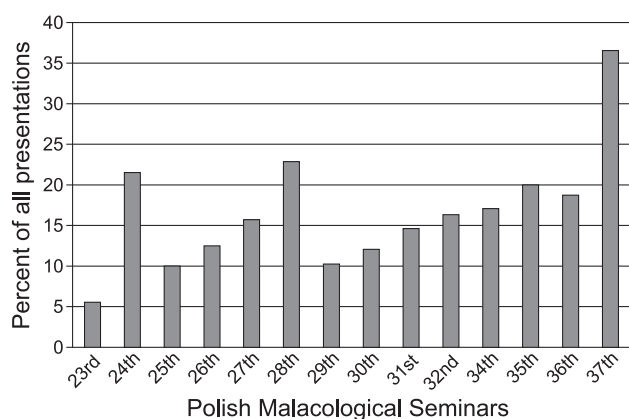


Fig. 7. Participation of research on alien and invasive species in presentations of Polish Malacological Seminars

where the tours usually took place on the last day of the meeting, after the scientific program. The planetarium is located in the centre of the Silesian Park, so we could go there on foot. The weather was good and a walk around was an additional attraction of the day and an opportunity for less official talks with fellow malacologists. That day in the evening there was also a meeting dedicated to PROF. DR. HAB. BEATA POKRYSZKO. An obituary commemorating her person and excellent scientific achievements was published earlier (FM, 2022: 30(4): 189–210). Most of us, participants of the seminar, are Beata's friends and colleagues, to whom her scientific achievements are well known. That's why we wanted this memorial meeting to be more personal and unofficial. The Wrocław team has collected a large number of photos of Beata from malacological conferences, field trips, social meetings and private life. In these pictures we saw Beata as we knew and as we want to remember: cheerful, kind, loving life, independent, and full of a unique sense of humour.

There was also a time dedicated to the memory of PROF. DR. HAB. MAŁGORZATA STRZELEC, on the second day of the seminar (for obituary see FM, 2019: 27(3): 159–165). The person and her scientific achievements were presented by her colleagues more traditionally. Another event of the day, apart from the scientific sessions, was the general meeting of the Association of Polish Malacologists' members. For the first time in many years, we managed to gather enough members to change the statutes. Our statutes were established in what seem like ancient times, when no one dreamed of online meetings in Poland. So, it was high time to adapt them to the current times and modern technology. Traditionally, a formal banquet was held at the end of the day and the seminar. There was delicious food, drink and endless conversations. It was also here that the jury composed of WITOLD P. ALEXANDROWICZ and JAROSŁAW MAĆKIEWICZ awarded the prizes for the best talk and poster in the competition for young malacologists. This year, the jury awarded prizes to KINGA LESIAK for the presentation entitled: "Imported ornamental molluscs as a source of Digenea larvae – preliminary results" and to ŚCIBOR SZYMANIAK for the poster entitled: "Influence of stress factors on reproduction of viviparous clausiliid *Reinia variegata* (A. Adams, 1868) in laboratory conditions".

Time passed quickly, the 37th seminar went to history, and we are looking forward to the next one, which will be organised by BEATA JAKUBIK from Siedlce University of Natural Sciences and Humanities.

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ABSTRACTS OF THE 37TH POLISH MALACOLOGICAL SEMINAR

MOLLUSCAN ASSEMBLAGES IN SEDIMENTS OF
LANDSLIDE ON THE MAJERZ HILL IN NIEDZICA
(PIENINY)

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A detailed malacological analysis was carried out on the basis of sediments associated with a landslide system developed on the north-eastern slope of the Majerz hill near Niedzica. This hill is part of a small range known as Pieniny Spiskie. The presence of two scarps indicates the existence of two stages of landslide activation. The surface of the landslide body is undulating. Two flattenings are noticeable here – originally landslide lakes, now filled with peat. Three profiles were analysed, from which 41 samples of sediments were collected. The identified fauna included 55 land snail species and one aquatic species. The calcareous plates of slugs have been included in the collective group: Limacidae. In total, the shell material included over 8,500 specimens. In the analysed fauna six faunistic assemblages were distinguished. In the thill part, a poor assemblage containing cold-loving taxa (assemblage with *Vertigo genesii*) was identified. It represents solifluction deposits formed during the Late Glacial. Above, in the calcareous silts, there is an assemblage with numerous shade-loving species. Cold-loving taxa also appear here, and *Discus ruderratus* is the most numerous (assemblage with *Discus ruderratus*). It corresponds to the Early Holocene. Above the silts lies, an older layer of colluvial sediments, devoid of mollusc shells. In the upper layer, a higher proportion of forest taxa is noticeable, among which there are snails with narrow ecological requirements (assemblage with *Discus perspectivus*). This fauna corresponds to the Middle Holocene. Above is a second, younger colluvial layer. In the depressions formed on the surface, small, shallow water bodies were formed. This is evidenced by the occurrence of a fauna with *Galba truncatula*. These reservoirs were filled with phytogenic sedimentation (peat). The period of their deposition is associated with the presence of fauna with numerous taxa typical of wetland terrestrial habitats (assemblage with *Succinea putris*). The final stage of the development of the landslide on the Majerz hill includes drying of habitats, which is manifested by the appearance of an assemblage with *Vallonia pulchella*. The age of the

individual stages of the landslide development was determined by means of radiocarbon dating. The periods of activation of the landslide fall on the Early/Middle Holocene and on the Late Holocene (probably on the Iron Age Cold Period). These phases are closely related to periods of increased mass movements in the Carpathians and the Alps, the stages of glacier advance in the Alps and periods of increased fluvial activity in rivers.

EUROPEAN CLAUSILIIDAE: THE STRANGE
PATTERNS OF SPECIES DIVERSITYROBERT CAMERON¹, ANNA SULIKOWSKA-DROZD²,
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Clausiliidae are remarkable for their characteristic shell shape, which might suggest a common way of life. Within Europe, however, the patterns of distribution at different scales vary in a way that is hard to explain. At the scale of whole countries, diversity is at its greatest in south-eastern Europe, and least in the far west and north-west. Central and northern Europe are intermediate, and this condition persists some way to the east. In countries in and to the north of the great mountain ranges, there are remarkable similarities in national faunas even when far apart, due to a suite of species with large geographical ranges. In the south-east, by contrast, there are many species with very small ranges; endemism is very common. At the level of small sites, however, the pattern is different. The richest sites, with up to 10 co-existing species, are characteristic of Carpathian forests and those in the north of Poland. In southern Europe, it is very rare to find more than two co-existing species in the open rocky habitats where most occur; even forests are poorer than those further north. We are using some of our earlier work to examine the ways in which co-existing species differ in microhabitat preferences, and to explore the historical and ecological processes that have combined to produce the pattern we observe.

INVASIVE SPECIES *POTAMOPYRGUS ANTIPODARUM* (GRAY, 1843) IN THE “WYWIERZYSKO” SPRING IN DĄBROWA GÓRNICZA (SILESIAN UPLAND)

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Springs are unique aquatic environments with specific fauna and flora, including endemic and rare species. The aim of the study was to assess the colonisation success of the invasive snail *Potamopyrgus antipodarum* in spring in Dąbrowa Górnicza, the Silesian Upland. The research was carried out in 2012–2015 in two areas: in a spring and in a small creek flowing out of it. *Potamopyrgus antipodarum* dominated the benthic fauna in both areas, but its population size was much higher in the watercourse than in the spring. This New Zealand mud snail was smaller and less fertile (maximum shell height 4.7 mm; maximum number of embryos in the breeding chamber – 37) in the spring compared to the watercourse (maximum shell height 5.1 mm; maximum number of embryos in the breeding chamber – 42). The results indicate that the low water temperature in the spring (maximum 10.1 °C) may limit the size of the population of *P. antipodarum*, which may be the reason for the lack of impact of this invasive snail on the benthic fauna inhabiting the spring area.

GENES OR ENVIRONMENT? WHAT INFLUENCES THE GROWTH RATE AND SHELL SHAPE OF THE THICK-SHELLED RIVER MUSSEL (*UNIO CRASSUS*)?

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Shell shape is a very characteristic feature of molluscs, which is often used in many scientific disciplines, including taxonomy, paleobiology, geology, climatology, evolutionary biology and archaeology. A surprisingly large number of Unionidae species (about 4,000 species) have been described in the past based on shell morphology. An enormous phenotypic plasticity of the shell can be a serious problem as it still leads to many cases of misidentification. The aim of the study presented here was to investigate differences in the growth rate and shell shape of *Unio crassus* on several spatial scales: 1) catchment scale, 2) river basin scale, 3) river scale, also taking into account 4) genetic differences between mussel populations inhabiting 22 European rivers, located in 5 countries. These rivers are characterised by very different geographical conditions (from the Baltic States to Bulgaria) and habitat conditions (lowland and mountain rivers). Statistical analysis (hierarchical generalised linear models) showed that both genetic and environmental factors influence the shell size of *U. crassus*, however, genetic distance between clades is the least significant factor and explains only 1% of the variation, while the influence of the river and the catchment area explains about 40% of the variation of shell length. The same model also showed that the age of mussels explains the largest part of the variation in the growth rate of individuals (80%) and the significant influence of interactions between the age of individuals and the river, as well as between their age and the catchment area (which explain 26% and 18% of the variation in growth rate, respectively). The obtained results suggest that both

shell size and growth rate in *U. crassus* depend mainly on environmental conditions in specific rivers and catchments and should be attributed to phenotypic plasticity rather than genotype. Statistical analysis also showed that: 1) environmental factors have a significant impact on all Principal Components describing the shape of the *U. crassus* shell; 2) the larger the spatial scale, the smaller part of the variability is explained by individual Principal Components, and 3) the genetic factor significantly affected only some of the Principal Components describing the shell shape of *U. crassus* and was always the factor that explained the smallest part of the variability of a given Principal Component. The results suggest that the shell shape of *U. crassus* depends mainly on environmental conditions in specific rivers and catchments, and should be attributed to phenotypic plasticity, not genotype.

