

## THE 38TH POLISH MALACOLOGICAL SEMINAR

### SEMINAR REPORT

The 38th Polish Malacological Seminar was held (22–25.05.2024) in Siedlce, a city in eastern Poland. Our annual meeting was organised by The Association of Polish Malacologists (APM) and Institute of Biological Sciences, University of Siedlce. On this occasion, we also celebrated the 55th anniversary of the establishment of this university. The organising committee included active and retired employees of the Faculty of Science and Natural

Sciences: BEATA JAKUBIK, KRZYSZTOF LEWANDOWSKI, and AGATA TRĘBICKA (Fig. 1).

The seminar was attended by 40 malacologists (Fig. 2), who presented 37 scientific contributions: 26 speeches and 11 posters. The meeting was divided into six oral sessions (Fig. 3) and one poster session (Fig. 4). The topics were, as always, diverse (Table 1). “Ecology and Conservation” dominated, and there were also numerous presentations concerning “Fossil



Fig. 1. The organising committee of the Seminar (photo: ANNA DROZD)

Molluscs” or “Systematics and Phylogeny”. The ratio of aquatic to terrestrial molluscs was almost equal (1.08 : 1), while gastropods featured more than twice as often as bivalves (2.4 : 1). Fossil molluscs were not included in these calculations, assuming that these papers concern both environments and both taxonomic groups. This year, alien species were a topic of 7 talks (19%). It is a visible decrease compared to last year’s record, when 36% of presentations concerned such species.

Our sessions took place in a room, with walls covered with nature graphics. These went well with the theme of the seminar. The pleasant atmosphere was conducive to losing track of time, so some (just

me) had a problem with keeping to the time limit for their presentation... and would have talked the audience to death if it had not been for dinner time... Our hotel was placed just next to the aquapark, which tempted us with cooling after many hours spent on scientific sessions. However, most participants spent their free time primarily in more or less malacological conversations. Some also preferred walks to get to know the city hosting us better.

The general meeting of the members of The Association of Polish Malacologists took place on the second day of the seminar. Officers reported the previous year’s activity and presented plans for the next. Traditionally, a formal banquet was held at the end

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

Discipline	2007–2023		2024	
	n	%	n	%
Ecology & Conservation	222	29.7	9	24.3
Applied Malacology & Parasitology	92	12.3	3	8.1
Miscellaneous: general, behaviour, archaeology, collections, history, education, methodology	79	10.6	4	10.8
Life Histories	77	10.3	1	2.7
Biogeography & Faunistics	77	10.3	4	10.8
Systematics / Phylogeny (including molecular)	60	8.0	6	16.2
Fossil Molluscs	57	7.6	7	18.9
Structure (histology, cytology, shell) & Variation	45	6.0	2	5.4
Physiology	38	5.1	1	2.7



Fig. 2. Participants of the 38th seminar at the stadium adjacent to the conference venue (photo: ANNA DROZD)



Fig. 3. The oral session (photo: ANNA DROZD)

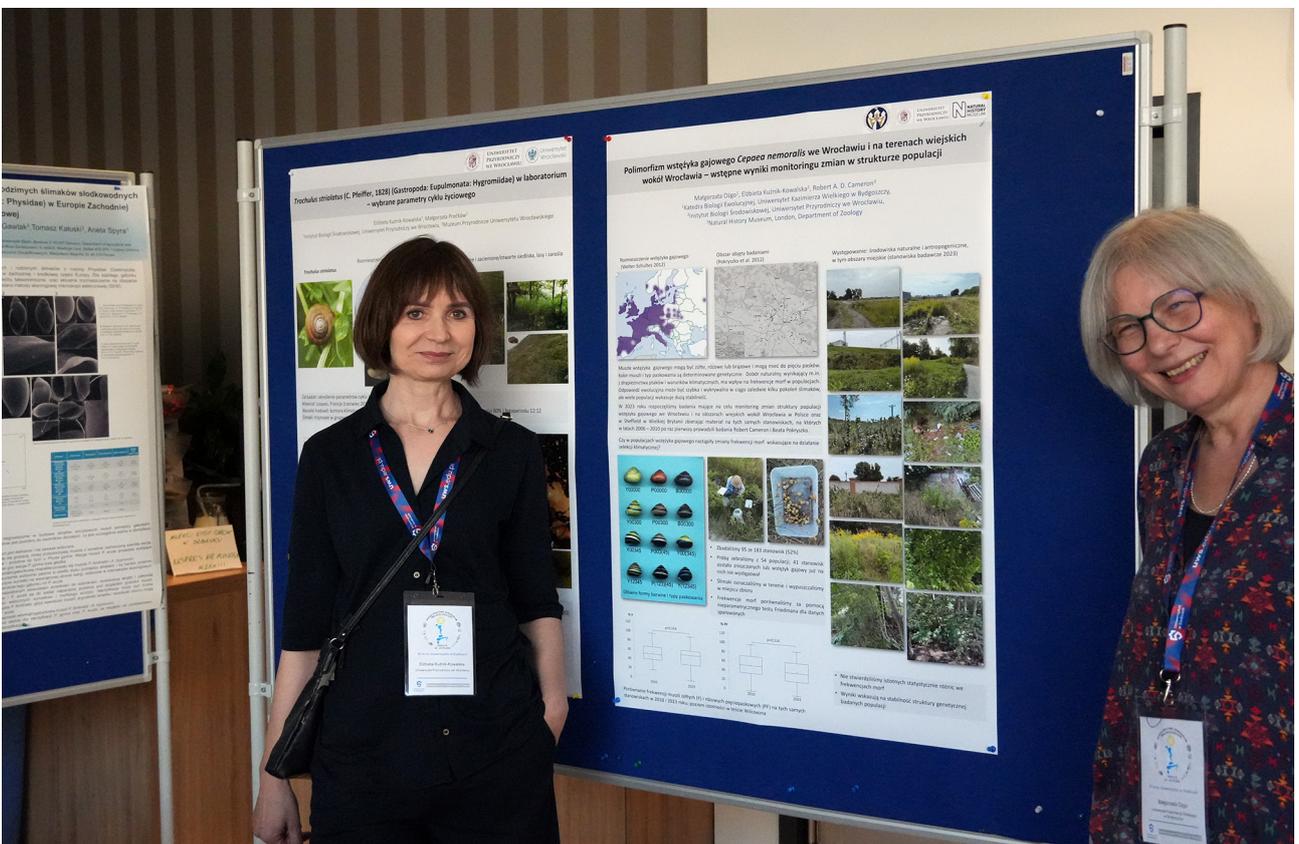


Fig. 4. The poster session (photo: ANNA DROZD)



Fig. 5. Awarding honorary membership of the APM: the President reads the laudation (photo: ANNA DROZD)



Fig. 6. The Honorary Member of the APM, prof. ANDRZEJ LESICKI (photo: ANNA DROZD)

of the official part of the seminar, at which a great ceremony took place: Professor ANDRZEJ LESICKI was presented with the title of honorary member of the APM (Figs 5–6) (see official announcement below). There was a lot of emotion, memories, and photos. During the banquet, awards were also presented to young malacologists for the best presentations at this year's seminar. The awards committee, consisting of MAŁGORZATA OŹGO and WITOLD ALEXANDROWICZ, awarded GABRIELA KARLIK in the poster category for the contribution entitled “Molecular diversity of the genus *Bythinella* Moquin-Tandon, 1856 (Gastropoda: Caenogastropoda: Truncatelloidea) in the Carpathians”. The jury appreciated the scientific quality and aesthetic side of the poster. The best talk, also chosen for its scientific quality and attractive presentation, was “Cryptic diversity and phylogeny of selected genera of snails from the Helicoidea superfamily” by NATALIA PAJAŁ (Fig. 7).

On the last day, we had a trip to the nearby nature reserve “Stawy Siedleckie” (Siedlce Ponds). Our guides were ornithologists from the University of Siedlce. We walked along the causeways, looking out for rare bird species. We learned about the importance of ponds in bird conservation and the projects and research plans of Siedlce ornithologists. Although we looked at the birds with enthusiasm through binoculars and telescopes, at the same time our watchful eyes of malacologists spotted *Cepaea nemoralis* present on the shores or empty shells of *Anodonta cygnea*...

As usual, the time passed too quickly. We left with our heads full of thoughts or new ideas, which we may talk about at the meeting next year. The organisation of the next seminar will be undertaken by scientists from Toruń.

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Fig. 7. The awards committee and the winner of the award for the best presentation by young malacologists (photo: ANNA DROZD)



## AWARDING HONORARY MEMBERSHIP OF THE ASSOCIATION OF POLISH MALACOLOGISTS (APM) TO PROFESSOR UAM, DR HAB. ANDRZEJ LESICKI

The General Assembly of the APM, which met on 26th May 2023 during the 37th Polish Malacological Seminar in Katowice (see *Folia Malacologica* 31(4): 236–260, 2023) unanimously adopted a resolution granting Prof. UAM, dr hab. ANDRZEJ LESICKI honorary membership of the APM in recognition of his contribution to the development of malacology in Poland and in the world, and in appreciation for his

commitment in APM. The official ceremony took place in Siedlce on 24th May 2024, during the 38th Polish Malacological Seminar. The official diploma of honorary membership was presented to PROFESSOR LESICKI by MARCIN SZYMANEK, President of the Association of Polish Malacologists, in the presence of members attending the Seminar.

### THE LAUDATION

Professor Andrzej Lesicki has been a pillar of the Association of Polish Malacologists (APM). A founding member of the APM in 1994, he then served a number of a variety of functions in the organisation for many years. First as the treasurer (1995–2004), then as Vice-President (2004–2012) and as APM's President (2012–2016). Without his commitment our Association would not have worked so dynamically and the APM's journal *Folia Malacologica*, whose editor-in-chief he has been for many years, would not have presented such a high standard and perhaps would not even exist today.

