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THE 39TH POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

This year's Polish Malacological Seminar (PMS) took place from May 8th to 10th, 2025, in Krobia, near Toruń. The meeting was organised by The Association of Polish Malacologists (APM) and the Fundacja Akademia Biologii i Ochrony Środowiska. The organising committee consisted of researchers and doctoral students of the Nicolaus Copernicus University in Toruń (Faculty of Biological and Veterinary Sciences): ELŻBIETA ŻBIKOWSKA, JAROSŁAW KOBAK, ANNA NOWAKOWSKA, MAŁGORZATA POZNAŃSKA-KAKAREKO, ANNA CICHY, KINGA LESIAK, DANIEL SZARMACH, KAMIL WIŚNIEWSKI, ZUZANNA PLICHTA, and JANUSZ ŻBIKOWSKI. The seminar's logo (Fig. 1), prepared by ANNA CICHY from the Toruń team (perfectly linked Copernicus's heliocentric worldview with the mollusc-centric worldview of malacologists).

Thirty-eight Polish malacologists and two guests from the UK and Austria participated in the seminar, giving this year's meeting an international character (Fig. 2). Over the past decade, the number of both PMS participants and the presentations presented here has remained similar (Fig. 3). Interestingly, certain trends (statistically insignificant) can be observed: we are decreasingly working alone and

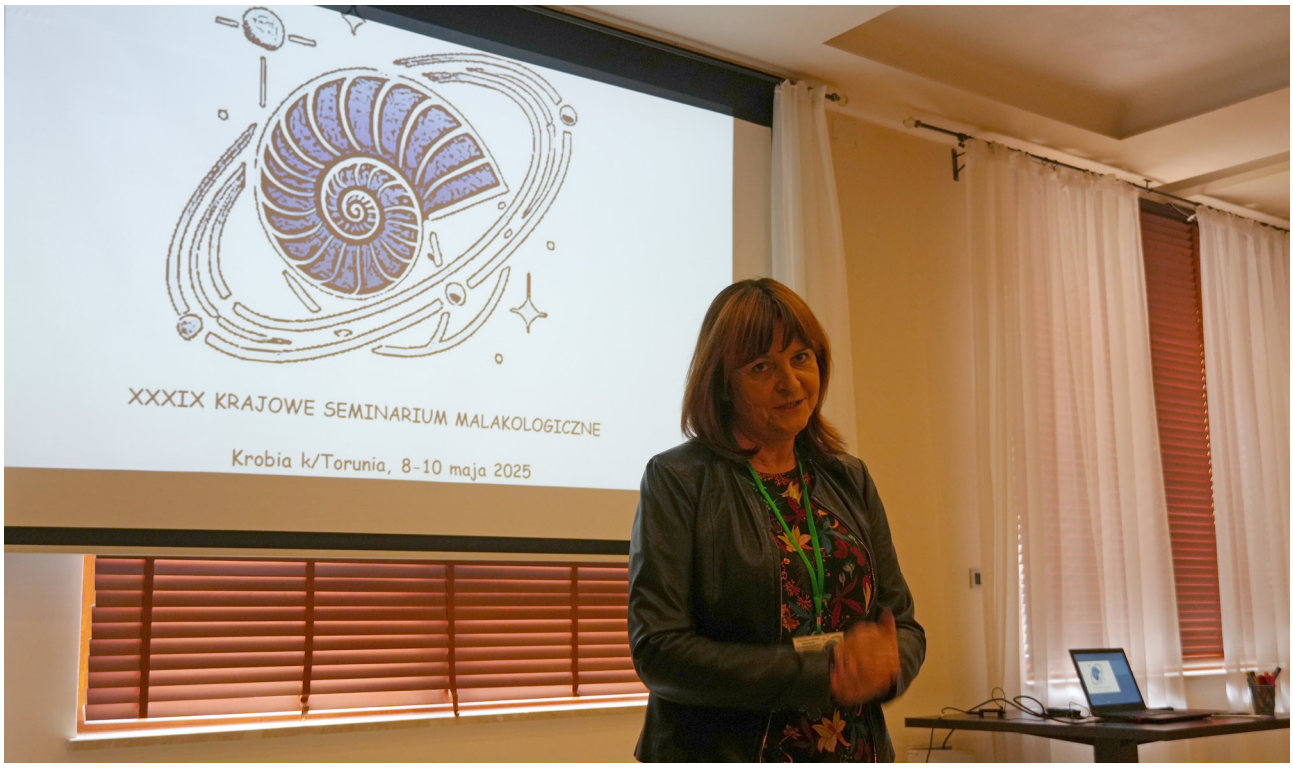

Fig. 1. ELŻBIETA ŻBIKOWSKA opens the 39th PMS, with the logo of this year's seminar in the background (photo: ANNA DROZD)