BIOCHEMICAL ACTIVITY OF BACTERIA ISOLATED FROM THE INTESTINE OF *HELIX POMATIA* L.

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Intestinal microbiota of *Helix pomatia* may play a significant role in digestion, protection against fungal pathogens and in the ability to hibernate. Despite the fact that snails empty their intestines in autumn, some bacteria remain and can perform various functions. Two bacterial strains isolated from intestines of overwintering snails with chitinolytic properties were selected for the study. They were identified on the basis of the 16S rRNA gene sequence.

The main objective of the experiment was to determine the activity of chitinolytic enzymes and to optimise conditions for the synthesis of these enzymes. In addition, the activity of antifungal enzymes from the group of 1,3- β -glucanases was determined and the antagonistic activity of the isolates against fungi causing diseases of snails was specified. Based on the results, it was found that the isolates belonged to the *Sphingobacterium faecium* and *Luteimonas* sp. and they differed in chitinolytic activity and 1,3- β -glucanase activity. Chitinases were most active in unaerated cultures after 4 days at 30 °C with octopus chitin and pH 7 and 8 for *Luteimonas* sp. and *S. faecium*, respectively. At the same time, a clear antifungal activity

of the isolates against *Fusarium oxysporum*, *Fusarium culmorum*, *Botrytis cinerea* was observed. The antifungal effect may be related to the activity of the tested enzymes and other metabolites secreted by bacteria. This may suggest that chitinases in the snail intestine may have other functions, such as cryoprotection during hibernation.

RESEARCH ON DISTRIBUTION AND ABUNDANCE OF THE ROMAN SNAIL (*HELIX POMATIA* L.) POPULATIONS IN WIELKOPOLSKIE VOIVODESHIP IN 2020

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Between June and July 2020, the Regional Directorate for Environmental Protection in Poznań funded research on the distribution and size of populations of *Helix pomatia* in Wielkopolskie voivodeship. Using orthophotomaps (Google Earth, geoportal.gov.pl), the locations of environments preferred by the Roman snail were determined. On this basis, research sites were selected, which were then verified during field studies.

The location of each individual found in the field was recorded using GPS, and the coordinates noted in the .gpx format were used to visualise the distribution of individuals and to determine the range of local populations in the HELIX 1.0 program.

The collected data on the biometric characteristics of individuals (shell diameter and height, snail weight), age structure of the population (number of adults and juveniles) and empty shells, as well as the percentage of individuals with a shell diameter ≥ 30 mm, allowed to determine the condition of local populations of the studied species, as well as its value for commercial use.

All 226 communes located in Wielkopolskie voivodeship were investigated. Only in 6 of them (Chodzież, Drawsko, Zbąszyń, Słupca, Kramsk, Koło) the species was not found. A total of 15,414 specimens were recorded in Wielkopolskie voivodeship, of which 8,330 were alive at 351 sites. In 2020, the mean weight of a mature specimen was 20.54 g. While in terms of age structure, 50% of all live individuals were adults and 4% were juveniles. The percentage of empty shells was 46%. Among adults, 23.6% were commercially valuable, while among juveniles no specimens with a shell diameter ≥ 30 mm were recorded.



The findings indicate that *H. pomatia* is fairly evenly distributed in Wielkopolskie voivodeship and its population size is stable. The snail harvest limit for coming years has been estimated at 100 tons per year.

IMPACT OF STIMULATED DROUGHT ON BEHAVIOUR OF FRESHWATER MUSSELS – PRELIMINARY RESULTS OF A SCIENTIFIC TRIP TO PORTUGAL

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Climate change and system modifications are among main drivers of global biodiversity loss. Nowadays, molluscs, especially freshwater mussels, are among the most endangered animals on the planet. There are well-documented widespread and rapid declines of these animals in Europe. At the same time, they perform important ecosystem functions and provide key services. Freshwater bivalves show at least two primary responses to dehydration events (burrowing and horizontal movement). Behavioural responses and tolerance to dehydration are presumably different on interspecific and intraspecific levels, however this remains highly speculative. Therefore, an experiment was carried out to assess the impact of drainage on a behaviour of Portuguese freshwater mussel populations: *Anodonta anatina*, *Potomida littoralis*, *Unio delphinus* and *U. tumidiformis*. The aim of the study was to measure horizontal and vertical movements in three drainage scenarios (control, slow, moderate and fast) for mussels from two different populations of each species (except *U. tumidiformis*) along a latitudinal gradient. Mussels were collected from the south and the north of the country. They were transported to the Castrelos Biological Station for two weeks of acclimatisation and then used in external “mesocosm” experiments. The results indi-

cate that in the rapid drainage scenario, all species had significantly faster rates of burrowing as well as faster horizontal movement. However, *Potomida littoralis* showed much slower horizontal movement compared to other species. Comparing the southern and northern populations, no significant overall pattern of the response to drainage was noted. However, in both moderate and rapid drainage scenarios, the southern population of *Anodonta anatina* buried faster and exhibited faster horizontal movement than the northern population. These results can be explained by the habitat characteristics of *A. anatina* and the climatic differences in the south and north of Portugal. The obtained results allow for a better understanding of the impact of changes in the hydrological regime and declining freshwater resources on freshwater mussel populations. This information may be crucial for an implementation of appropriate protective measures in the context of climate change.

The research was carried out as part of the project “EdgeOmics – Bivalves on the edge: Adaptation genomics and climate-change impact on freshwater biota” and as the Short Term Scientific Missions of the COST CA18239 project “Conservation of freshwater mussels: a pan-European approach”.

LIGHTS AND SHADOWS OF DNA BARCODING - CAN SNAIL SPECIES BE “SCANNED”?

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The dissemination of barcoding of organisms has led not only to the creation of a powerful comparative database, enabling quick identification of studied organisms, but most of all to a better insight into real resources of genetic variation in populations. This type of research is also important in the case of snails, for which descriptions of new species are

still based only on differences in shell morphology, sometimes supplemented by a morphology of internal organs, such as reproductive systems. Such an approach may in some cases lead to an underestimation of interspecies variation, e.g. as a result of lack of morphological differences between cryptic species. On the other hand, it may lead to an overestimation of species, and even to describe biodiversity centers that do not exist in reality, as a result of not distinguishing between the actual inter- and intra-species variation resulting, among others, from phenotypic plasticity, age-related variability or different habitats. Barcoding of snails, even using a single DNA fragment (COI), which is widely used, very often leads to the detection of high genetic diversity, as in the case of freshwater snails of the Hydrobiidae family in Georgia. Our study allowed molecular identification of 28 species, for which in many cases it was also possible to confirm morphological distinctness. However, these are small organisms, occurring in almost unexplored areas, so the existence of species unknown to science is not surprising. The situation was different in the case of a well-known and common species, i.e. *Fruticicola fruticum*, in which barcoding allowed the identification of two new species from Southern Europe. Barcoding is undoubtedly an important tool that enables the determination of genetic (cryptic) variation, which is necessary for the correct identification of biodiversity resources in study areas and ensuring their protection. However, it should be remembered that the barcoding method also has limitations, for example related to maternal inheritance of mtDNA and possible cases of introgression, as exemplified by the snails of the Hydrobiidae family: *Hauffenia* and *Kerkia*. Therefore, only an integrated approach, using other DNA fragments and morphological studies, can confirm or reject the obtained picture of biodiversity.

EFFECT OF INOCULATION WITH ENTERIC MICROORGANISMS ON FREEZING TOLERANCE OF *HELIX POMATIA* L. SNAILS

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Microbiota plays a key role in most biological processes affecting both population dynamics and distribution and survival of host species. The most important processes affecting host fitness include nutrient absorption, digestive capacity, immune responses, and adaptation to abiotic stress. Most strains of bacteria inhabiting intestines of Helicidae are of exogenous origin. *Helix pomatia* snails eat the soil as well as faeces to obtain beneficial microbes. During a period of torpor such as overwintering, bacterial populations undergo changes because feeding is suspended and thus exogenous species are not supplied. In addition, various factors such as host genetics and its diet, pathogens, diseases, interactions with the immune system and interactions between gut strains, and seasonal changes can affect the microbiota, exposing the host to serious health consequences. Therefore, we think that increased host survival under stress conditions is closely related to eubiosis. The main objective of our study was to check whether snails' food supplementation with a microbiological preparation containing bacterial strains isolated from intestines of overwintering snails can improve cold tolerance in the summer. The research was carried out on two groups of snails: control and experimental, to which a microbiological preparation was served on sterile cellulose scraps. After a month, we assessed the effect of supplementation on the cold tolerance of wild snails in the summer, based on measurements of the supercooling point (SCP) of their body fluids. The experiment was carried out in a chamber with controlled cooling temperature (0.5 and 1 °C/minute) until the SCP point was reached. The supercooling point temperature for the snails of the experimental group was statistically significantly lower ($p < 0.05$) than for the snails of the control group. The average SCP value of the control group was -0.97 °C and the experimental group -1.73 °C ($p < 0.05$). Our finding confirmed that the microbiota has a signifi-



cant impact on cold tolerance. The microbiological preparation used, prepared based on strains taken from overwintering snails, had an impact on lowering the supercooling temperature of *H. pomatia* in the summer, thus shedding new light on the mechanism of adaptation to cold, which still hides many secrets.