Since early childhood Professor Andrzej Lesicki had a profound interest in nature. He would breed hamsters, white mice, budgies and canaries and collect shells. After he had developed his interest in nature in high school, i.e. in the Karol Marcinkowski High School in Poznań in late 1960's, he started his zoological studies at the Adam Mickiewicz University (AMU), Poznań. He completed his studies with honours in 1973 following which he started working at the very same University. He conducted research and has been continuing work at AMU until now. Despite his retirement age he is still an active professor. In 1981 Professor Andrzej Lesicki was awarded a Ph.D. after defending his doctoral dissertation "Hormonalna regulacja aktywności fosfofruktokinazy i kinazy pirogronianowej w wątrobotrzustce i mięśniu odwłokowym raka *Orconectes limosus* Raf. [Hormonal regulation of phosphofruktokinase and pyruvate kinase activity in the hepatopancreas and abdominal muscle of the crayfish *Orconectes limosus* Raf.]". In 1994 on the basis of his research accomplishments and the presentation of his habilitation dissertation "Fosfofruktokinaza i kinaza pirogronianowa w tkankach skorupiaków i owadów [Phosphofruktokinase and pyruvate kinase in crustacean and insect tissues]" he was awarded a post-doctoral title. He became university professor in 1995. He worked in the AMU Department of Animal Physiology between 1973 and 2003 and then in the AMU Department of Cytology

and Histology between 2003 and 2005. Since 2005 Professor Lesicki has been in charge of the section of Cell Biology in the Department of Cell Biology which is a part of the Institute of Experimental Biology of the AMU Faculty of Biology.

Professor Lesicki carried out research and worked also in Great Britain and Germany. In 2014 he completed his post-graduate MBA studies conducted jointly by AMU and the Poznań School of Economics.

For many years, Professor Andrzej Lesicki has been undertaking research in the field of cell biology, focused on the analysis of the structure and function of proteins of cell membranes and in particular on the analysis of the structure and function of receptor proteins (nicotine and aquaporin receptors). He has investigated crustaceans and insects as well as molluscs. The description of the characteristics of aquaporin proteins in organs of pulmonate snails is Professor Lesicki's exceptional international achievement.

Another area of Professor Lesicki's interest is the systematics of terrestrial and freshwater pulmonate gastropods based on molecular biology techniques. The discovery of *Monacha claustralis* found for the first time on the AMU Morasko Campus initiated a series of research activities on the new species and generated a number of articles authored in cooperation with other Polish and foreign malacologists including Professor Folco Giusti and Professor Giuseppe Manganelli from Italy. Animal physiological ecology is yet another area of Professor's concern. In particular, Professor Lesicki has focused on the physiological ecology of animals living in extreme conditions, including oceanic hydrothermal vents.

Professor Andrzej Lesicki has authored or co-authored over 230 publications including original research papers, monographs, chapters in academic textbooks and handbooks for high schools, popular science articles as well as many reviews of doctoral and post-doctoral dissertations. He has also supervised three doctoral dissertations.



Intensive academic work is only one of many activities Professor Lesicki has contributed to AMU. For 24 years he has performed a number of important functions at AMU. He served as Vice-Dean (1996–2002), then as Dean of the Faculty (2002–2008), as AMU Vice-President (2008–2016) and as AMU Rector Magnificus (2016–2020). On top of being editor-in-chief of *Folia Malacologica*, Professor Lesicki was also the editor-in-chief of semi-annual “Biological Letters” published jointly by the Poznań Society of Friends of Science and AMU Faculty of Biology. Professor Lesicki is also a member of the Poznań Society of Friends of Science and since 2010 a member of Freshwater Biological Association.

He has been awarded a variety of prizes and distinctions including a silver “*Labor omnia vincit*” medal and an “Honorary Hipolit” by the Hipolit Cegielski Society, AMU President’s awards and an award by the Ministry of National Education for the post-doctoral (habilitation) dissertation. The International Astronomical Union named planetoid

82937 “Lesicki” in recognition of the foundation of the University of Poznań in 1919 and AMU’s centennial.

Intensive academic life, teaching obligations and commitment to various kinds of organisational work in our Society do not take away time and willingness from Professor Andrzej Lesicki, a truly good man, to help colleagues, students and young malacologists. He remains available for the family, particularly for his beloved granddaughters.

His research and organisational work for our Society, and particularly top-quality editorial activity for our journal deserve exceptional recognition and justify reasons to award Professor Andrzej Lesicki the status of an honorary member of the Association of Polish Malacologists.

Professor EWA STWORZEWICZ, Ph.D.  
Professor Emeritus  
The Polish Academy of Sciences

## ABSTRACTS OF THE 38TH POLISH MALACOLOGICAL SEMINAR

NO LONGER *MONACHOIDES* GUDE & WOODWARD, 1921, ONLY *PERFORATELLA* SCHLÜTER, 1838 – INTEGRATIVE TAXONOMIC APPROACH

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*Monachoides* and *Perforatella* are genera of medium-sized European land snails in the family Hygromiidae. Up to six species were recognised in *Monachoides* lately, but the inclusion of three of them was questionable. In *Perforatella* two species were classified. Our extensive phylogenetic and morphological analyses showed that the examined species belonged to two different subfamilies of Hygromiidae. Three Balkan *Monachoides* species were transferred to the genus *Xerocampylaea* in Trochulinae (*X. fallax*, *X. taraensis* and *X. kosovoensis*), while the remaining *Monachoides* and *Perforatella* species were included in Hygromiinae, with the latter generic name having priority. The taxonomic decisions also included the synonymisation of *M. bacescui* and redescription of a previously overlooked taxon *M. incarnatus welebitanus*. Therefore, the genus *Perforatella*, in addition to *P. bidentata* and *P. dibothrion*, now consists of *P. incarnata*, *P. vicina* and *P. welebitana*, which can be distinguished by microsculpture of the shell surface and the morphology of the love dart. On the other hand, adults of *P. bidentata* and *P. dibothrion* are characterised by two prominent teeth on the lower aperture margin and shells with regular riblets but no periostracal structures. From the biogeographical point of view *Perforatella* belongs to a group of several Hygromiidae genera that apparently diversified and persisted over the Quaternary glacial cycles north of the southern European peninsulas in the Alps, Carpathians and central Europe.

ARE WE AT RISK OF A NEW ICE AGE, AND WHAT DO SNAILS THINK ABOUT IT?

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Climate is one of the most critical factors influencing processes occurring on Earth. The climate has changed many times throughout our planet's more than 4.5 billion-year history. Their causes are not fully explained. The causes of climate change on a global scale are, on the one hand, "terrestrial" factors (set of continents, the composition of the atmosphere) and, on the other hand, "cosmic" factors (parameters of the Earth's orbit, activity of the Sun). The mutual interaction of these factors led to changes in cyclical conditions operating with different intensities, on various scales and in other periods. Hence, large ice ages lasting several, a dozen or even several dozen million years, more short-term climatic fluctuations whose duration is measured in thousands of years (sometimes in tens or hundreds of thousands) to short-term changes taking place on a scale of tens or hundreds of years. Finally, catastrophic processes leading to short-term (several or a dozen years) but significant climate fluctuations are known. Undoubtedly, the last glaciation had the most significant impact on modern ecosystems. It was marked by alternating climatic fluctuations – cold (glacials) and warm (interglacials) in Poland. Over the last million years, at least nine glacial advances have been associated with climatic cooling phases. Warm interglacials separated these periods. The youngest geological period – the Holocene – has features of the interglacial period. During its duration, there are warm phases (e.g. the Middle Holocene Climatic Optimum) and cooler phases covering periods of several thousand years. Short-term climate changes have been well documented over the last 2,000 years. During this time, we distinguish two cooling periods (Early Medieval Climatic Pessimism (Dark Ages) and the Little Ice Age) and two warming periods (Medieval Climate Optimum and the modern period). Climate change has a significant impact on the malacofauna communities inhabiting Poland. In cold periods, the importance of northern European, boreal, and Siberian species increases. In warm climatic phases, the share of southern European, Mediterranean, and Balkan taxa increases significantly.



## MALACOFAUNA OF YOUNGER LOESS IN THE ZALESIE PROFILE NEAR PRZEMYŚL

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Lithological and malacological analysis was conducted at the loess site in Zalesie near Przemyśl. The profile exposed here includes a loess-soil sequence up to 7 m thick. The sediments recognised here represent the last glaciation and are correlated with MIS-4-MIS-2 isotopic stages. At the site in question, three covers of silty sediments (loess) are separated by interstadial levels of fossil soils. Within the two younger covers, corresponding to the younger middle loess (LMs) and the younger upper loess (LMg), and in the soil horizon separating them (Gi/LMs), numerous mollusc shells were found. No mollusc shells were in the footwall part of the profile (younger lower loess LMd). The diversity of the malacofauna made distinguishing five types of faunal associations possible. In the lower part of the sequence (LMs loess), the main components of the fauna were taxa typical of cold climates and dry, open Arctic steppe-type habitats (*Pupilla loessica* and *Pupilla muscorum*). The numerous occurrences of the former indicate the high intensity of aeolian deposition. A fauna with a completely different composition appears in the interstadial fossil soils (Gi/LMs) lying above. The dominant role here is played by taxa typical of humid and even marshy habitats: *Vertigo genesii* and *Vertigo geyeri*. Their presence indicates a humid climate phase and an arctic tundra-type habitat. This period is also associated with slowing down or even stopping the accumulation of loess, which enabled the development of soil-forming processes. The top part of the sequence (LMg) represents the maximum phase of the last glacial period (MIS-2 isotope zone). The malacofauna recognised in this section included mainly mesophilic taxa, *Trochulus hispidus* and *Succinella oblonga elongata*, indicating the presence of open but relatively humid biotopes of the type of humid Arctic steppe. The profile in Zalesie belongs to a tiny group of loess sites in Poland, where a complete malacological sequence has been preserved, including both the younger upper and middle loess and the level of fossil soils separating them.

## LATE HOLOCENE MALACOFAUNA IN THE ROGOŹNIK STREAM SEDIMENTS IN PODHALE

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Lithological and malacological studies covered the sediments building the low terrace of the Rogoźnik stream in the northwestern part of the Podhale Basin. This terrace has a uniform structure over a large part of the valley. There are three layers of gravel and four levels of sandy and dusty mud. Gravel levels represent periods of intense fluvial activity of the stream correlated with the cooler and wetter climatic phases of the Holocene. No mollusc shells were found in the gravel. A rich and diverse malacofauna was present in fine-grained sediments (silts). Over 50 species have been recognised here. The analysis of the malacofauna enabled the characterisation of environmental conditions during sediment deposition. It is possible to distinguish two different types of malacocenoses. In the lower part of the sedimentary sequence, species typical of shaded habitats and mesophilic forms play a dominant role. Such fauna indicates a significant forestation in the Rogoźnik stream catchment area. Taxa of open environments predominate in the upper part of the sequence. Radiocarbon dating of individual elements of the lithological succession made it possible to determine the age of the sediments and the time of significant reconstruction of the habitats. The entire analysed sequence represents the period of the last 2000 years. The phase of rapid deforestation of the Rogoźnik stream valley is associated with the warm climatic phase starting in the 12th-13th centuries and lasting until the 15th century. This is the Medieval Climatic Optimum. During this period, there was an increase in settlement in the Podhale region, and the need to acquire new arable land was the main reason for reducing forest areas at the expense of pastures and arable fields. At the same time, processes related to human activity are becoming the main factor shaping the environment, influencing the course of geological processes and changing the species and ecological structure of fauna and flora communities occurring in this area.