Fig. 2. Participants of 39th Polish Malacological Seminar (photo: ANNA DROZD)

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

Discipline	2007–2024		2025	
	n	%	n	%
Ecology & Conservation	231	29.5	8	26.7
Applied Malacology & Parasitology	95	12.1	4	13.3
Miscellaneous: general, behaviour, archaeology, collections, history, education, methodology	83	10.6	2	6.7
Biogeography & Faunistics	81	10.3	3	10.0
Life Histories	78	9.9	1	3.3
Systematics / Phylogeny (including molecular)	66	8.4	5	16.7
Fossil Molluscs	64	8.2	6	20.0
Structure (histology, cytology, shell) & Variation	47	6.0	0	0.0
Physiology	39	5.0	1	3.3

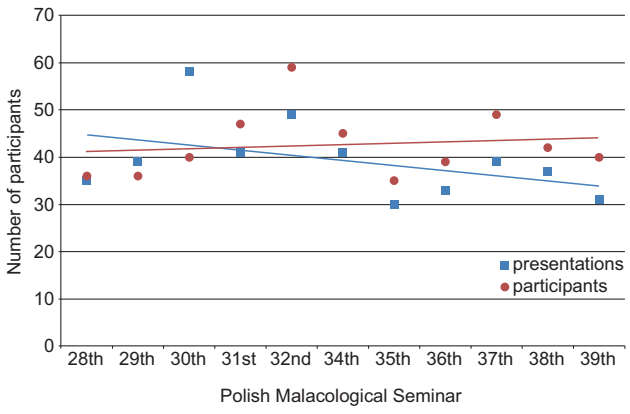

Fig. 3. Number of participants and presentations at Polish Malacological Seminars

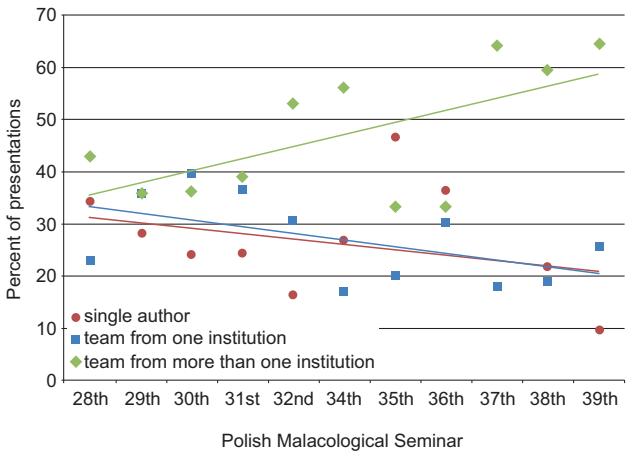

Fig. 4. Percentage of presentations prepared by a single author and research teams at Polish Malacological Seminars

Fig. 5. Malacologist and alpacas

increasingly in teams composed of scientists from various institutions (Fig. 4). This year's seminar featured a total of 24 oral presentations and 8 posters. As in previous years, the majority of presentations focused on the following topics: Ecology & Conservation, Fossil Molluscs and Systematics & Phylogeny (Table 1). Among the presentations was a special talk to commemorate Professor STEFAN W. ALEXANDROWICZ (see obituary, FM32(4): 223–246), who passed away last year. The professor made a significant contribution to the development of Polish malacology and also to the integration of Polish malacologists. He was the originator and organiser of the first Polish Malacological Seminar in 1985, which evolved into a regular annual meeting. He was also the originator and founder of the scientific journal Folia Malacologica, which you are currently reading.

Although the organisers did not plan any excursions this time, some of us visited a local alpaca farm during a short break. The animals were cute, and contact with them provided us with a wealth of positive energy (Fig. 5). But as soon as bright malacologists' eyes spotted *Caucasotachea vindobonensis* in the grass, they immediately abandoned nice mammals in favour of snails.