ISOLATION AND ENDEMISM OF SELECTED SNAILS INHABITING UNDERGROUND WATERS

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Subterranean aquatic snails may serve as a model of evolutionary studies involving the opposing phenomena of endemism/isolation and long-distance migration. Of the approximately 20,000 described species of subterranean animals, more than 350 are stygobiont gastropods, with 97% of them belonging to the superfamily Truncatelloidea. Often, these snails live in habitats that are very hard to sample, which imposes severe limitations on their study. As a result, species have been described only based on shells, sometimes incomplete, which may have led to an overestimation of their numbers. This phenomenon is further coupled with the widespread belief in strict geographic isolation of cave species and their common allopatric speciation. Consequently, “new” species have been described due to their occurrence, for example, in each cave or spring. Molecular studies are necessary to verify and reveal the actual level of genetic variation within and between populations, and to determine the efficiency of gene flow.

Therefore, we performed molecular and morphological studies of three snail genera, both from caves and interstitial habitats. Interpopulation differentiation of *Montenegrospeum bogici* shows that metapopulation variation is best described by the isolation-by-distance model. Probably interstitial habitats provide ways of migration for this species with a distribution range reaching over 200 km, unusual for a cave dweller. The same applies to *Belgrandiella kusceri*, whose geographic distribution is much smaller. A slightly different picture emerges for the genus

Kerkia. We found the presence of eight cryptic species (five of them are new to science), resulting from morphostatic evolution – they are morphologically similar, but molecularly distinct. Moreover, individual species are grouped into three evolutionary lineages, the occurrence of which was correlated with divergence. Additionally, the ranges of individual species were limited to small areas. The described endemism in *Kerkia* may suggest that interstitial habitats are not used for migration, perhaps due to the flattened shape of the shell, which makes it difficult to move in the sediment.

IS WORSE THE ENEMY OF THE BAD? WHY DOES THE QUAGGA MUSSEL REPLACE THE ZEBRA MUSSEL IN INVADED AREAS?

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The invasive zebra mussel, *Dreissena polymorpha* (ZM), is being replaced by a more recent invader, the quagga mussel, *D. rostriformis bugensis* (QM) in Europe and North America. We checked life history, behavioural and physiological differences between the dreissenids to reveal drivers of this displacement. Our experimental and field studies revealed that: (1) QM grow faster than ZM, including faster soft tissue weight increase per unit length; these differences become more pronounced at low food concentrations. (2) ZM condition may deteriorate after the appearance of QM. (3) QM accumulate more lipids at low than at high food concentrations, and than ZM; this suggests a metabolic shift that allows QM to replace the missing storage materials (carbohydrates) and may allow QM survival and growth in harsh conditions. (4) QM accumulate more glycogen and have higher caloric content than ZM. (5) QM have lower attachment and shell strength (anti-predator resistance) than ZM, especially at young age. (6) Predators preferentially prey upon QM. (7) QM more often detach from substrate, but, when detached, move less than ZM. (8) QM are less selective for habitat than ZM; in particular, QM do not avoid attachment to mussel shells, and more often form aggregations (9) QM show lower physiological stress (superoxide dismutase expression) than coexisting ZM. (10) QM exert a lower fouling pressure on unionids than ZM because of the more common detachment of QM from initial sites, but due to dreissenid substratum preferences. Thus, QM seem to be a better competitor, especially under harsh environmental conditions, due to their higher starvation tolerance, faster growth,

lower habitat selectivity, lower energy expenditure for site selection, but despite greater susceptibility to predation. However, negative environmental impact of QM seems lower than that of ZM due to their weaker fouling pressure and providing molluscivores with food of better quality.

COMPARISON OF MALACOFaUNA OF DOWNTOWN AND MID-FOREST RESERVOIRS IN WARSAW

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In Warsaw, water bodies are located not only in parks and poorly urbanised areas, but also in forest areas. Continuing studies of the malacofauna (as part of the study of entire invertebrate macrofauna) of Warsaw's water reservoirs, we paid attention to the southern part of the city – the valley Dolina Potoku Służewieckiego and the forest Las Kabacki. The water bodies of Dolina Potoku Służewieckiego, created in the 1980s, were characterised by a diverse malacofauna (18 species; from 1 to 10 in a reservoir), despite the artificial nature of the reservoirs, periodic drying of some of them and very intensive penetration of this region by inhabitants of the surrounding housing estates. *Planorbarius corneus* was the most abundant; there were four other species of Planorbidae, four species of Lymnaeidae, two species of Physidae and at least three species of Sphaeriidae were also found. On the other hand, the malacofauna of reservoirs in the forest Las Kabacki, much older, because mainly created at least 100 years ago as watering tanks for forest animals, surrounded by forest and (currently) partly closed for walkers, is of extremely poor quality. Only 8 species of molluscs were found there, 7 of them in the Grabowski Canal, located on the edge of the Reserve, drying up at the end of summer. In the remaining reservoirs, the number of mollusc species ranged from zero to two. The most frequent and most numerous were only two species – *Segmentina nitida* and *Planorbarius corneus*, and the only representative of bivalves was *Musculium lacustre*. The species composition of the malacofauna of mid-forest reservoirs turned out to be poorer than in the majority of not only natural, but also artificial,

drained park reservoirs. It seems that in the forest area, the abundance of molluscs is not related to the durability/drying of reservoirs at the end of summer, but rather to the density of trees around them and the amount of hard-to-decompose allochthonous matter flowing in this way. Also, their isolation and location in a compact forest complex may limit the ability of colonisation – introduced by both waterfowl and humans. Revitalisation works recently carried out on one of the reservoirs in the valley Dolina Potoku Służewieckiego and on one of the reservoirs in the forest Las Kabacki also seem to be the cause of their poverty of malacofauna and, in general, of their entire invertebrate macrofauna.

PRELIMINARY STRUCTURAL AND CHEMICAL STUDIES OF *CEPAEA NEMORALIS* EGG SHELLS

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Egg shells of *Cepaea nemoralis* from a laboratory culture at the Museum and Institute of Zoology of the Polish Academy of Sciences were used in structural and chemical studies. The snails laid their eggs in groups in the soil into holes about 6 cm deep. The mean number of eggs in a single batch was 84 ($n = 9$). The eggs were spherical in shape and 2.4 mm in diameter ($n = 30$). Eggs with a whitish shell colour prevailed. Structural studies of the egg shell examined using a scanning electron microscope (SEM) showed the presence of three layers in the cross-section: 1) organic gelatinous (external), 2) mineral (middle), 3) organic gelatinous (internal). In the mineral layer, calcium carbonate crystals of various sizes and different positions relative to each other are visible. Qualitative chemical analyses performed using an X-ray microanalyser (EDS) showed that the main elements of egg shells are Ca, C and O, which are mainly components of calcium carbonate. In addition to these three elements, there are others, such as: Mg, Al, Si, P, Mo. The chemical composition of egg shells (except Mo) is similar to the chemical composition of shells. Imaging and egg shell roughness studies were carried out using a digital microscope. Roughness refers to unevenness with relatively small vertex distances. The average deviation of the profile from the mean line – Ra, was 2.8 μm , which indicates a relatively large development of the examined egg surface.



HIBERNATION DURATION AND OVIPOSITION PATTERN IN *VERTIGO ANTIVERTIGO*

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Vertigo antivertigo (Draparnaud, 1801) is a tiny species of hygrophilous land snail associated with wetlands and periodically flooded environment. Although it is a Palearctic species with a wide range and quite common in Poland, its biology, and particularly the effect of hibernation on reproduction, have not yet been thoroughly investigated. In order to start the experiment, adults of *Vertigo antivertigo* (fully developed shell) were collected from the field in September 2020. Snails were divided into 3 groups of 25 individuals each. On October 29, 2020, the snails were hibernated in a breeding room, in constant temperature conditions (4 °C), in the dark. During hibernation, each snail was kept in a separate test tube with a moist cotton swab, leaves of sedges and trees, as well as dolomite powder. During hibernation, the snails were sprinkled with cooled, boiled water once a month.

The snails were woken up on 3 dates: (A): February 11, 2021 (106 days of hibernation), (B): March 19, 2021 (142 days of hibernation), (C): April 22, 2021 (176 days of hibernation). 16 individuals from group A, 23 individuals from group B and 16 individuals from group C survived hibernation. The awake snails from the test tubes were transferred to ventilated dishes with a diameter of 5 cm. In each dish a wet cotton swab, dolomite as a source of calcium, and litter as a source of food were placed. The dishes were transferred to a culture room at 17 °C, photoperiod: 12:12. The number of eggs laid was monitored once a week for almost 8 months (a total of 31 observations per group). The substrate and food were changed once a month.