## “SLOW DOWN TO HURRY” – WHAT THE LIFESTYLE OF LAND SNAILS CAN TELL US ABOUT THE ENVIRONMENT

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Snails are the most numerous classes among molluscs. They have achieved incredible evolutionary success, allowing us to find them in seas, lakes, and on land. One of the methods used successfully in malacology is stable isotope analysis, which currently forms the basis of almost every research endeavour. As a result, we can increasingly better investigate paleoclimate and paleoenvironment. Most scientific studies focus on aquatic organisms. Understanding the mechanisms and processes that influence the incorporation of stable isotopes of oxygen and carbon into the shells of land snails is more complex. The multitude of sources of oxygen and carbon assimilated by terrestrial organisms and the wide range of factors that affect their value make it extremely important to learn about behaviourism, diet, survival strategies, life effects, and environmental adaptations, all of which are crucial to reconstructing and interpreting life environments. Due to the narrow specialisation of land snails, their mode of locomotion, life cycle, activity rhythms, susceptibility to dehydration, they have developed a range of survival strategies under worsening climatic and environmental conditions. Interpreting the results of stable isotope analysis of oxygen and carbon from fossilised land snail shells is best done in the context of analogous data from modern snail studies. Optimally, both modern and fossil snails belong to the same species. In this case, we can assume that the individual environmental, climatic, and behavioural requirements have not significantly changed, and the mechanisms influencing the same species in the past and present are identical. Due to the low mobility of snails, the reconstructed parameters will be based on local conditions. Through numerous analyses of fossil material and experiments on modern snails, we know that precipitation has the greatest impact on  $\delta^{18}\text{O}$  values of shells, while diet and assimilated carbonates have the greatest impact on  $\delta^{13}\text{C}$ . However, these are not the only factors that influence isotopic records.

## DOES THE PRESENCE OF *SINANODONTA WOODIANA* AND MUSSEL MACROPARASITES INFLUENCE THE PATTERN OF USE OF EUROPEAN MUSSELS BY THE EUROPEAN BITTERLING?

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Parasitic infections, including co-infections, are ubiquitous, and their effects on hosts can play a role in ecosystem processes and affect the fitness and reproduction of many species. Parasites and diseases may contribute to the mass extinction of mussel populations. This is a serious problem because freshwater mussels are one of the most endangered groups of animals in the world that perform important ecosystem functions. Moreover, parasite-host relationships in the presence of alien species and their impact have not been comprehensively described. This study tested the following assumptions: (1) the presence of the non-native swan-mussel *Sinanodonta woodiana* influenced the pattern of swan-mussel utilisation by the European bitterling (*Rhodeus amarus*), which is a parasite of freshwater mussels, (2) there is a negative relationship between parasitism of the European bitterling and the presence of parasites other than the European bitterling. Polish populations of all native species of mussels from the Unionidae family (*Anodonta anatina*, *A. cygnea*, *Pseudanodonta complanata*, *Unio crassus* s.l., *U. pictorum*, *U. tumidus*) and the alien *Sinanodonta woodiana* were examined. The overall prevalence of eggs and embryos of the European bitterling reached 18.8% and was represented by high variability among bivalve species. The number of the bitterlings ranged from one to 70 and was significantly higher in species of the *Unio* genus. All six native species of mussels were used by the European bitterling (larger individuals were used more often), while in the 152 examined individuals of *S. woodiana*, no eggs and embryos of the European bitterling were found. Other macroparasites were found in 59.9% of the mussels examined. Water mites were most frequently found in mussels (in 46.5% of the examined mussels), followed by flukes (24.9%), oligochaetes (3.1%) and chironomids (1.6%). Among native spe-



cies, the presence of the European bitterling in mussel gills was most strongly associated with host species, with *U. tumidus* and *U. pictorum* being used most frequently. There was no significant impact of the occurrence of *S. woodiana* and macroparasites on both the use of native mussel species by the European bitterling and the number of the European bitterling inside the mussels. However, the presence of glochidia had a negative impact on the size of the European bitterling broods.

#### MICROBIAL POPULATIONS OF *HELIX LUCORUM*

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Last autumn, two scientific manuscripts were published (Szpalek et al. 2023; Zając et al. 2023) describing the first population of the Turkish land snail *Helix lucorum* in Poland. So far, the range of this species covered the southeastern part of Europe and the Balkan Peninsula. The population discovered in a city park in Warsaw is characterised by a relatively large number of both young and adult individuals, which indicates that the population is able to reproduce and that the environmental conditions in the new location are favourable for them. We assume that the presence of *H. lucorum* in this latitude is caused due to human activities, such as the transport of flowering potted plants. We suppose that the basis for the survival of *H. lucorum* in a temperate climate is the species' synanthropy, i.e. the ability to inhabit places with favorable temperatures, such as city parks where the ground does not freeze, mostly thanks to the underground urban infrastructure. Moreover, acclimatisation to a new environment is probably related to the role of the local microbiota, which by colonising newly arrived species can increase their ability to protect themselves against changing environmental conditions, such as freezing, as well as the effects of freezing of the body fluids. The main aim of our project was to identify the intestinal microbiota of *H. lucorum* during the seasons, and then compare it with the microbiota of the native species *Helix pomatia*, as well as search for strains capable of ice nucleation. So far, the identification of strains has been carried out in three experimental groups corresponding to the seasons: autumn, winter and spring. The isolated biological material from the intestines was cultured on TSA medium at 10 °C for 14 days, then DNA was

isolated from selected strains and Sanger sequencing followed by identification based on the 16S rDNA gene were performed. Preliminary analysis of the results indicates a large diversity in microbial populations between the studied groups, with the lowest diversity during the winter. Some of the identified strains correspond to the seasonal profile obtained for *H. pomatia* in previous years.

#### CONTROVERSIES OF CONTEMPORARY SNAIL TAXONOMY

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Snails that produce shells have long been of interest to not only collectors but, above all, scientists. The basis for all research is the knowledge of taxonomic affiliation in analysed individuals. The beginning of the XX century has brought awareness that the taxonomy of snails at the species level cannot be based solely on shell morphology, as it only reflects similarities, not relationships. Other characteristics, such as the morphology of radula, were introduced into taxonomical studies. The research on the *Lymnaea* from profundal of the Lac Geneva is a good example of that change. Using the anatomy as a basis for species determination later became a rule for Lymnaeidae. The “key-and-lock” concept, popular in entomology, resulted in obligatory studies and descriptions of the morphology and anatomy of copulatory, or sometimes the whole reproductive organs when diagnosing new species as well. The only solution to reduce the risk of incorrect taxonomic classifications resulting from convergence is to use as many morphological features as possible. This requires detailed morphological research, combined with biometry of internal structures and shell morphometry, which may provide up to several dozen features related to the structure of the soft parts. All these features still did not provide a clear and reliable distinction between species. The best direction for further research is the estimation of genetic diversity at the level of DNA sequences, mainly the mitochondri-



al cytochrome c oxidase subunit I – COI, commonly used in barcoding and therefore characterised by very rich reference libraries. The usefulness of this method has been repeatedly confirmed for determining species distinctiveness and close relationships within the Truncatelloidea. It is possible to detect cryptic variations occurring between morphologically indistinguishable, distinct species. Barcoding can also reveal that morphologically, very different individuals can constitute the same species. Therefore, it should be remembered that even the most correctly reconstructed phylogeny based on a single gene does not have to be identical to the species phylogeny. The only solution is to use many DNA markers, which includes nuclear DNA, in addition to very thorough morphological and anatomical tests.

MOLECULAR DIVERSITY OF THE GENUS  
*BYTHINELLA* MOQUIN-TANDON, 1856  
(GASTROPODA: CAENOGASTROPODA:  
TRUNCATELLOIDEA) IN THE CARPATHIANS

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Within the framework of the Polish-Slovakian BioSprings project, which aims to study model groups of invertebrate populations inhabiting springs of different geographic locations, we focused on aquatic snails of the genus *Bythinella*. This genus includes small snails primarily inhabiting springs across Europe. They pose considerable taxonomic challenges, furthermore their morphological identification relies on a combination of conchological features, body pigmentation and the anatomy of the male and female reproductive systems. Currently, to determine the species affiliation of *Bythinella*, molecular methods are preferred. The present study used “DNA barcoding” technology analysing the mitochondrial cytochrome oxidase (COI) gene, an official marker for animals. The study encompassed the Carpathian Mountain ranges: Żywiec Beskid, Bieszczady, Považský Inovec, Veporské vrchy, and Beskid Wyspowy. In each of these ranges, aquatic invertebrates were collected from at least 10 sites, totaling 63 springs sampled. *Bythinella* snails were found in 44 of these sites. Preliminary results revealed the molecular diversity associated with the geographical location. A total of 39 haplotypes were identified, representing *Bythinella austriaca* and *Bythinella micherdzinskii*. The latter was found exclusively in the Bieszczady Mountains. The outcomes of this study

will be used in the BioSprings project aimed at understanding the molecular diversity of invertebrates in springs, considering geographic isolation and environmental factors. Additionally, the obtained sequences will contribute to creating a DNA barcode library as part of the PolBOL (Polish Barcode of Life) initiative, aiming to document biodiversity of Poland.

IS RE-CULTIVATION OF URBAN WATER BODIES  
BENEFICIAL FOR THEIR MALACOFUNA?

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At the previous Seminar, we drew attention to the possible negative impact of re-cultivation of urban water bodies on the malacofauna inhabiting them. Such activities are being carried out more and more often and on a larger scale, hence the continuation of our research. Of the 32 water bodies in Warsaw we examined in different years, five have recently been subjected to intensive reclamation works. We compared their malacofauna with the malacofauna of various types of water bodies not subjected to this type of activities. Among non-reclaimed water bodies, oxbow lakes have the most diverse malacofauna (14–24 species), while some artificial park ponds located on the Vistula flood terrace have a poorer fauna (5–7). Only in these groups of water bodies do Unionidae mussels occur. The malacofauna of the park’s seasonal ponds (drained in winter) is very diverse (7–9 species) and numerous, although it includes almost exclusively Gastropoda. Among Bivalvia, only a single species of Sphaeriidae (*Musculium lacustre*, *Pisidium*) occurs there. However, the malacofauna of reclaimed water bodies, sometimes very large and old, turned out to be exceptionally poor; from 0 to 3 species (only single individuals of Gastropoda, sometimes only empty shells). In terms of the poverty of molluscs, they can only be compared with small forest water bodies, filled with decaying leaves. This may indicate that the drastic reconstruction of the structure of the bottom and shoreline, although it “improves” the appearance of the water body, for example by introducing emergent macrophytes, and creates a favorable environment for avifauna, has a definitely negative impact on the presence of mollusks there.