Analyses included the individuals that survived to the end of the observation, i.e. A: 13 individuals; B: 14 individuals; C: 15 individuals. The number of eggs laid by each snail was compared by randomised ANOVA. The number of eggs laid by individuals from options A, B and C differed statistically significantly ($F = 4.871$; $p = 0.01$). On average, the largest number of eggs were laid by snails from group B ($\bar{x} = 9.571$; $SD = 5.827$), while significantly less in groups C ($\bar{x} = 5.4$; $SD = 3.007$) and A ($\bar{x} = 4.846$; $SD = 2.597$). Repeated measurement analysis also showed that the distribution of eggs laid over time differed significantly depending on the wake-up date ($F = 44.480$; $p < 0.001$). Individuals from group A laid the largest number of eggs in the eleventh week after awakening. In group B, two “maximums” of the

oviposition were observed: first in the third week, then in the eighth and ninth weeks. Individuals from group C laid the most eggs in the fourth week of the observation.

PROTECTION OF SELECTED SNAIL SPECIES AS PART OF THE LIFE PROJECT “KAMPINOSKIE BAGNA II”

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The Kampinoski National Park (KNP) is located in the proglacial valley of the Wisła river and is characterised by latitudinally arranged belts of dunes and marshes. Most of the KNP wetlands had no outflows. However, meliorations carried out for over 100 years disturbed the natural water relations, caused a significant lowering of the groundwater table and its large fluctuations in the annual cycle. These changes led to the degradation of wetland habitats and the reduction of their area in the Park. As part of the Life project “Kampinoskie Bagna II”, a number of activities are planned for the protection and restoration of wetland habitats, i.e. improvement of wetlands’ hydrology, naturalisation of watercourses, creation of ponds, etc. These activities are directly related to the active protection of the most valuable species associated with wetlands, including snails: *Vertigo moulinsiana*, *V. angustior*, *Anisus vorticulus*. As part of the activities devoted to the snail protection, an inventory of the above-mentioned species was carried out in the KNP.

In the next stages, live specimens will be collected from the most numerous populations and reintroduced to newly created or reconstructed habitats. *Anisus vorticulus* will be reproduced in artificial laboratory conditions and transplanted to newly created ponds. *Vertigo* species on the other hand, will be taken from local parent populations and relocated to newly created localities. All resettlements of protected species will take place within the KNP. The tasks will be implemented until 2026.



XEROCAMPYLAEA ERJAVECI (BRUSINA, 1870)
(GASTROPODA: PULMONATA: HYGROMIIDAE)
IN LABORATORY – SELECTED PARAMETERS OF
LIFE CYCLE

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Xerocampylaea erjavecii is a medium-sized (shell width 9–16 mm, shell height 5.5–11 mm) land snail native to the north-eastern Balkans. It occurs from southern Slovenia through Croatia, Bosnia and Herzegovina, Montenegro, Kosovo, to North Macedonia and Albania. Locally it is also found in Hungary and Bulgaria. It inhabits mostly plants, in moist and shady habitats, in forests and shrubs. The aim of the study was to determine the life cycle parameters of *X. erjavecii* in laboratory conditions. Initial material was collected in September 2017 in Croatia, in the Una river basin near Hrvatska Kostajnica (45°13'07"N, 16°30'13"E). The snails were kept in Petri dishes and in plastic containers, placed in a climatic chamber, under constant conditions of temperature (22 °C during the day and 18 °C at night), humidity of 80% and photoperiod 12:12. The snails were grouped in 10 individuals and reared singly from the early juvenile stages. Five-year observations of the maturation, reproduction and growth of *X. erjavecii* in laboratory conditions have shown that it is an oviparous species. Partially calcified, almost spherical eggs (1.0–1.5 × 1.4–1.6 mm, mean 1.2 × 1.5 mm) were laid in the soil, in batches of 2 to 75 eggs (mean 25), by individuals kept in groups. Uniparental reproduction was not recorded. Juveniles hatched after 12–25 days with almost 50% success. Their shells achieved 1.4–2.1 whorls (mean 1.6) at hatching. Snails from the F2 generation, kept in breeding groups, lived for about 30 months (518–1,288 days, mean = 921, n = 80). They laid eggs (65–139, mean 72.9 eggs/individual) for about 12 months (126–647 days, mean = 368). Sexual maturity (first oviposition) was reached by individuals with a shell having about 5 whorls within 339–601 days of life (mean 455 days). The study group was characterised by low survival rate (44.4% until maturity).

NATURAL AND ANTHROPOGENIC DIVERSITY
OF SNAIL HABITATS ON LIMESTONE ROCKS IN
THE AREA OF JERZMANOWICE NEAR KRAKÓW

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The aim of the study was to reconstruct changes in the environment based on molluscan assemblages found in fillings of small karst forms developed within limestone rocks near Jerzmanowice in the southern part of the Kraków-Częstochowa Upland. The main subjects of the study were fillings with their malacological content, found on two isolated rock formations: Witkowie Skały and Ostatnia Skała in Jerzmanowice. Studies of the malacofauna of selected karst forms in the Jerzmanowice-Przebinia commune were carried out based on 35 sediment samples. As a result, 13,936 specimens of gastropods belonging to 55 species were identified. These include shells of species currently living in Jerzmanowice, but also belonging to those that no longer occur in the study area. About 108 species of land snails live in the southern part of the Kraków-Częstochowa Upland. Thus, around 50% of the taxa found in the Upland occur in the vicinity of Jerzmanowice. The observed ecological and age diversity of malacocenoses allows for the reconstruction of environmental changes in the discussed area during the end of the Late Glacial and Holocene. Fillings of small karst forms usually represent only short periods of time. This is related to the high susceptibility of sediments to erosive processes. Malacocenoses and their differentiation within individual flint formations indicate the existence of many microhabitats, often adjacent to each other, but significantly different from each other.



IMPORTED ORNAMENTAL MOLLUSCS AS A SOURCE OF DIGENEA LARVAE – PRELIMINARY RESULTS

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Exotic snails are among the most valued ornamental species in the aquarium hobby. These animals are often obtained from the wild in endemic areas where they are attacked by numerous pathogens and parasites. Among the parasites found in snails, special attention should be paid to digenic flukes (Digenea), which end their life cycle in representatives of various groups of vertebrates, including humans. As part of the preliminary work, diagnostic tests were carried out for the presence of Digenea larvae in molluscs imported from Thailand and positively assessed on EU veterinary certificates. Parasitological dissections were performed in 742 individuals of snails belonging to nine species, i.e. *Anentome helena* (100 ind.), *Clithon corona* (78 ind.), *Faunus ater* (80 ind.), *Filopaludina martensi* (77 ind.), *Neritina natalensis* (87 ind.), *Neritina pulligera* (120 ind.), *Plotia scabra* (80 ind.), *Tylomelania* sp. “Golden Rabbit” (60 ind.), and *Tylomelania* sp. “Yellow Spot” (60 ind.). Parasites were detected in 4.1% (29 individuals) of all examined molluscs, of which 86.2% of animals (25 individuals) were infected by digenic flukes. They were recorded in individuals belonging to three species. *Tylomelania* sp. “Yellow Spot” individuals acted as the first intermediate host (1.7%), *C. corona* – the second intermediate host (1.3%), and *F. martensi* were the source of cercariae (2.6%) and metacercariae (27.3%). The results prove that imported snails, even in hard transport conditions, can retain live stages of parasites, which can lead to uncontrolled spread of parasites, and pose a potential threat to species kept in aquariums, as well as to human health. Our further work will focus on the molecular identification of Digenea species detected in order to verify their veterinary and medical significance, as well as on the development of practical solutions and methods for controlling undesirable parasites.

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SUBSTRATE STRUCTURE MODIFICATION – IMPACT OF *CORBICULA* SHELL BEDS ON NATIVE MUSSELS

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Biological invasions are among the greatest threats to biodiversity, and clams of the genus *Corbicula* are one example of threats in freshwater environments. Occurrence in high densities and extensive shell beds formed by *Corbicula* after death significantly modify the structure of the substrate. This may affect native mussels that spend most of their time buried in the substrate, including those of the family Unionidae, which share the same habitat preferences as the invasive *Corbicula*. A long-term modification of the substrate by *Corbicula* shells, as well as the presence of its live individuals, may result in the reduction of preferred habitats for native Unionidae and their displacement to suboptimal habitats, which in turn may lead to a reduction in the range of their occurrence. Therefore, the aim of the study was to (1) determine the avoidable density of live *Corbicula* clams and their shells by native Unionidae mussels: *Anodonta anatina* (Linnaeus, 1758) and *Unio tumidus* Phillipson, 1788, and (2) determine possible changes in the behaviour (horizontal locomotion and burrowing) of the mussels due to the presence of shells and live *Corbicula* specimens in the substrate. It was assumed that the native mussels (1) will avoid substrates contaminated by shells and live *Corbicula* individuals, (2) Unionidae mussels will burrow slower and to a shallower depth, and (3) will show increased horizontal activity on the contaminated substrates. To determine the effect of substrate contamination, aquariums were used in which the preferred sand was placed, and in the second part – sand contaminated with shells and live *Corbicula*. In the second experiment (recorded with CCTV cameras), single substrates were tested: preferred sand, sand contaminated with avoidable *Corbicula* densities. Unionidae mussels were found to avoid sand contaminated with *Corbicula* shells with minimum densities of 1,400 and 2,100 ind./m² for *U. tumidus* and *A. anatina*, respectively; both species avoid live *Corbicula* at densities of 1,400 ind./m²; they show increased horizontal activity, burying to shallower depths in substrates contaminated with shells and live *Corbicula* individuals in relation to the preferred substrate. The spread of invasive *Corbicula* clams and the formation of extensive shell beds may limit the range of native Unionidae mussels.