EFFECT OF WINTERING CONDITIONS ON REPRODUCTION OF *VERTIGO ANTIVERTIGO* (DRAPARNAUD, 1801)

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*Vertigo antivertigo* is a small, hygrophilous land snail inhabiting humid and swampy areas. In studies on the impact of hibernation on the reproduction of the species (number of eggs laid and their laying pattern), adult snails were used. In the analyses, we considered only those animals that survived to the end of the experiment. We compared two experimental groups, with the individuals coming from the same site. The first one consisted of snails that were collected in October 2022 (16 individuals), and the second one consisted of snails collected in March 2023 (55 individuals). Snails kept in laboratory conditions overwintered at a constant temperature (4 °C) and in the dark. During hibernation, each snail was kept in a separate tube equipped with a damp cotton swab, sedge and tree leaves, and dolomite dust. During hibernation, the snails were sprinkled with cooled, boiled water once a month. We woke up the snails from hibernation at the turn of March and April, which corresponded to the occurrence of conditions conducive to snail activity also in natural conditions. The awakened snails and those collected from the field were then placed in breeding conditions. The individuals from the tubes were transferred to ventilated dishes with a diameter of 5 cm. Each dish was equipped with a cotton swab soaked in water, dolomite as a source of calcium, and litter as a source of food. The dishes were placed in a culture room at 17 °C, photoperiod: 12:12. The number of eggs laid was monitored every two weeks. The substrate and food were changed once a month. Analyses showed that the number of eggs laid by the snails from these two options differed statistically significantly. Snails hibernating in natural conditions laid more eggs than those that hibernated in the laboratory. The egg laying pattern was also different. In the case of snails collected from the field, we noticed a single, larger egg laying maximum. Snails overwintering in the lab started laying eggs later, with two significant increases in egg numbers.

*TROCHULUS STRIOLATUS* (C. PFEIFFER, 1828) (GASTROPODA: EUPULMONATA: HYGROMIIDAE) IN LABORATORY – SELECTED PARAMETERS OF LIFE CYCLE

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*Trochulus striolatus* is a medium-sized land snail that can live in a variety of environments. This rather thermo- and moisture-loving species in the lowlands favours damp and shaded areas near rivers, in forests, thickets, and roadsides, but is also capable of surviving in open grassy habitats and even in high mountainous regions (up to 2,000 meters above sea level). As an introduced synanthrope, it also occurs in gardens and other places modified by humans. This study aimed to examine the life cycle parameters of *T. striolatus* under laboratory conditions. The material used for the laboratory culture was collected in Licques, France in June 2018 (50°47'48"N, 01°56'34"E, 81 m a.s.l.). The snails were raised in Petri dishes and plastic containers, which were kept inside a climatic chamber with constant temperature conditions (22 °C during the day and 18 °C at night), 80% humidity, and a photoperiod of 12:12. The snails were arranged in groups of 10 individuals (15 groups) and singly (30 individuals) from their early juvenile stages. Four-year observations of the maturation, reproduction and growth of *T. striolatus* in laboratory conditions showed that it is an oviparous species. The eggs are partially calcified and almost spherical, measuring 1.1–1.5 × 1.2–1.6 mm, with an average size of 1.3 × 1.4 mm. Individuals kept in groups typically laid eggs in soil, in batches ranging from 2 to 66 eggs, with an average of 20 eggs per deposit (n = 996). Notably, no uniparental reproduction was observed. Newborn snails had a 37.5% success rate of hatching after an incubation period of 11–27 days. Their shells reached 1.5–2 whorls (average 1.7; n = 180). Snails from the F<sub>1</sub> generation, kept in groups and singly, lived approximately 39 months (530–1589 days, mean = 1162; n = 88). They laid ca. 3.7–236.5 eggs, with an average of 38.7 eggs per individual, for about nine months (60–520 days, mean = 280; n = 17). Sexual maturity (the first egg laid) was reached by individuals with shells having about 5 whorls, within 573–1173 days of their lives, with an average of 762 days (n = 23). The study group was characterised by low survival.

## DIVERSITY OF THE ENVIRONMENT OF LIMESTONE ROCKS NEAR JERZMANOWICE IN THE LIGHT OF MALACOLOGICAL ANALYSIS

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The aim of the research was to reconstruct environmental changes based on mollusc communities in sediments filling small karst formations developed within limestone rocks near Jerzmanowice, in the southern part of the Krakow-Częstochowa Upland. The limestone rocks found in this area are karst inselbergs. Various types of karst formations appear in them. In addition to large caves, there are many small forms such as small rock shelters, niches, depressions or ledges. Many of them are completely or partially filled with sediments. These are most often clay with limestone rubble or initial rendzina. Mollusc shells are a common component of these sediments. Samples found in three groups of inselbergs were subjected to detailed malacological tests: Wilisowe Skały, Sokołowe Skały and Chochołowe Skały. The analysis was based on material obtained from thirty-seven samples. The presence of a rich and taxonomically and ecologically diverse malacofauna was recognised here, including 54 species of land snails represented by over 6,500 specimens. Such a rich and diverse fauna allowed for the reconstruction of changes in the natural environment and the recognition of the diversity of microhabitats within individual rocks. The discussed malacocenoses represent the late Holocene, probably the period of the last several hundred years.

## SNAILS IN THE LIFE CYCLE OF AVIAN SCHISTOSOMES: SPECIES COMPATIBILITY AND SPECIFICS OF PARASITE-HOST INTERACTIONS

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In the face of growing interest in the evolutionary and ecological mechanisms shaping interspecies interactions, especially in the context of parasites and their hosts, the prepared review focuses on the role of snails in the life cycle of avian schistosomes. It is indicated that the mobility and environmental specificity of bird hosts, combined with the wide availability of snails in aquatic environments, are key factors

enabling schistosomes to continue their life cycle and infect subsequent hosts successfully. In analysing the various snail-avian schistosome relationships, it has often been emphasised that the parasites show a limited ability to exploit numerous species belonging to the same genus. Authors have long suggested a narrow specificity in individual snail-fluke systems. However, some researchers point to deviations from this rule. Among others, avian schistosomes from *Dendritobilharzia pulverulenta* and *Trichobilharzia regenti* show adaptation to different intermediate host species in various geographical regions. The reasons for these deviations are seen, on the one hand, in the possible influence of ecological factors on shaping snail-fluke associations. On the other hand, they point to the need for molecular verification of parasite species described in intermediate hosts. In the context of these suggestions, a comprehensive approach to studying the life cycles of schistosomes is necessary, focusing on intermediate hosts – snails, combining morphological studies with molecular research. Such an approach will allow for a deeper understanding of the complex, mutual relationships between parasites and molluscs and the verification of the compatibility of digenetic flukes with host snail species. This distinction is also crucial for identifying avian schistosome vectors in the environment. Given the dualism of transmission of these parasites in vertebrates - through the blood or nervous system, also in experimentally infected mammals, precise diagnostics of fluke species and their relationships with intermediate hosts will help prepare protection strategies in regions threatened by swimmer's itch.



POSSIBLE HYBRIDISATION OF *MONACHA CARTUSIANA* (MÜLLER, 1774) AND *M. CLAUSTRALIS* (ROSSMÄSSLER, 1834) IN POPULATIONS FROM MOLDOVA, ROMANIA, THE CZECH REPUBLIC AND POLAND

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*Monacha cartusiana* and *M. claustralis* are two closely related species of the genus *Monacha* Fitzinger, 1833, which can be distinguished anatomically and molecularly. In the reproductive system, the length of the vagina (short in *M. cartusiana*, long in *M. claustralis*) and the presence of a characteristic large vaginal sac on the vagina in *M. cartusiana* and its absence in *M. claustralis* are the major anatomical features that distinguish the two species. The species also differ clearly in their mitochondrial gene sequences (COI and 16SrDNA). COI barcoding genetic distances are significant (12–15%). During the study of specimens from several populations from Moldova, Romania, the Czech Republic and Poland, we were surprised to find specimens with divergent anatomical and molecular identification, i.e. some specimens had the reproductive system structure of *M. cartusiana* and *M. claustralis* mtDNA, others recognised anatomically as *M. claustralis* showed *M. cartusiana* haplotypes, while further specimens with *M. cartusiana* or *M. claustralis* haplotypes were characterised by an unusual female part of the reproductive system (moderate long vagina with slight bulge in various places). These specimens are probably hybrids in which the mitochondrial genome, introduced by the egg cell, retains the features of one or the other species, while anatomical structure and nuclear genes have variably pronounced hybrid features. *M. cartusiana* was first reported in Poland as late as 1973, and for over 25 years the locality in Wrocław was considered unique in Poland. In the early 2000s, new populations of *Monacha* were discovered in other sites, specimens

from which were identified as *M. claustralis*. In Poland we now know several dozen localities where *M. cartusiana* or *M. claustralis* are reported. Both species now have the status of invasive species with rapidly expanding ranges in Europe: *M. claustralis* spread north from its original localities in south-eastern Europe and *M. cartusiana* spread east and south from western Europe. As a consequence, the ranges of these species increasingly overlap in Poland and generally in central and eastern Europe. We can therefore expect more frequent cases of their interbreeding.

The present results allow us to draw several conclusions. First of all, if further localities of these species are discovered, integrative research with anatomical and molecular methods will be necessary for all the specimens from these populations. Previously detected localities should also be verified by the same integrative approach, especially since dispersion may lead to changes in their species composition. Moreover, barcoding based on nucleotide sequences of subunit 1 of the cytochrome oxidase (COI) gene, becomes of little use in the case of hybridisation, particularly if COI sequences are used alone to assign individual specimens to one of two interbreeding species.

*REINIA VARIEGATA* (GASTROPODA: CLAUSILIIDAE: PHAEDUSINAE) – STRUCTURE AND FUNCTION OF THE SPERMOVIDUCT IN THE CONTEXT OF THE REPRESENTED REPRODUCTIVE STRATEGY

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In the case of door snails (Clausiliidae) three reproductive strategies have been demonstrated: oviparity, embryo retention and lecithotrophic viviparity. Embryo retention and lecithotrophic viviparity are possible due to the specific structure of the spermooviduct and the free oviduct.