ACTIVITY OF WETLAND SNAILS OF THE GENUS *VERTIGO* AT LOW TEMPERATURES

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Snails are hydrophilous and ectothermic animals, for which both temperature and humidity are among the main factors regulating their activity. In temperate climates, land snails hibernate in winter, and the period of winter hibernation is one of the most critical in their lives. On the other hand, there are a number of studies indicating the winter activity of invertebrates, including snails. This activity was found mainly under the snow layer, which, acting as an excellent insulator and buffer of temperature fluctuations, created appropriate microhabitat conditions. By that means, it enabled the activity of these animals, even at below zero temperatures above the snow canopy. The aim of our study was to determine whether snail species can be active during winter in our latitude. Two wetland species were selected for the study: the rare *Vertigo moulinsiana* and the common *Vertigo antivertigo*. The individuals used for the study came from two climatic regions – northern and southern Poland. The research was carried out twice a year: in autumn and winter. The increase of the activity of both species was found with increasing temperature, and in autumn, even at 0 °C, activity was observed in both species. Also in autumn, both species responded to changes in the photoperiod with increased activity in the presence of light. The results suggest that with the right level of humidity and access to light, these species can be active under the snow.

ON THE TAXONOMY OF *CORBICULA* CLAMS

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The taxonomy of the *Corbicula* clams is like a detective puzzle. The systematic position of these molluscs has been studied for a long time, but the greatest doubts arose when it was recently noticed in Europe that at least two taxa occur in the same localities. They were identified as *Corbicula fluminea* (O. F. Müller, 1774) and *C. fluminalis* (O. F. Müller, 1774).

This was surprising, because according to previous findings, these clams were not sympatric. *Corbicula fluminalis* was considered a brackish species, and *C. fluminea* – freshwater. When in areas these clams invaded, there were difficulties with identification of the species, alternative names were introduced, such as *Corbicula* sp., *Corbicula fluminea/fluminalis*, *Corbicula* cf. *fluminalis*, *Corbicula* cf. *fluminea*. It was also proposed to designate morphotypes with letters. The morphological diversity of New World clams was marked with successive letters of the alphabet (A, B, C, D), and in Europe – it came from the first letters of English words: R (round dark coloured), S (saddle), I (intermediate), Rlc (round light colour). Environmental conditions may be responsible for part of the phenotypic variation of these molluscs, but difficulties with the identification and taxonomic assessment of *Corbicula* clams also result from the way of reproduction. In addition to sexual reproduction, they have androgenetic reproduction leading to the formation of clonal offspring. Such *Corbicula* lines produce double flagellate spermatozoa not reduced in meiosis. When the male germ cell enters the oocyte, it does not fertilise it. The female nuclear DNA is removed and replaced with male DNA; female mitochondria remain in the cytoplasm of the oocyte. It happens that the oocyte is fertilised with unreduced sperm. As a consequence, the zygote is characterised by an enlarged genome. Different morphological forms of clams can also hybridise with each other, and cyto-nuclear-morphological incompatibilities are discovered in *Corbicula* lineages. Cytogenetic studies have shown that there are di-, tri-, and tetraploid forms in *Corbicula* populations. And how many species of *Corbicula* clams can we identify among the invaders? *Corbicula* are a species complex and invasive lineages include the known *C. fluminea*, *C. fluminalis*, *C. leana* Prime, 1864, *C. largillierti* (R. A. Philippi, 1844) as well as their potential hybrids.

KRYNICKILLUS MELANOCEPHALUS

KALENICZENKO, 1851 (STYLOMMATOPHORA: AGRIOLIMACIDAE) – A NEW COMPONENT OF POLISH MALACOFAUNA

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The occurrence of *Krynickillus melanocephalus* Kaleniczenko, 1851 outside its natural range, including the Caucasus, northern Turkey and Iran, was reported from Germany in the late 1990s. Recently it has been confirmed in new sites, e.g. in Ukraine, Belarus, Lithuania, Latvia, Estonia, Sweden, Slovakia and Hungary. The publicly available citizen science database iNaturalist contains data on the occurrence



of this species also in Finland and in the European part of Russia. So far, it has not been recorded in Poland. Due to the observed increase in the range of this species, the author undertook a series of field searches aimed at confirming the occurrence of *K. melanocephalus* in Poland. In November 2022, a student of biology at the University of Warsaw, Olsza Borys, reported this species from the forest Las Kabacki in Warsaw via the iNaturalist network. Identification based on the automatic iNaturalist algorithm was confirmed by two users of the website. At the request of the author, two live individuals were collected from the locality, and the search in the vicinity revealed another population, located several dozen meters away. Prof. Anna Sulikowska-Drozd (Łódź) confirmed the identification based on anatomical features. The talk is focused on the basic and most characteristic external features that enable initial identification of the species, the structure of its reproductive system and data on its ecology. The Polish name of the species “pomrowik czarnogłowy” has been suggested. A discussion on how to deal with newly identified potentially invasive species was also proposed. The importance of amateur observations and citizen networks for the development of malacology was discussed.

MOLLUSCS OF WROCŁAW – WHAT HAS CHANGED OVER THE LAST 50 YEARS?

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In the 1970s, the thorough investigation of mollusc species composition in Wrocław was carried out. 96 species were found in the city including 28 species of aquatic snails, 58 species of terrestrial gastropods and 10 species of bivalves. Apart from native molluscs, the presence of 9 introduced species was found: *Helicodiscus singleyanus*, *Opeas pumilum*, *Tandonia budapestensis*, *Limax maximus*, *L. flavus*, *Boettgerilla pallens*, *Lehmannia valentiana*, *Monacha cartusiana* and *Dreissena polymorpha*.

Later studies, conducted in the 1990s and the first two decades of the 21st century, showed the presence of new, previously undisclosed species: the native land snail *Truncatellina costulata* and introduced snails and bivalves: *Potamopyrgus antipodarum*, *Arion vulgaris*, *Theba pisana*, *Sinanodonta woodiana*, *Corbicula fluminea* and *C. fluminalis*. The presence of these species is caused by human activities related to agriculture, horticulture, trade, animal breeding and the

natural spread of molluscs from areas of their original introduction.

In 2018, research was carried out in the riverside forest areas of Wrocław, consisting in the collection of abandoned beverage containers (bottles, cans) and testing their contents for the presence of live and/or dead invertebrates (garbage as traps and/or new habitats). In total, 939 containers were collected. Molluscs were found in 214 containers (23%). In 195 containers there were well-preserved specimens that could be identified to the species, while in 19 only remains (fragments of shells, internal plates of slugs). The presence of 30 species of molluscs was recorded: one species of bivalve, three species of aquatic snails and 26 species of terrestrial gastropods (including two species of slugs). Thanks to these studies, a new locality of *Truncatellina costulata* in Poland was recorded (a species known from a few scattered localities in the Wielkopolska-Kujawska Lowland; placed on the Red List of threatened and extinct animal species in Poland).

ON THE PHENOLOGY OF THE BLACK SEA POPULATION OF INVASIVE ASIAN DATE MUSSEL *ARCUATULA SENHOUSIA* IN SUKHYI LIMAN

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The non-indigenous *Arcuatula senhousia* in the Black Sea region was reported by single specimens in Romania, Bulgaria, and the Kerch Strait. In Ukraine, it has been recorded firstly from Maly Adzhalytskiy estuary in 2017 (Varigin 2021). During a field survey in 2018 we found a dead specimen with remains of soft body directly in the sea near Odesa and collected live specimens from the Sukhyi estuary. In the following years, a stable population settled in the Sukhyi estuaries (2020–2022), providing regular spring cohorts; the larvae were recorded in the Maly Adzhalytskiy estuary (late autumn, 2021), and single specimens were found in the Danube delta (2022). In 2021, the species was recorded in Tiligul estuary (Varigin, 2022). To determine both condition and settling process of the population in Sukhyi estuary, both benthic and planktonic samples from there from 2020–2022 were analysed. The influence of invasion, in particular local elimination of sensitive species, alteration of native communities, modification of habitats, changes in food web functioning was cal-

culated via biopollution Levels (BPL). We found that spawning and larval development began when water temperatures dropped to 5–10 °C in late October and November. This differs from the life strategies of native Mytilidae, as well as from populations of *A. senhousia* known from some other regions around the world with summer gametogenesis and spawning at higher water temperatures in early fall (Srgo et al. 2002; Watson et al. 2021). The spring cohort was represented mainly by specimens up to 5 mm in size and very few large specimens. This is believed to be connected to episodes of winter coastal freezing and food deficits, which reduce the population. The biopollution Levels (BPL) is 2 (Moderate), counted by: class of occurrence (C), influence on the native species and communities (C2 Moderate), habitat alteration (H0 None), influence on the ecosystem functions (E1 Weak).