In these animals the reproductive system is semi-triaulic – composed of three partially connected canals: oviduct, allospermiduct and autospermiduct. In the representatives of most subfamilies examined in this respect (i.a. Aloiinae and Clausiliinae) the allospermiduct is present in the spermooviduct and in the free oviduct, while in Phaesusinae this canal is visible only in the spermooviduct, while it gradually disappears in the free oviduct. Embryo retention takes place in the free oviduct, except for Phaesusinae, in



which the embryos are retained in the spermooviduct. Such embryos are surrounded by a partially calcified eggshell. Anatomical and histological studies (paraffin sections stained with hematoxylin and eosin, Epon sections stained with methylene blue) of the reproductive system of *Reinia variegata* have shown that these snails differ from other Phaedusinae snails examined in this respect. Developing embryos (1–5) are devoid of the typical, partially calcified eggshell, but are surrounded by a very thin organic envelope. In the back of the foot there is a flattened, thin lobe, much wider than the foot, which indicates a large absorbent surface (podocyst). The upper part of the spermooviduct, composed of three partially connected ducts, the prostate and the albumen gland are immersed in the lobes of the hepatopancreas. After separation from the hepatopancreas, the spermooviduct consists mainly of the oviduct, where the embryos are kept, while the prostate disappears and the allospermiduct undergoes a significant reduction. It can therefore be assumed that, as in the case of the gonad of snails, which maintains communication with the hepatopancreas and is nourished by this organ, in *R. variegata* the albumen gland, the prostate and the allospermiduct are supplied with nutrients from the hepatopancreas, and the secretions of these organs constitute nourishing fluid for developing embryos (matrotrophy-histotrophy). This would therefore be a new reproductive strategy in the world of Clausiliidae.

#### MONITORING OF MOLLUSCS AS A PART OF THE NATURAL ENVIRONMENT MONITORING IN THE KAMPINOS NATIONAL PARK

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Integrated Monitoring of the Natural Environment “Kampinos” carries over 20 measurement programs devoted to various environmental components of the Kampinos National Park (KPN). It includes environmental components (meteorological data, air pollution, the chemistry of atmospheric precipitation, groundwater, surface water, soil solutions, etc.) and biotic components. Mollusc monitoring is an example of the latter. Observations are held in the experimental catchment area of 21,003 km<sup>2</sup>, of which 8,199 km<sup>2</sup> (39%) are no-drain areas.

Molluscs are very sensitive bioindicators of the natural environment. Their monitoring in KPN was

carried out so far in 2008, 2009, 2011, and 2014 by Dr. J. A. Barga-Więcławska. 10 years after the last study, i.e. in 2023, monitoring was resumed by our team on the previous eight research plots while maintaining the current methodology, i.e. at each site, material from various microhabitats was collected in autumn, from a total area of 1 m<sup>2</sup>. The material (plants, litter, topsoil) was sieved, dried, and then all mollusc shells were removed. 2023 was a very dry year and there were no aquatic environments at any of the sites, i.e. the existing ponds, canals and ditches were completely dry. At all sites in 2023, 21 species of land snails, 15 species of aquatic snails (fresh or old shells) and the presence of Sphaeriidae shells were found. In the years 2008–2014, a total of 38 species of land snails, 30 species of aquatic snails and the presence of mussels from the Sphaeriidae family were found. At individual sites, high variability in the malacofauna assemblage was observed between individual research seasons. The greatest diversity of terrestrial species was recorded in 2014, and of aquatic species in 2011. In this paper, we present the characteristics of individual research sites and discuss the observed changes in the malacofauna.

#### MODELLING OF THE EUROPEAN DISTRIBUTION OF THE INVASIVE *SINANODONTA WOODIANA* (LEA, 1834)

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The alien freshwater mussel *Sinanodonta woodiana* has rapidly spread throughout Europe over the past decades. This species can cope with a broad range



of environmental conditions and has a high reproductive capacity making it a successful invader. Due to its negative effects on native freshwater mollusk communities and parasitised fish it is critical to identify suitable habitats where *S. woodiana* may persist and how these habitats may be altered under future climate projections. We applied multivariate ordination methods to analyse the space-time relationship and a maximum entropy approach (MaxEnt) to predict the recent (1970–2000) and future (2041–2060 and 2081–2100) distribution of *S. woodiana* using environmental and climate variables for the European continent. After first sightings in 1979 there were only a few new locations and findings which increased unevenly and exponentially to a maximum of about 100 new locations per year followed by decline during the last few years. Under recent climate condition, 2.3% of European watersheds are predicted as highly suitable habitat for *S. woodiana* and located in the temperate climate zone between 40°N and 60°N. Suitable habitat was associated with lowland watersheds characterised by fluvial deposits and agriculture. Elevation, the distance between water bodies, land cover and mean temperature of the coldest quarter were the main factors influencing the modelling results. For future climate scenarios, highly suitable habitat increased to 2.4% by the middle of this century and decreased to 2.2% by the end of the century under the ‘least radiative forcing’ scenario. For the intermediate and high radiative forcing in 2050 and 2100, highly suitable habitat decreased to 2.2% and 1.7% and to 2.2% and 2.2%, respectively. Results from our study can be used as a baseline to better understand potential invasion pathways, identify high risk areas, and to initiate early detection and rapid response strategies.

OCCURRENCE OF THE LAND SNAIL  
*CAUCASOTACHEA VINDOBONENSIS* ON  
XERTHERMIC GRASSLANDS OF THE *FESTUCO-*  
*BROMETEA* CLASS IN POLAND

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The continuous range of *Caucasotachea vindobonensis* in Poland covers the southeastern part of the country, while the island range includes the valleys of the Vistula, Warta, Oder and Noteć Rivers. The geographical location of the sites and habitat characteristics of *C. vindobonensis* within the continuous range showed a connection between the occurrence of the species and the distribution of xerothermic

grasslands of the *Festuco-Brometea* class. Within the island range, these connections are no longer so clear mainly due to the rare and irregular occurrence of xerothermic grasslands in river valleys. Xerothermic grasslands of the *Festuco-Brometea* class are thermophilic grassy communities with steppe characteristics. They most often develop on pararendzina and rendzina soils formed on carbonate (e.g., limestone), carbonate-siliceous (e.g., opoka), evaporite (e.g., gypsum) and clastic (e.g., loess) rocks. They are a characteristic habitat type of *C. vindobonensis* usually found on the slopes of hills and mountains with southern exposure. The process of deforestation, carried out on agricultural soils rich in calcium carbonate, as well as long-term farming and grazing, played an important role in the spread of grasslands in Poland. The establishment of open habitats with a steppe-like character favoured the spread of *C. vindobonensis*. Stone quarrying, including limestone and gypsum, also contributed significantly to the development of the grasslands. Grasses found suitable conditions for development on the rocky slopes of disused quarries and pits. These sites gradually became habitats for *C. vindobonensis*. The development of railways, which used carbonate rock for their construction, was also important in the spread of grasslands. Embankments and escarpments created pathways that allowed xerothermic vegetation to spread. The same pathways became typical for *C. vindobonensis*. The reduction and even abandonment of xerothermic grasslands of the *Festuco-Brometea* class, which has been observed for many years, contributes to the loss of their original character. As a result of natural succession, they are gradually being transformed into scrubland and then into woodland communities. This leads to a decrease in the density of *C. vindobonensis*, which may result in its retreat or disappearance from many regions of Poland.

BENEDYKT DYBOWSKI (1833–1930) –  
RESEARCHER AND COLLECTOR OF ASIAN  
MALACOFUNA

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Benedykt Dybowski (1833–1930), doctor, naturalist, collector. Lecturer at the Warsaw Main School. Sentenced to 12 years in exile in Siberia for participation in the January Uprising. In 1868–1872, he carried out important scientific research on Lake Baikal. He continued his work in Kamchatka and on Bering



Island in 1879–1883. Among other things, Dybowski demonstrated the species diversity of Baikal's malacofauna and presented its vertical distribution. He proposed a systematics and nomenclature of Baikal molluscs. He compared the malacofauna of Lake Baikal and the Caspian Sea. The material collected during his research is still kept today in the Museum and Institute of Zoology of the Polish Academy of Sciences (MIZ PAS) and the Zoological Museum of the Ivan Franko National University of Lviv (ZMD) in Ukraine. The MIZ PAS collection includes more than 4,500 specimens from Lake Baikal, the Onon, Argun, Ussuri and Amur Rivers (1869–1873), Kamchatka and Bering Island (1879–1883). The molluscs belong to two classes: (1) Bivalvia – 11 families: Anomiidae, Cardiidae, Mactridae, Margaritiferidae, Mytilidae, Ostreidae, Pectinidae, Psammobiidae, Tellinidae, Veneridae and Yoldiidae; (2) Gastropoda – 23 families: Acmaeidae, Baicaliidae, Calyptraeidae, Callistomatidae, Camaenidae, Cochliopidae, Gonyodiscidae, Haminoeidae, Helicidae, Hydrobiidae, Hygromiidae, Lymnaeidae, Naticidae, Planorbidae, Tegulidae, Thiaridae, Trochidae, Turbinidae, Valloniidae, Valvatidae, Vertiginidae, Viviparidae and Zonitidae, with a total of more than 130 species. The ZMD collections contain more than 10,000 specimens. The material comes mainly from Lake Baikal, the Ussuri and Amur Rivers, the Sea of Japan (East Sea) (1864–1876, 1879) and Kamchatka (1879–1883). The molluscs belong to two classes: (1) Bivalvia – 3 families: Mactridae, Sphaeriidae and Unionidae; (2) Gastropoda – 15 families: Acroloxidae, Arionidae, Baicaliidae, Bithyniidae, Camaenidae, Clausiliidae, Helicidae, Limacidae, Lithoglyphidae, Lymnaeidae, Planorbidae, Semisulcospiridae, Thiaridae, Valvatidae and Viviparidae, with a total of more than 75 species. The ZMD contains, among others, type specimens *Choanomphalus omphalotus* W. Dybowski, 1901; *Euglesa trigonoides* (W. Dybowski, 1902); *E. raddei* (W. Dybowski, 1902); *Gerstfeldtiancylus renardii* (W. Dybowski, 1884); *Sphaerium dybowskii* Lindholm, 1909; *S. korotniewii* W. Dybowski, 1902; *Pisidium baicalense* W. Dybowski, 1902; *Pseudobaikalia contabulata* (W. Dybowski, 1875).