GENETIC VARIATION OF SNAILS OF THE GENUS *ARIANTA* IN CENTRAL EUROPE

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Detection and analysis of cryptic variation has been one of the most important areas of biodiversity studies in recent years. It is assumed that up to 10% of known species on Earth are actually two or more cryptic species. Without knowing the actual number of species and their distribution ranges, it is not possible to correctly estimate biodiversity, which may have negative consequences, even for the effective protection of endangered species. The detection of cryptic variation is possible thanks to molecular studies, such as DNA barcoding, using fragments of the first unit of cytochrome c oxidase (COI). However, it is also necessary to remember about limitations related e.g. to maternal inheritance or mtDNA introgression. The presented studies show the variation of COI within the genus *Arianta* in Central Europe. Its taxonomy is poorly understood, with most investigations focused on the alpine subspecies, but there is no data on the genetic variation of lowland members of the genus *Arianta* from Central and Eastern Europe. A total of 427 COI sequences were used in the study, including all retrieved from GenBank. Based on species delimitation analyses, 13 molecular taxonomic units (mOTUs) were distinguished. The genetic distances between them ranged from 6.2 to 18.7%. The results of the comparative analyses assigned some of the distinguished mOTUs to different *Arianta* species. The most diverse was the nominal species, *Arianta arbustorum*, within which nine mO-

TUs were detected. The level of genetic variation may suggest that distinct mOTUs may constitute separate species, being an example of cryptic variation within the Helicidae family. The results do not exclude the hypothesis of the survival of the descendants of the genus *Arianta* in the area of the Alpine refugia, and provide grounds for inferring about their migration routes after the last glaciation. However, the analyses are based only on a COI fragment, therefore they require further molecular, morphological and anatomical studies. The use of more loci, including nuclear, will allow a more accurate understanding of the genetic variation of the genus and, together with morphological data, a revision of *Arianta* taxonomy.

COMPETITION FOR ENVIRONMENTAL RESOURCES – COMPARISON OF HABITAT PREFERENCES AND BEHAVIOUR OF THE INVASIVE *SINANODONTA WOODIANA* (LEA, 1834) WITH NATIVE UNIONIDAE MUSSELS

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Bivalves play key ecological functions, e.g. they are involved in the transfer of matter from the water column, which affects the rate of sedimentation and consequently water transparency, primary and secondary production and biogeochemical cycles. In addition, bivalves are considered environmental engineers, leaving extensive shell beds, which significantly affect other benthic organisms. Anthropopressure, including biological invasions, is the main cause of the drastic decline in the number of bivalves, which is why they are considered threatened on a global scale. One of the invasive species is the Chinese pond mussel (*Sinanodonta woodiana*), which can compete for food and niches with native species. Therefore, we investigated habitat preferences and differences in the behaviour of the invasive *S. woodiana* and native *Anodonta cygnea*, *A. anatina*, *Unio pictorum*, *U. tumidus*, in order to determine the possibility of their coexistence and potential competition for environmental resources. Moreover, we determined the differences between the population of *S. woodiana* from artificially heated waters (primary population) and the population from waters with a natural thermal regime (invasion front). We performed selection tests on sandy, gravel and muddy substrates, analysed the lo-



comotion and burrowing of mussels on preferred and avoided substrates. All species preferred fine-grained materials in which they burrowed deeper. The widest range of preferences was found in both populations of *S. woodiana*, while *A. cygnea* was the most selective. The preferences of *S. woodiana* coincided with the preferences of native species. *Sinanodonta woodiana*, especially from heated waters, was not very mobile (compared to the most active *A. cygnea*) and buried shallower (compared to *Unio* spp. and *A. anatina*). Our results suggest that native mussels may be threatened by *S. woodiana* due to overlapping habitat preferences and the plasticity of the invasive species, potentially impeding habitat separation. However, more mobile native mussels may migrate to suboptimal habitats avoiding competition. The spread and pressure of invasive species is intensifying and may have an increasing impact on native fauna.

MORPHOLOGICAL VARIATION AND GENETIC DIVERSITY OF *TROCHULUS STRIOLATUS* (GASTROPODA: HYGROMIIDAE)

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Terrestrial snails as cold-blooded organisms with limited ability to actively disperse are excellent objects to study interactions between climate change and phenotypic plasticity. They can also be a good model for a better understanding of mechanisms responsible for morphological variation. Genetic data suggest that *Trochulus striolatus* has a monophyletic origin, unlike many other species in this genus. Its shells are characterised by a great diversity in terms of size and shape, which resulted in distinguishing several subspecies. Comprehensive analyses showed that synergistic interactions between climate seasonality, temperature and humidity are responsible for the morphological variation. The final shell size is therefore a response to changes in the local environment and/or climate, which does not justify subspecies taxonomy. The genetic variation of microsatellites shows a clear west-east geographic gradient from Ireland through Great Britain and Western

Europe to Central Europe. There is also variation between populations of the European continent and the British Isles, whose isolation has led to genetic differences. Canadian *T. striolatus* individuals were most likely introduced from these islands. However, the isolation of individual populations is not complete, as in some regions there are individuals assigned to genetic clusters typical of other regions. The identified clusters do not coincide with the morphologically distinguished subspecies. Based on bioclimatic data, models of current and future distributions of *T. striolatus* show that favorable conditions for this species exist almost throughout the British Isles, in north-western France and in the foothills of the Alps. The climate scenario for 2040 suggests some disappearance of this species in areas already occupied and a possible expansion towards the east and north. This thermophilous and moisture-loving species, together with the relative tolerance to diverse habitats, may benefit from ongoing environmental and climatic changes, if the climate is not locally too dry.

MALACOFAUNA OF BOLKÓW CASTLE - TRENDS AND PERSPECTIVES

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The malacofauna of Bolków castle, located on the border of the Western and Central Sudetes, was examined in 2006, 2010 and 2021 in three ways: by hand, litter samples and rock ledges and walls samples. Together with data from the literature, 36 gastropod species were recorded, including: 28 species in 2006, 26 in 2010, and 20 in 2021. In 2010, the eu-dominants were *Pupilla muscorum* (Linnaeus, 1758), *Vallonia costata* (O. F. Müller, 1774) and *Trochulus hispidus* (Linnaeus, 1758). In 2021, *Alinda biplicata* (Montagu, 1803) was the dominant, reaching 50.9% of the total sampling, and *P. muscorum* was not found. Additionally, over the years, the proportion of shaded habitats in relation to open habitats has increased and in 2021 species such as *Cochlicopa lubricella* (Porro, 1838) and *Truncatellina cylindrica* (J. B. Férussac, 1807), as well as the only xerothermophilous species *Cecilioides acicula* (O. F. Müller, 1774) were not found. Some shade-loving snails were also not documented, such as *Vertigo pusilla* O. F. Müller, 1774, *Sphyradium doliolum* (Bruguière, 1792) and *Euobresia*

nivalis (Dumont & Mortillet, 1854). Climate change and the renovation of the castle walls in 2015 may be reasons for the differences. Certainly, anthropogenic pressure also matters. It is associated with tourist traffic and the annually organised “Castle Party” festival, which enjoys great interest and is loudly advertised in social media and in the press. The greatest malacological similarity to the castle in Bolków was found in the nearby ruins of Stary Książ and Książ (Nei index 0.64 and 0.61, respectively). In order to confirm the trend of disappearance of some populations and the decrease in biodiversity of this area, regularly repeated studies are required.

INFLUENCE OF NATIVE AND INVASIVE AMPHIPOD SPECIES ON SNAIL-FLUKE INTERACTIONS

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Predation is considered one of key factors shaping animal relationships, including parasitism. Thousands of invasive larvae of parasites – cercariae, are released daily from bodies of molluscs infected with digenic flukes, constituting not only an asset in the transmission of parasites, but also an important food for non-host species, mainly invertebrates. In order to check whether invasive species of amphipods are more effective predators of parasitic larvae than native species, we performed a series of laboratory experiments. We used two native (*Gammarus jazdzewskii* and *G. pulex*) and two invasive Ponto-Caspian species (*Dikerogammarus villosus* and *Pontogammarus robustoides*) amphipods as potential consumers of *Echinoparyphium aconiatum* cercariae exploiting freshwater molluscs as first and second intermediate hosts. All amphipods fed on cercariae, but their effectiveness depended on the species and the presence of alternative food or intermediate host (*Planorbarius corneus*). In all tested variants, the invasive species showed a higher or equal degree of larval consumption than the native species. The above differences in larval consumption efficiency resulted in a lower level of infection of the host in the presence of invasive amphipods. The results suggest that amphipods may contribute to a significant dilution

of host-parasite encounters, but the strength of their impact depends on their origin and the presence of additional factors. High rates of cercariae consumption, especially in the presence of readily available alternative food resources, highlight the importance of free-living cercariae as a source of energy in aquatic food webs. In contrast, observed differences between predators in cercariae consumption are evidence for the competitive ability of invasive species. The results indicate that the emergence of new predators in the environment can disrupt host-parasite interactions.

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PREDICTED CHANGES IN COMPOSITION OF TERRESTRIAL MALACOFaUNA IN POLAND IN THE 21ST CENTURY

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Observing publications on the terrestrial malacofauna of Poland's neighbouring countries, we notice a gradual shift to the north and from west to east of the species ranges from the Mediterranean and Ponto-Caspian areas. This phenomenon has intensified recently, which must be associated with the progressing climate warming. This means that more and more (un-) intentionally introduced species form stable populations in Central Europe. Additionally, alien species, previously recorded only in greenhouses, are increasingly found outside, although still in synanthropic habitats. In the last decade, in Germany, the expansion of *Hygromia cinctella* (Draparnaud, 1801) has been recorded, in the Czech Republic and Slovakia there are further localities of *Limacus maculatus* (Kaleniczenko, 1851), *Helix lucorum* Linnaeus, 1758 and *Cornu aspersum* (O. F. Müller, 1774), reports of populations of *Harmozica raveriensis* (A. Férussac, 1835) are published from Ukraine and Belarus. The dynamic changes in ranges of land gastropods in the entire region allow for a cautious prediction of the future composition of the Polish malacofauna. It is worth drawing attention of naturalists to the need to monitor habitats preferred by expected newcomers, primarily in urbanised areas (e.g. urban greenery, wasteland, railway embankments, aggregate depots), which in the near future may result in the first records of these species in our country. Social media and applications such as iNaturalist will be helpful



in documenting sites of large and distinctive species. In other cases, consultation with specialists is necessary.