EVOLUTIONARY DYNAMICS IN POPULATIONS OF *CEPAEA NEMORALIS* IN WROCLAW AND RURAL AREAS AROUND WROCLAW – PRELIMINARY RESULTS OF A RESURVEY STUDY

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*Cepaea nemoralis* is a relatively common land snail species inhabiting both natural and man-made habitats, including urban areas. Its shells can be yellow, pink or brown and bear up to five bands. The colour and banding patterns are genetically determined. It has been shown that morph frequencies in populations respond to natural selection, including bird predation and climate. This response can sometimes be rapid, occurring over just a few snail generations, but many populations are remarkably stable. In 2023, we started a study aimed at monitoring the evolutionary dynamics of *C. nemoralis* populations in Wrocław and rural areas around Wrocław, Poland, and in Sheffield, UK, collecting snails at exactly the same sites at which they were first studied in 2006–2010 by Robert Cameron and Beata Pokryszko. We hypothesised that the current global climatic changes, especially temperature increase, would result in an increase of the frequencies of light-coloured shells, i.e. yellow and yellow effectively unbanded. Here, we present some preliminary results from the Polish part of the study. We resurveyed 52% of the original sites (95 out of 183), and collected samples from 54 populations; 41 sites were destroyed or no longer inhabited by *C. nemoralis*. In most cases where resurvey was possible, the habitat type (open, intermediate or shaded) remained the same. We compared changes in morph frequencies using the nonparametric Friedman's multiple pairwise comparisons test for paired samples. We compared the frequencies of yellow and yellow effectively unbanded, as well as the banding types (unbanded, midbanded, threebanded, and fivebanded) within each colour. No statistically significant changes were detected in any of the morphs. This result points to the stability of the genetic composition of populations and indicates that in the studied area *C. nemoralis* is not under an extreme evolutionary pressure resulting from the global climatic change.



## CRYPTIC DIVERSITY AND PHYLOGENY OF SELECTED GENERA OF SNAILS FROM THE HELICOIDEA SUPERFAMILY

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The development of DNA barcoding methods provides insight not only into traditional taxonomy, but also into the distribution and phylogeny of taxa. This is particularly important in the case of organisms whose genetic diversity is poorly known, often despite of their widespread occurrence. Presented research can lead to the description of a surprisingly high level of cryptic diversity, which, linked with phylogenetic analyses, is of great importance, both theoretical and practical, including understanding and conservation of biodiversity. The aim of the study was to investigate the genetic diversity of poorly known, but common genera of land snails belonging to the Helicoidea superfamily: *Euomphalia*, *Isognomostoma* and *Perforatella*. A fragment of the cytochrome c oxidase subunit I (COI), a widely-adopted taxonomic marker, was used for this purpose. Phylogenetic and phylogeographic analyses, using newly obtained and reference sequences, showed a surprisingly high level of previously unknown cryptic diversity, even in the small number of samples analysed. Moreover, some of the obtained OTUs may actually constitute separate taxonomic units, which do not fully correspond to the currently distinguished species. These preliminary data indicate 8 distinct clades for *Euomphalia*, 5 for *Isognomostoma*, and 5 for *Perforatella*. The study also showed distribution of particular genera/OTUs in Europe. The obtained results are therefore a good starting point for detailed genetic and morphological research leading to the description of the geographical distribution of diversity of the studied genera,

showing the level of genetic variability and will allow taxonomic implications, also in the biodiversity conservation context.

## EFFECT OF SUBSTRATUM DRYING ON SURVIVAL AND MIGRATION OF NATIVE CLAMS *SPHAERIUM RIVICOLA* AND INVASIVE ASIAN CLAMS *CORBICULA LEANA*

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Climate warming causes frequent events of water level decrease, especially in summer. The aim of the study was to determine survival, migration and burrowing of freshwater clams: native, globally vulnerable *Sphaerium rivicola* and invasive Asian *Corbicula leana*, in response to water level decrease and substratum drying. Three laboratory experiments were conducted in tanks with sandy substratum and gradually evaporating water, causing substratum drying. In parallel, control treatments were carried out in tanks with constant water level. Survival time of 50% and 10% of *S. rivicola* individuals (LT50, LT90) was 6.4 and 8.7 days, respectively, with substratum water content of 12% and 10%, respectively (visually moist substratum). This species showed horizontal migration following the decreasing water level at a distance up to 24 cm, but with increasing distances (48 cm), migration became unsuccessful. *S. rivicola* did not burrow into drying substratum (9% clams burrowed), while in control conditions 80% clams burrowed. There was no mortality of *C. leana* during 16 days of substratum exposure, with the final water content of 1–2% (visually dry sand). This species did not move following the decreasing water level, but burrowed deeper into drying substratum: 55% clams burrowed at a depth >1 cm, compared to 20% under control conditions. The adaptation of native *S. rivicola* is horizontal migration following the decreasing water level, though this behaviour is efficient only at a limited distance. An adaptation of invasive *C. leana* is deep burrowing into the substratum and desiccation resistance. These results demonstrate advantages of the invasive species during periods of bottom exposure, which are expected to be more and more common in the temperate zone.

DIVERSITY OF MICROHABITATS IN THE SOUTHERN PART OF THE KRAKÓW-CZĘSTOCHOWA UPLAND ON THE BASIS OF MALACOFAUNA FROM HOLOCENE SLOPE SEDIMENTS

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Samples from three areas in the southern part of the Krakow-Częstochowa Upland were analysed: the Mnikowska Valley, the Zimny Dół Valley and the Jerzmanowice area. From the latter, four limestone hills: Wielka Skała, Skała Grodzisko, Mazurkowa Skała i Łysa Skała were selected. A total of 46 sediment profiles were examined, 18 from the Mnikowska Valley, 15 from the Zimny Dół Valley and 13 from the Jerzmanowice area. A total of 157 samples were collected, of which 119 contained malacofauna. The aims of the study were: (i) to investigate the diversity of microhabitats and their modification by local factors; (ii) to reconstruct the environmental conditions at the site and time of sediment deposition in terms of the composition of subphosile mollusc assemblages in slope sediments; (iii) to characterise the natural factors shaping the environment, especially short and medium-term climatic changes, on the basis of malacological analyses; (iv) to assess the level of environmental transformation and anthropopressure in areas of different relief. The analysis of the profiles and their malacological content shows that the malacofauna in the study areas varied considerably, which was determined by the exposure of the slopes. Slope exposure influenced solar radiation, humidity, substrate temperature and vegetation cover, leading to differences in microhabitats. Radiocarbon dating and the species composition of the material analysed indicate that sediment deposition took place during the Late Holocene. During the last millennium, especially during the Medieval climatic optimum, the Krakow-Częstochowa Upland underwent significant environmental changes caused by demographic growth, settlement and increasing anthropopressure. The increasing human influence, together with the deforestation of the area, contributed to the decline of the local malacofauna, in which open and xerothermic habitat species began to dominate. On the other hand, areas not affected by human influence (e.g. valleys or hills) have retained their original natural character, with a predominance of forest taxa. The fills of small karst forms in the

Krakow-Częstochowa Upland are a promising area for malacological studies due to their abundance and accessibility. Such studies can complement analyses carried out in caves and provide a basis for independent interpretations.

NATURAL AND ANTHROPOGENIC ENVIRONMENTAL CHANGES IN THE AREA OF BISKUPICE VILLAGE (POGORZE WIELICKIE HILLS) ON THE BASIS OF MALACOLOGICAL AND PLANT MACROREMAINS STUDIES – PRELIMINARY RESEARCH

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The Biskupice archaeological site represents the period of the earliest agriculture in the Pogorze Wielickie Hills (southern Poland). During excavations in 2020 and 2021, the remains of four houses from the late phase of the Linear Pottery Culture were discovered. One of the 5 profiles (Biskupice-4) was studied in detail. Malacological, plant macrofossil, geomorphological and palynological analyses were carried out and 139 samples were collected for study. In 65 samples 566 mollusc shells were identified, representing 27 taxa – 25 gastropods and 2 bivalves. In 103 samples, 1,361 plant remains were found, representing 51 taxa, as well as animal and fungal remains. The profile is clearly divided into two parts, representing the last phase of the Late Glacial and the Holocene. The Late Glacial was characterised by tundra-type communities that developed on wet soils. This is indicated by the occurrence of malacocoenoses with *Vertigo genesii*, *Columella columella*, *Semilimax kotulae*, *Succinella oblonga*, as well as plant communities with *Betula* sect. *nana*, *Selaginella selaginoides*, *Filipendula ulmaria* and *Carex* sedges. During the Late Glacial, a small periodic water body developed which is indicated by the presence of aquatic malacofauna: *Galba truncatula*, *Anisus leucostoma*, *Pisidium obtusale* and the aquatic plants *Batrachium* sp.



and *Potamogeton filiformis*. With the beginning of the Holocene, there was a high diversification of malacofauna with the complete disappearance of plant remains. Humid habitats were occupied mainly by *Carychium minimum* and *Vallonia enniensis*. Open habitat taxa (*Vallonia pulchella*, *Vallonia costata*), mesophilic taxa (*Euconulus fulvus*, *Punctum pygmaeum*) increased their share, and shaded sites were dominated by *Vertigo alpestris*. The malacofauna also indicates a persistent periodic water reservoir. The later Holocene phase, recorded in the B4-4 L MAZ level, is characterised by the complete disappearance of the malacofauna and an increase in the proportion of plant remains taxa. The decrease of the water level led to the development of the peat bog, and on the banks appeared stinging nettle (*Urtica dioica*), mint (*Mentha pulegium*), grassland plants, as well as alder (*Alnus glutinosa*) and elder (*Sambucus nigra*). In the upper part of the profile, the development of the plant communities indicates a declining Holocene phase with a moderately warm climate and ruderal vegetation, documenting the human presence in the study area.

#### MULTISPECIES INTERACTIONS IN A POORLY KNOWN SYSTEM CONSISTING OF *SPHAERIUM RIVICOLA* (HOST), DIGENEA (PARASITES), AND *DREISSENA POLYMORPHA* (INVASIVE BIOFOULER)

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Understanding the impact of biological invasions, diseases (including those of parasitic origin), and their interactions is crucial in the era of global environmental changes. Such comprehensive knowledge

is crucial for adequately planning biodiversity conservation both on the local and global scale. Bivalves are among the organisms that have experienced sharp declines in biodiversity and abundance in recent decades. Despite this, only a few threats have been specified for clams of the Sphaeriidae family, which is a consequence of the lack of data, particularly evident at the species level. We traced multispecies interactions in a poorly known system based on *Sphaerium rivicola* (an endangered clam), which is a host for Digenea larvae (parasites), and *Dreissena polymorpha* (an invasive biofouler). Sphaeriid shell size, condition, and fertility were examined in relation to the prevalence and abundance of digenean infections and zebra mussel fouling. We demonstrated a negative impact of both parasites and biofouling on the host clams, with the simultaneous presence of both stressors leading under certain conditions to a synergistically increased adverse impact on the host. Moreover, we observed a positive relationship between the occurrences of different parasites: tetra-cotyle metacercariae (*Cotylurus* sp.) and *Bunodera* infections, for which clams act as the second and first intermediate hosts, respectively. Furthermore, our results raise the debate on the role of zebra mussels in the success of transmission of echinostome metacercariae from their intermediate to final hosts. It can be assumed that the impact on individual hosts detected here may translate into negative consequences at the clam population level. We believe that the dissemination of these research results will be an essential impulse to introduce appropriate protective measures for neglected and endangered representatives of Sphaeriidae that are far too rarely the focus of scientific research.



## THE BARCODE LIBRARY OF POLISH TERRESTRIAL MALACOFUNA – PROGRESS STATUS

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DNA barcoding has been applied to the study of biodiversity of animals for over 20 years, utilising a tool based on the analysis of variability in a fragment of the mitochondrial gene encoding cytochrome c oxidase (COI). The effectiveness of this method largely relies on the availability of publicly accessible libraries of reference COI sequences, isolated from individuals identified to traditionally designated taxa. Currently, the most important database collecting DNA barcodes is the Barcode of Life Database (BOLD). In this database (which also includes data from GenBank), based on clustering of the most similar COI sequences, a special algorithm determines molecular operational units with low internal variability, which potentially correspond to species distinguished based on morphological and anatomical differences. These units are assigned a unique BIN (Barcode Index Number) code. So far, based on 154 thousand records for Gastropoda, over 20 thousand BINs have been assigned. The dynamic increase in the number of sequences deposited in the databases is ensured by numerous projects focusing on the fauna of specific regions, countries, or taxonomic groups. One of these projects is PolBOL (Polish Barcode of Life), coordinated by the Department of Invertebrate Zoology and Hydrobiology, University of Lodz. As part of this initiative, a barcode library of Polish terrestrial malacofauna is being prepared. Our goal is to gather COI sequences for as many taxa occurring in Poland as possible, taking into account their intraspecific molecular variability, and then make them available through the BOLD database. Currently (as of March 2024), barcode sequences for 136 species out of 177 occurring in the country are available in public databases, but for 123 species (90%), they originate from other areas of Europe, mainly

Slovakia, Austria, Germany, and Spain. Surprisingly, there are no comparative COI sequences in the public domain for 41 species recorded in Poland. Utilising our own collections of snails and slugs, we obtained new barcodes for 97 species, including 13 of them being the first known COI sequences. The number of new sequences within species ranges from 1 (for 30 taxa) to 50 (for *Helicigona lapicida*). Taking into account previously published data from Poland, at least single barcodes are known for 108 (61%) of the domestic species. Over 40 species have more than one BIN assigned, indicating their significant molecular diversity. The sequences obtained as part of our research will not only supplement the barcode databases but will also provide the basis for further analyses of genetic variability of gastropods in Poland. After obtaining a larger number of individuals and sites evenly covering our country, they will enable detailed phylogenetic and phylogeographic analyses leading, among other things, to understanding the distribution of different phylogenetic lineages and detecting potential cryptic taxa in Central Europe.

## MALACOLOGICAL OBSERVATIONS IN CUC PHUONG NATIONAL PARK (VIETNAM)

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The vast biological diversity of Vietnam (part of the Indo-Burma biodiversity hotspot) encompasses, among others, the terrestrial malacofauna with over 850 described species. However, the country, affected by intense deforestation and the development of the construction industry, has preserved large parts of its rich fauna only in areas inaccessible to humans or under strict legal protection. One of such areas is Cuc Phuong National Park, established in 1962, which is located in a low mountain range (max. 648 m a.s.l.) composed of Mesozoic limestone rocks and covered with tropical, evergreen lowland forest. In 2019, as part of the VIETBIO project (Innovative Approaches to Biodiversity Discovery and Characterisation in Vietnam) funded by the German Federal Ministry of Education and Research (BMBF), we participated in field studies conducted in Cuc Phuong National Park with the aim to extend knowledge about the park's biodiversity. Furthermore, this expedition aimed to test innovative inventory and recording methods and served training purposes. Our malacological research in the park was conducted at 34 sites using quali-



tative sampling methods, including visual search and hand-collecting of specimens from selected microhabitats (vegetation, rock surfaces and ground), soil sieving, and night searches. At the richest site, 41 species of terrestrial Gastropoda were recorded (average richness 16.0 species per site). Among the surveyed microhabitats, 58 species were collected on vegetation, 52 on rocks, and 39 on the ground. In total, over 1800 living individuals and over 700 empty shells belonging to 116 species from 22 families of Neritimorpha, Caenogastropoda and Eupulmonata were collected, among them most likely several species new to science. The highest species diversity was noted for Ariophantidae (18 species), Camaenidae (16), and Cyclophoridae (13). The identified material included over 20 species not found in Cuc Phuong National Park during a previous survey conducted by J. J. Vermeulen and L. Deharveng in 1998. The main part of the collection has been deposited at the Museum für Naturkunde in Berlin, while a subset will be transferred to the Institute of Ecology and Biological Resources in Hanoi.

#### EFFECT OF *DREISSENA POLYMORPHA* (PALLAS, 1771) FOULING ON THE BEHAVIOUR OF THE ASIAN CLAM *CORBICULA LEANA* PRIME, 1867

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Biological invasions lead to global homogenisation of communities. Freshwater ecosystems belong to the most susceptible to their impact. Freshwater invasive species include two quickly spreading bivalves: the Ponto-Caspian zebra mussel *Dreissena polymorpha* and the Asian clam *Corbicula leana*. Both species are “ecosystems engineers”, significantly modifying occupied habitats. They also compete with native mussels for environmental resources. *Dreissena polymorpha* attaches to hard substrata, including living mussels, e.g. native Unionidae, which are negatively affected by fouling. Our aim was to determine the effect of mussel fouling on behaviour of another invasive bivalve, *Corbicula leana*. We glued small (<0.5 cm) or large (0.5–1.5 cm) mussels to *C. leana* in various numbers (1, 5, 10, 15 individuals). Then, we recorded their behaviour in containers with sandy bottom and conditioned water. With the increasing number of attached small or large mussels, *C. leana* burrowed deeper or shallower into the substratum, respective-

ly. With heavy large mussel fouling, all clam activity stopped. Moreover, *C. leana* fouled by small mussels travelled longer distances than non-fouled individuals, whereas biofouling by large mussels delayed activity onset. Comparison of behaviour of *C. leana* fouled by small and large mussels of the same total weight (5 small vs. 1 large) showed a longer distance travelled and deeper burrowing of individuals fouled by large mussels. In conclusion, zebra mussel fouling negatively affects *C. leana*, with the stronger effect of smaller fouling individuals. The defence mechanism of *C. leana* is burrowing, which can result in removal of fouling mussels.

#### MALACOFAUNA OF LSA SEQUENCE AT BUSHMAN ROCK SHELTER IN LIMPOPO PROVINCE, SOUTH AFRICA

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Malacological studies were conducted at Bushman Rock Shelter in South Africa. They focused on the late Pleistocene and early Holocene deposits containing archaeological artefacts of the Later Stone Age (LSA). Crushed shells of the snail species *Lissachatina immaculata* and numerous fragments assigned to the Achatinidae family were particularly numerous in the sediments. Single representatives of *Succinea striata* and *Tropidophora* cf. *insularis* were also found. The origin of the shell material was examined (anthropogenic vs. natural) based on its state of preservation, colour and depositional conditions. In the examined sediments, on the basis of the morphology of the shells, not heated, heated and possibly heated shells were distinguished. Up to 80% of the examined shells could have been exposed to high temperatures. The fragmentation of shells and the co-occurrence of burnt and unheated shells may indicate intentional human activity.

#### MAINTENANCE WORKS AS A CAUSE OF MORTALITY OF MUSSELS (UNIONIDAE) ON THE EXAMPLE OF THE PRĄDNIA RIVER

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The Prądnia River is a left tributary of the Barycz River. Its length is 34 km and the catchment area is 243.43 km<sup>2</sup>. In the system of surface water bodies it is classified as a lowland sandy stream. More than half of the catchment area is located within

the Natura 2000 areas “Ostoja nad Baryczą” and “Dolina Baryczy”, as well as in the “Dolina Baryczy” Landscape Park. In turn, the estuary section, 8 km long, flows through the “Stawy Milickie” nature reserve. Maintenance works on Prądnia are carried out systematically on selected sections. They were last performed in November 2023 in the middle course of the river over a length of over 7 km – from the Żeleźniki Weir to the Grabownica Weir. The work consisted of removing vegetation and sediment from the watercourse bed using an excavator. The excavated material was deposited along the bank and partially spread in a 3 m wide strip. In February 2024, the river banks were thoroughly examined along the entire length of the works performed in search of mussel shells of the family Unionidae. On the 3.5 km section from the Żeleźniki Weir to the Kotlarka Weir, no mussel shells were found. They started to appear only below the Kotlarka Weir, gradually increasing in number, up to the Grabownica Weir. On this 3.7 km long section, 16 sites were designated (on average every 230 m), each 10 m long and 3 m wide, from which all found shells were selected. A total of 312 complete shells belonging to the species *Unio tumidus*, *Unio pictorum*, *Anodonta cygnea* and *Anodonta anatina* were found. The most numerous in the material was *U. tumidus* (193 shells) 61.8%, then *U. pictorum* (57 shells) 18.2%, *A. cygnea* (48 shells) 15.4% and *A. anatina* (14 shells) 4.5%. The occurrence constancy index calculated based on Szujecki's formula was as follows: *U. tumidus* C = 93.75%, *U. pictorum* C = 87.5%, *A. cygnea* C = 68.75% and *A. anatina* C = 56.25 %. According to the Tichler scale, both species of *Unio* be considered absolutely permanent, while the *Anodonta* are considered permanent species. The condition of the shells and their contents (dried or advanced decomposition of mollusc bodies) clearly indicated that all the animals died after being extracted from the bottom of the stream and left on the bank. The age structure calculated for all species indicates that most mussels died at the age of 1–4 years. Since no appropriate research was carried out before the maintenance works, it is difficult to assess the actual scale of destruction of the Unionidae population. However, absolute numbers indicate that it may be large. Over 7,000 specimens could have died per 3.7 km section. Moreover, it should be noted that the stream bed is 4 m wide and the maximum water depth is 1 m, so the excavator bucket can easily penetrate the bottom along the entire width of the river bed, leaving no refugia for the mussels. However, with this size of the stream and the scale of maintenance works, the mortality of mussels can be effectively reduced by organising actions to collect them and put them back in the stream.