INVASIVE *CORBICULA* CLAMS – SPREADING AND CO-OCCURRING MALACOFaUNA

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Asian clams of the genus *Corbicula* have been recorded in Europe since the 1980s; in Poland they were found 20 years ago. Initially, they were observed only in post-industrial heated waters. Currently, they occur mainly in many sections of the Wisła and Odra rivers, apart from thermally contaminated waters. *Corbicula* clams form stable populations in a short time, which, combined with their high filtration activity, may limit the food base of native bivalves. In order to monitor the degree of spread of *Corbicula* clams in the Wisła and Odra rivers and co-occurring malacofauna in an initial period of the invasion, we undertook the research that can be used to assess the degree of invasiveness of *Corbicula*.

We selected two study sites in the Wisła near Dobiegniew and Toruń, and three sites in the Odra: in Głogów, Gryfino and in the area of the German national park “Nationalpark Unteres Odertal”. At each locality, we took eight one-meter samples with Surber’s sampler of 25 cm side. The taxonomic position of molluscs was registered.

Corbicula clams occurred at all studied sites and co-occurred with Unionidae, Sphaeriidae, Dreissenidae bivalves and Neritidae, Viviparidae, Bithynidae, Hydrobiidae, Valvatidae, Lymnaeidae, Physidae gastropods. Most mollusc species were observed in the Odra river in Gryfino, and the least in Głogów, where no species of the genera *Pisidium* and *Euglesa* were recorded. The highest density of *Corbicula* was found in Gryfino and Głogów, and the lowest in the German national park and in the Wisła in Dobiegniewo. Moreover, at some sites we observed protected species of molluscs: *Borysthenia naticina*, *Sphaerium solidum* and *S. rivicola*. At all sites of the Odra river, we found a *Corbicula* morphotype that has not been recorded in Poland so far.

The results provide important information on the spread of *Corbicula* clams in inland waters and

can be used for further comparative and monitoring studies, which will be carried out again in the future to determine the impact on the co-occurring native malacofauna.

MALACOFaUNA OF SEDIMENTS OF ŁABAJOWA CAVE (KRAKÓW-CZĘSTOCHOWA UPLAND)

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Malacological analysis was based on 62 samples from 12 layers of sediments filling the Łabajowa cave in the Kraków-Częstochowa Upland. The malacocenosis includes 38 taxa of land gastropods (including 26 species), represented by 521 specimens. The highest frequency of shells was recorded in the H8, H8', H8+H9 and H9 layers. In the H9 layer, there were 27 taxa, mainly shade-loving, forest taxa, with a predominance of deciduous and mixed forest species (including species with higher ecological requirements – *Discus perspectivus*, *Ruthenica filigrana*). Open habitats are represented by several specimens of *Vallonia costata* and *Vallonia pulchella*. There is also a forest mountain snail *Semilimax kotulae*, which prefers rather cold and damp habitats. If no secondary mixing of fauna has occurred, this assemblage seems to indicate temperate conditions, possibly interglacial (or rather warm interstadial). Radiocarbon dating of charcoal (> 43,000 years BP) and OSL from sediments of the H9, H10, and H12 strata (68.9–108.7 thousand years ago) indicate Early and/or Middle Vistulian. In the upper part of the profile (layers H3, H4) the mollusc assemblage becomes poorer, and the low number of specimens does not allow paleoecological interpretation. *D. ruderratus* and *S. kotulae* reach slightly higher frequencies, but they are represented by only a few shells. Single representatives of taxa with higher ecological requirements also appear in the sediments. Based on the dating, the upper part of the profile should be associated with the late Vistulian (13.9–22.9 thousand years ago).

INFLUENCE OF STRESS FACTORS ON REPRODUCTION OF VIVIPAROUS CLAUSILIID *REINIA VARIEGATA* (A. ADAMS, 1868) IN LABORATORY CONDITIONS

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Reinia variegata (Adams, 1868) is an arboreal species inhabiting the islands of Japan. It is characterised by a strongly reduced closing apparatus (lack of clausilium), which can be associated with its reproduction strategy – viviparity. In 2016–2022, we conducted laboratory observations on the reproduction of *R. variegata*, modifying humidity conditions and the number of individuals in the cultures. We studied fertility and reproduction dynamics in four variants: in optimal conditions (high, constant humidity), during drought, in conditions of high density and in individuals isolated before reaching maturity. At the end of the observations, we measured the shells of adult snails, assessed the degree of developments of lip and plicae in the shell opening. We dissected snails to determine the number and maturity of embryos in the spermoviduct, as well as the variation of the reproductive system structure (bursa copulatrix, diverticulum of bursa copulatrix, penis length). We found that one to five embryos simultaneously developed in the *R. variegata* spermoviduct. Each was surrounded by a thin, translucent membrane without calcium carbonate crystals, and had an elongated, flattened lobe at the rear end of foot (podocyst?), which probably aided gas exchange or nutrition during embryonic development. The collected data on the shell morphology of adults and the number of offspring developing in their reproductive system suggest that snails with a stronger reduction of the closing apparatus (residual upper lamella) were characterised by greater fertility. The obtained results also indicate that *R. variegata* is capable of self-fertilisation. Moreover, the annual fecundity of isolated individuals was higher than that of snails kept in pairs, which have not been previously reported in any member of the Clausiliidae family.

MATERIALS TO KNOWLEDGE OF UNIONIDAE MUSSELS OF THE PONDS STAWY MILICKIE

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The work discusses selected issues concerning the mussel populations of the genera *Anodonta* and *Unio* inhabiting the area of the ponds Stawy Milickie.

Information was taken from the literature and from unpublished observations and the author's own data. Attention was focused on such aspects as: species composition (also in historical terms), shell biometrics, and the impact of fisheries management. The parasitological aspect of a relationship between mussels and water mites (Hydrachnidia) was also analysed. As a result, in the area of Stawy Milickie five species were recorded including *Anodonta cygnea*, *Anodonta anatina*, *Sinanodonta woodiana*, *Unio pictorum* and *Unio tumidus*. The morphometry of *Anodonta cygnea* showed that in the collected samples this species reached, on average, larger sizes than those reported in the literature from Poland. Other species were also relatively large. In turn, at the site (Staw Rudy), where *A. cygnea*, *S. woodiana* and *A. anatina* coexisted, it was found that the first two species are hosts of *Unionicola ypsilophora* water mite. Fishing and carp farming affect the mussels in a very diverse way. The occurrence of glochidia host fish and the liming of ponds are examples of a positive impact, while the cycles of draining water from ponds and frequent removal of mud from basins and water supply channels are causes of high mussel mortality. In summary, the importance of the ponds Stawy Milickie for the Unionidae populations was indicated. Although these are anthropogenic reservoirs used for fish farming, based on the presented data, they may constitute the largest enclave of freshwater mussels in the Barycz basin and throughout the border of Lower Silesia and Wielkopolska. Therefore, there is a justified need for a more thorough and systematic recognition of populations of these molluscs inhabiting the ponds, which would not only have a purely cognitive value, but also a practical dimension, consisting in their more effective protection.

EXOTIC ORNAMENTAL SNAILS – POTENTIAL SOURCE OF INTRODUCTION OF INVASIVE DIGENEA LARVAE

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There is a growing interest in exotic snails among aquarium hobbyists. Because of the variety of coloration and shell shapes, they are attractive objects in an aquarium, at the same time playing numerous important functions there, e.g. removing algae and decaying organic matter. Many ornamental molluscs available on the European market are obtained directly from their natural environment. The most visually attractive molluscs come from tropical coun-

tries, which are endemic areas of numerous trematodes of veterinary and medical importance. The aim of this study was to check, based on literature data, whether mollusc species, which are popular in the trade of ornamental animals, are hosts of Digenea larvae invasive for vertebrates in the area of endemic occurrence. The most frequently imported molluscs include *Filopaludina martensi* (Viviparidae) and *Anentome helena* (Nassariidae). The representative of Viviparidae (*F. martensi*, commonly known as the “white wizard”) is of the greatest interest among parasitologists, since it is a frequent part of the humans’ diet in the endemic area (Asia). Among the most common representatives of Digenea in this mollusc species are *Echinostoma revolutum* metacercariae, whose consumption together with undercooked/raw snail meat in extreme cases may lead to hemorrhagic gastroenteritis in humans. In the second mentioned mollusc species, *A. helena* (commonly known as “killer snail” or in Polish “helenka”), e.g. cercaria of *Brachylaima virginianum* was detected. Flukes of the genus *Brachylaima* are of an increasing interest to scientists both because of difficulties in morphological identification of these parasites and their zoonotic importance. In conclusion, there are few reports of representatives of Digenea recorded in exotic mollusc species traded as ornamental animals. Moreover, the review of literature shows that the import of exotic snails, originating directly from the natural environment, is associated with the risk of introducing parasites that are dangerous to other inhabitants of the aquarium and to a breeder. Moreover, there is an increasing number of reported cases of irresponsible release of such molluscs into European water bodies, posing a risk of introducing alien parasite species that are dangerous not only to native biocoenoses, but also to human health.