## THE OCCURRENCE OF MUSSELS OF THE GENUS ANODONTA IN THE MILICZ PONDS AND THE METAPOPOPULATION THEORY

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Stawy Krośnicko-Żeleźnickie is located in Lower Silesia in the Barycz basin. They are part of the entire complex of breeding ponds called Milickie Ponds. The pond complex has 29 ponds with an area of over 700 ha and probably dates back to the mid-17th century. The fishing economy here is focused on breeding *Cyprinus carpio*, *Tinca tinca*, *Ctenopharyngodon idella* and *Hypophthalmichthys nobilis*. Additionally, *Carassius carassius*, *Perca fluviatilis*, *Rutilus rutilus*, *Esox lucius* and *Silurus glanis* are caught. Research on clamshell mussels (Unionidae) was conducted from October 2023 to March 2024. A total of 18 ponds covering a total area of 610 ha were examined. Mussels were collected after the water was drained during fish catching. In total, 763 individuals of *Anodonta cygnea*, 30 individuals of *Sinanodonta woodiana*, 131 individuals of *Anodonta anatina* and a random specimen of *Unio tumidus* were found. In the collected material, the percentages of individual species were as follows: *A. cygnea* 82.5%, *A. anatina* 14.2% and *S. woodiana* 3.2%. The *A. cygnea* was found in 16 ponds, the *A. anatina* in 11 ponds, and the *S. woodiana* in one pond. The stability of occurrence was calculated using Szujecki's formula  $C = (q / Q)100\%$ . The highest occurrence constancy of 88.9% was observed for *A. cygnea*, for *A. anatina* this coefficient was 61%, and for *S. woodiana* it was 5.5%. Based on the type of stability according to the Tichler scale, *A. cygnea* should be considered an absolutely permanent species, *A. anatina* a permanent species, and *S. woodiana* an accidental species. The shell length of *A. cygnea* was in the range of 31–175 mm (average 103.5 mm), the shell length of *A. anatina* was from 43 mm to 134 mm (average 90 mm), while in the case of *S. woodiana* the shell length ranged between 35 mm and 200 mm (average 137 mm). Further analysis of the research material showed significant differences between the ponds in terms of the distribution and structure of the *A. cygnea* and *A. anatina* populations. In some ponds there was a relatively large and centuries-old population, while in other ponds only single individuals were found. There were also ponds where, despite favourable habitats for mussels, their occurrence was not found. This state of affairs can be explained by assuming that populations of native mussels of the genus *Anodonta* function as a metapopulation throughout the pond complex. An attempt was also made to determine which metapopulation model best describes this situation. However, confirmation of the presented theses requires continued research.



## IN THE FOOTSTEPS OF THE PAST: PHYLOGEOGRAPHY OF THE *ENA MONTANA* (DRAPARNAUD, 1801) IN EUROPE

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*Ena montana* (Draparnaud, 1801) is common in Europe, especially in the Central and Eastern regions. Several isolated populations are found in Western Europe, including: the Pyrenees, southern England and northern Italy. In Poland, it is often found in the southern part of the country, where it can be observed on damp tree trunks, especially common beech.

As part of the project, 27 *E. montana* populations from 12 European countries were morphologically and genetically examined. Three molecular markers were used to assess genetic variability within and between populations: two mitochondrial – cytochrome oxidase subunit I (COI) and 16S rRNA; and one nuclear – ITS2. The obtained genetic data made it possible to check whether there is a geographical pattern in the distribution of haplotypes and to examine the relationships between isolated populations of *E. montana* and populations with continuous ranges of the species. Snail shells were subjected to morphometric examinations (the height and width of the shell, the height and width of the shell aperture were measured) in order to learn about intra-population variability and variability of shell parameters within the entire species.

## MOLLUSCS – A KEY LINK IN THE TRANSMISSION OF PROSTHOOGONIMOSIS

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Prosthogonimosis affects various species of both farmed and wild birds. Its symptoms include inflammation of the oviduct, leading to disturbances in egg formation and even reduction/inhibition of egg laying. Typically, infected birds lay eggs with a thin, deformed eggshell or its complete absence. As a

consequence, the disease is a significant problem for the poultry industry. However, it is also important to remember that severe cases are reported for protected species of wild birds. The pathology is caused by parasitic flatworms of the genus *Prosthogonimus* (Digenea) with a three-host life cycle. The first intermediate hosts, molluscs – freshwater snails from the families Bithyniidae, Lymnaeidae, and Planorbidae – are a source of infective larvae, cercariae, for subsequent hosts, which is a critical element of Digenea's life success. Snails infected with digenetic trematodes release hundreds or even thousands of free-living cercariae daily – which is extremely important in the parasite spread. This review aims to examine the species composition of the malacofauna responsible for transmitting *Prosthogonimus* spp., determining the degree of knowledge of the problem (spread, prevalence) at the level of the first intermediate hosts, both in Poland and other European countries. Preliminary studies on the second intermediate hosts suggest we deal with a neglected, re-emerging parasitic disease of significant veterinary and economic importance.

## POND SNAILS OF THE CARPATHIAN SPRINGS (GASTROPODA: LYMNAEIDAE)

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Springs are distinctive ecological environments. They are characterised by small, annual and diurnal fluctuations in water temperature and chemical stability. Their main characteristic is high isolation, often caused by considerable geographical barriers, like mountain chains, which can promote diversification. Such diversification can be observed particularly among organisms with lack of dispersal stages like freshwater crustaceans and gastropods. Within Polish-Slovak project “Biodiversity of springs in the light of DNA barcoding: a reference library for environmental monitoring (BioSprings)”, macroinvertebrate samples from springs were collected. More than 60 localities in Carpathian mountain ranges were studied: the Orava Beskid and the Żywiec Beskid, the Považský Inovec, Bukovec Mountains, Bieszczady, Veporskie Mountains, Beskid Wyspowy. Pond snails (Lymnaeidae) were present at 20 sites. We identified the specimens based on the shape of their shells and then analysed by DNA barcoding. Generally, lymnaeids can be found in many types of freshwater or slightly saline habitats, and they tolerate a wide range of pH. Most species from this fam-



ily inhabit water bodies covered with aquatic vegetation where they obtain food, find shelter and lay egg cocoons. Springs are not typical habitats for most species within the Lymnaeidae family. The exception is *Galba truncatula*, which occurs in small and shallow water bodies such as drainage ditches, puddles, waterholes and springs. This species occurs in the lowlands and mountains, even at high altitudes, and we also identified it in our material. In samples from the Carpathian springs, we also found *Radix labiata*. We stored the newly obtained DNA sequences in the Barcode of Life Datasystems (BOLD) database. The next stage of work will be the analysis of COI sequences in order to validate species identity and determine molecular variability of studied snail populations from springs found across the north part of Carpathians.

#### EFFECT OF THE INVASIVE *DREISSENA* SPP. FOULING ON THE BEHAVIOUR OF *SINANODONTA WOODIANA* (LEA, 1834) AND *UNIO TUMIDUS* PHILIPSSON, 1788

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The zebra and quagga mussel, *Dreissena polymorpha* and *D. rostriformis bugensis*, are invasive species originating from the Ponto-Caspian region (the Caspian and Black Sea catchment area). In Europe, initially (since the 19th century) only *D. polymorpha* has occurred, but now (since 20th century) the other, highly expansive *D. rostriformis bugensis* has also been recorded. Both species are relatively similar to each other and have the same lifestyle, which involves attaching to various hard elements in the water, including other bivalves also from the Unionidae family. The aim of our study was to determine the effects of direct fouling and indirect presence of dreissenids on the behaviour of invasive *Sinanodonta woodiana* and native *Unio tumidus*. We assumed that fouling would limit horizontal locomotion and burrowing of bivalves, especially of smaller *U. tumidus*, and its removal would allow them to recover and achieve full activity. Moreover, bivalves will sense the presence of *Dreissena* spp. and react to it. We recorded the

behaviour of fouled and unfouled bivalves obtained from Lake Balaton (Hungary), then we exposed bivalves to *Dreissena* spp. kept in mesh bags. We have shown that dreissenid fouling limited burrowing and delayed overall locomotor activity in *U. tumidus*, but not in *S. woodiana*. The indirect presence of *Dreissena* spp. had no significant impact on the behaviour of unionids. After removing fouling from *U. tumidus*, we observed regeneration after two days, and the burrowing level was similar to that observed in control bivalves. The indirect presence of *Dreissena* spp. had a minor effect – only *D. rostriformis bugensis* increased the burrowing level of *S. woodiana*. We can conclude that invasive *S. woodiana* are less susceptible to the negative impact of the fouling and indirect presence of dreissenids than native *U. tumidus*, which may consequently lead to a further decline in native bivalves number and a reduction in the area of occurrence in a global scale.

#### THERMAL PREFERENCES OF *LYMNAEA STAGNALIS* INDIVIDUALS FROM THERMALLY POLLUTED LAKES

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The subject of the research was the adaptation of representatives of native freshwater malacofauna to thermal changes in the environment caused by water discharge from the Konin-Pątnów power plant. The heated waters of the lakes in the Konin system were a convenient field for observing the effect of global warming on a micro scale on the thermal preferences of snails tested experimentally. Individuals of *L. stagnalis* were collected in three lakes in the Konin system: Licheńskie Lake, Gosławskie Lake and Pątnowskie Lake in the period from May to September during two consecutive seasons of active vegetation. The thermal preferences of nearly 200 snails were examined using an oblong thermal gradient with automatic recording of the temperature selected by the animals. The preferences of two groups of individuals were compared: those infected with *Diplostomum pseudospathaceum* paratenites and those free from parasites. Differences were found both, between the average daily temperatures selected by both groups of snails and in the behavior of individuals belonging to these groups. Snails shedding *D. pseudospathaceum* cercariae were characterised by relatively low mobility and, after being directed to the cold end of the thermal gradient, they remained there for a long period of time. However, mobile individuals, free from



parasites, chose microhabitats in the experimental device with increased thermal conditions, significantly above the temperatures observed in lakes in the temperate climatic zone (even above 28 °C). The behavior of parasite-free individuals may indicate the plasticity of *L. stagnalis* in relation to thermal changes in the environment. However, the preferences of invaded snails indicate a very likely trend of losing

the native species of the parasite in the face of climate warming. An additional argument in favor of the above suggestion is the very low prevalence of *D. pseudospathaceum* in the studied populations of *L. stagnalis*, significantly lower than in snails from lakes with undisturbed thermal conditions studied over the last 20 years.