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IS THE INVASION OF MOLLUSC *MELANOPSIS PRAEMORSA* (GASTROPODA: PULMONATA: MELANOPSIDAE) IN UKRAINIAN HYDROLOGICAL NETWORK POSSIBLE IN THE NEAR FUTURE?

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The beginning of the 21st century was marked by irreversible climatic changes in Ukraine, related to the increasing warming of the Earth’s climate from year to year. Early spring downpours and spring-summer floods led to severe destruction of malacocenoses. The molluscs that managed to survive and found favourable conditions started new populations.

Alien molluscs species will spread in Ukraine as a result of global warming. One the potential invasive species, is *Melanopsis praemorsa* (Linnaeus, 1758) – widespread along the Mediterranean coast, from Gibraltar to Mesopotamia, in the north of Africa and Israel. This mollusc, due to its wide ecological tolerance, has a chance to settle in a variety of water bodies, both freshwater and poorly saline waters. It is an unrefined herbivorous species, but its diet also includes small, sedentary animals.

The ecological importance of *M. praemorsa* results from its high population densities. The type of bottom sediment seems to be a factor that may limit the occurrence of the species. *M. praemorsa* prefers gravel or sandy bottoms, avoiding muddy substrates.

At the beginning of the 21st century, this mollusc acclimatised in Spain, Portugal, Greece, Bulgaria, Romania, Italy and Hungary. Romania and Hungary border Ukraine and are connected by a common river network of the Dniester, Prut and Tisza. It is from here the possible initiation and further migration of *M. praemorsa* through the hydro-network of the left-bank part of the Dnieper to the northern and south-eastern directions throughout the territory of Ukraine. This area has been recently increasingly affected by global warming, but to a much lesser extent than environments and snail populations of the right-bank Dnieper river network suffering from the increase of temperature.

Reliable migration of *M. praemorsa* from the hydrological network of Hungary or Romania to the east to the Dnieper valley and further, and the successful colonisation of new territories by this mollusc due to its ability to quickly acclimate to new environmen-

tal conditions may lead to an increase in the number and density of the populations, and thus to the displacement of native species.

NOT AS BLACK AS IT IS PAINTED – INFLUENCE OF INVASIVE *SINANODONTA WOODIANA* (LEA, 1834) ON LOCOMOTION AND BURROWING OF SELECTED NATIVE UNIONIDAE MUSSELS

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The Chinese pond mussel *Sinanodonta woodiana* is an invasive species of the Unionidae family that is native to Southeast Asia. In Poland, *S. woodiana* initially occurred only in the heated waters of the Konin Lakes, but over time it adapted to waters with natural thermal regimes. Due to its rapid development, short life cycle and high fertility, it forms numerous communities, which significantly transform the environment in which it occurs, leaving shell beds. It is assumed that this mussel may compete for habitat and food, and consequently displace native species of Unionidae bivalves, whose numbers are drastically decreasing as a result of anthropopressure and climate change. Therefore, the aim of the study was to determine the effect of shells and live specimens of *S. woodiana* on the behaviour (horizontal locomotion and burrowing) of native mussels of the Unionidae family: *Anodonta cygnea* (Linnaeus, 1758) and *Unio tumidus* Philipsson, 1788. We assumed that native mussels on substrates containing shells and live specimens of *S. woodiana* will exhibit increased horizontal locomotion (searching for a more suitable habitat) and will burrow slower and shallower due to the physical obstacle of invasive mussels. We previously tested unique densities of shells on the surface or sand-buried as well as partially buried live *S. woodiana* individuals. We showed that shells on the surface and live *S. woodiana* affect the start of activity, distance traveled and locomotion time of *U. tumidus*, while limiting the speed of *A. cygnea* during horizontal locomotion. We also observed an effect on the degree of burial of native mussels, both buried shells and live *S. woodiana* individuals. The obtained results partially confirm our hypotheses and provide important information on the impact of *S. woodiana* on native Unionidae, especially the shell beds left behind.

Live individuals of this species affect native mussels only in densities significantly exceeding the highest densities recorded in the environment.

HELIX LUCORUM LINNAEUS, 1758 – THE FIRST RECORD OF THE SPECIES IN POLAND

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The native range of *Helix lucorum* L., 1758, includes the Caucasus, Anatolia and possibly the Balkan region. As a result of climate change and human activities, the distribution range of this species has been increasing, e.g. in several European countries it forms stable populations. The presence of this species was recorded for the first time in Poland. The species identification of individuals caught in central Poland was verified using integrative taxonomy methods: analysis of conchological features, anatomy of genital organs and the DNA sequence of the COI gene (barcode), which encodes the first subunit of cytochrome oxidase and is a useful tool in the molecular identification of species. The collected data confirmed the affiliation of the examined individuals to *H. lucorum*.

ENDOSYMBIONTS IN THE GENUS *UNIO* MUSSELS

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Unionidae mussels are an important element of an ecological network in which species are linked by interactions. The most significant for them are specific species of fish on which their larva – glochidium – transforms. Mussels are also an environment for a number of species classified as endosymbionts. They were studied in mountain tributaries of the Wisła river on the *Unio crassus* complex, an endangered and protected taxon in the EU. A total of 8 taxa of endosymbionts were found in these populations: Ciliphora ciliates including *Conchophthirus* sp., *Trichodina* sp. and *Tetrahymaena* sp., as well as



flukes *Rhipidocotyle campanula* (Digenea), annelids *Chaetogaster limnaei* (Oligochaeta), fly larvae (Chironomidae), various stages of water mites of the genus *Unionicola* sp. (Hydracarina) and embryos of the European bitterling *Rhodeus amarus*. The reported Ciliophora are relatively common and have a stable annual prevalence: *Conchophthirus* sp. from 2.1% to 5.7%, *Trichodina* sp. from 2.5% to 5.8% and *Tetrahymena* sp. from 1.2% to 2.8%. *Conchophthirus* are widespread in other Unionidae species and, together with *Trichodina*, were also found in the earlier study of *U. crassus* from Luxembourg. However, their role has not been clarified. Embryos of *Rh. amarus* were found mainly in May, their prevalence ranged from 0.14% in the Carpathians to as much as 43% in the Świętokrzyskie Mountains. These embryos may have a negative effect on mussel larvae that develop in the gill cavity of the females at the same time. The prevalence of less than 1% characterised endosymbionts classified to invertebrates: it did not exceed 0.1% for *Ch. limnaei* (commensal) and Chironomidae larvae (unknown role), ranged from 0.1 to 0.5% for *Unionicola* sp., and from 0.3 to 4.0% for *Rh. campanula*. In other species of Unionidae in the lowland part of Poland, the prevalence for this group is higher: from 2 to about 40%. Mussels may be negatively affected by *Unionicola* sp., which periodically use the mussels' gill cavity for reproduction, and certainly by castrating *Rh. campanula*. It destroys gonads of the host mussel, preventing it from reproducing, and uses it to multiply its invasive stages. Knowledge about endosymbionts in protected mussels will allow, among others, to prevent them from infections by parasites, which may strengthen effects of costly conservation programs, such as species restitution or captive breeding.

REPRODUCTION BEFORE DEATH – ABOUT ANNUAL CONFLICTS IN RESOURCE ALLOCATION BETWEEN REPRODUCTION AND SURVIVAL, MITIGATED BY PHENOLOGY

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Life history theory attempts to understand how natural selection designs organisms to achieve reproductive success. Since the amount of resources in nature is limited, there are competing demands. One of the basic competitive requirements is the conflict between reproductive effort and survival. In a seasonal environment, freshwater mussels face high mortality during higher temperatures, mainly in late spring and summer. They adapt to summer mortality

by shifting their reproductive effort to earlier periods in the growing season and by reducing investment in offspring brought out later in the season. In this way, their lifetime reproductive effort is optimised through repeated episodes of seasonal selection. The recently recorded increase in the mortality of mussels in the summer means that their reproduction is gradually limited to shorter and shorter periods of early spring. Such restrictions must reduce reproductive efficiency and may contribute to a further decline in the abundance of this already endangered group.

PARASITIC DISEASES TRANSMITTED BY SNAILS – POTENTIAL AND REAL THREAT

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Among invertebrates, Arthropoda and Mollusca play the most important role in the transmission of parasitic diseases. Eukaryotic parasites transmitted and maintained in the environment by molluscs, and in this group by snails, cause parasitoses of nervous, circulatory, respiratory, digestive or genitourinary systems, causing hypersensitivity of defense reactions, formation of cancer, organ failure, infertility and even death. Due to climatic, but also socio-economic factors, most diseases of parasitic etiology are recorded in developing countries. The belief of inhabitants of developed countries about the permanence of the division into safe and parasitologically dangerous climatic zones is successively weakened by reports on expansions of a parasite occurrence causing diseases in humans. Common knowledge about conditions of the transmission of exotic etiological agents of parasitoses is low, and the lack of education in this matter increases susceptibility to manipulations.

The aim of the analysis was to show a key role of snails in keeping parasites in the environment, and thus to present predictions on the potential and real threat of disease transmission in regions traditionally considered safe.

The contribution of over one hundred gastropod species belonging to 20 families that spread parasitoses was analysed. The geographical distribution of these hosts is presented, as well as the epidemiology and pathogenesis of the transmitted diseases. The reasons for the real and potential possibilities of extending the range of diseases transmitted by snails in human populations were indicated.