Traditionally, a formal banquet was held at the end of the official part of the seminar. This year,

Fig. 6. ZUZANNA PLICHTA and KAMIL WIŚNIEWSKI, winners of the award for the best presentations by young scientists (photo: ANNA DROZD)

we gathered to celebrate Professor ROBERT A. D. CAMERON being presented with the title of honorary member of the APM (see official announcement below). His official contributions to the APM, Folia Malacologica, and Polish malacology are immense, but no less important is the friendship he shares with many Polish malacologists. It was a solemn and very moving occasion. During the banquet, awards were also presented to young malacologists for the best oral presentations at this year's seminar. The awards committee, consisting of MAŁGORZATA OŻGO and WITOLD ALEXANDROWICZ, emphasised the scientific quality of all presented talks. The jury awarded two first prizes ex aequo: ZUZANNA PLICHTA for "Alien vs. Predator: selective predation of invasive crayfish on dreissenid mussels" and KAMIL WIŚNIEWSKI for "The impact of the invasive signal crayfish *Pacifastacus leniusculus* (Dana, 1852) on native and invasive Unionidae mussels" (Fig. 6).

Next year, our 40th anniversary seminar will take place in Krakow.

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AWARDING HONORARY MEMBERSHIP OF THE ASSOCIATION OF POLISH MALACOLOGISTS (APM) TO PROFESSOR ROBERT ANDREW DUNCAN CAMERON

The General Assembly of the APM, which met the 21st March 2025 online, unanimously adopted a resolution granting PROFESSOR ROBERT A. D. CAMERON honorary membership of the APM in recognition of his significant achievements in world malacology, its popularization and activities for the Association and the journal Folia Malacologica (Fig. 7). The official ceremony took place in Krobia on 9th May 2025, during the 39th Polish Malacological Seminar (Fig. 8). The laudation was written and presented by MAŁGORZATA OŻGO. The official diploma of honorary membership was handed to PROFESSOR CAMERON by MARCIN SZYMANEK, President of the Association of Polish Malacologists, in the presence of members attending the Seminar.

Fig. 7. Professor ROBERT CAMERON, the honorary member of The Association of Polish Malacologists (photo: ANNA DROZD)

Fig. 8. Members and friends of The Association of Polish Malacologists (photo: ANNA DROZD)

THE LAUDATION

It is an honour and a great pleasure to present this laudation for Professor Robert Andrew Duncan Cameron – a remarkable scientist and our friend. Today, we are celebrating an exceptional occasion. Professor Robert Cameron has been awarded Honorary Membership in the Association of the Polish Malacologists, the highest distinction in our Society. This title was conferred on him unanimously at the general meeting of the Association held on the 21st of March 2025.

Professor Robert Cameron is a highly regarded biologist specializing in the ecology, evolution, and biogeography of land snails. He developed his passion for studying snails as a student at the University of Oxford. In 1968 he earned his PhD at the University of Manchester with the thesis titled "The comparative ecology of three closely related helicid snails". He has devoted his life-long research to terrestrial molluscs exploring topics such as the polymorphism of *Cepaea* snails and the composition and richness of snail communities worldwide. He has also conducted studies on Quaternary fossil faunas.

Professor Robert Cameron has an impressive employment history. From 1967 to 1973, he was a Research Fellow and later a Lecturer at Portsmouth Polytechnic in the UK. From 1973 to 1994, he held successive positions as Lecturer, Senior Lecturer, Reader, and Full Professor of Evolutionary Biology at the University of Birmingham, UK. During this time, he also served as Staff Tutor in Biological Sciences, then Deputy Director, and Acting Director of the Department of Extramural Studies and the School of Continuing Studies.

From 1994 to 1998, he was a Professor of Evolutionary Biology and Director of Continuing Education at the University of Sheffield, UK. Since 1998, he has been a Scientific Associate at The Natural History Museum in London, UK, and served as an Honorary Professor of Evolutionary Biology at the University of Sheffield. From 2007 to 2010, he was a Consultant Professor at the Open University for the "Evolution Megalab" project. Since 2012, he has been an Honorary Associate at the Carnegie Museum of Natural History in Pittsburgh, USA.

Professor Robert Cameron is an Honorary Member of the Malacological Society of London, a title awarded in 2024, and an Honorary Doctor of the Open University, UK, awarded in 2001. He was elected as a Fellow of the Institute of Biology, UK, in 1994. He served as President of the Malacological Society of London from 1999 to 2003, and twice as a member of the governing council of the Linnean Society of London. From 2006 to 2012 he chaired the Conservation and Recording Committee of The Conchological Society of Great Britain and Ireland and has been Chair of the Project Grants Committee since 2023. Currently, he is on the editorial boards of Malacologia, Journal of Conchology and Folia Malacologica.

Professor Cameron is one of the most respected specialists in land snail research. His impressive body of work includes nearly 190 publications cov-

ering various aspects of the ecology and evolution of snails. His field guide has been translated into three languages. He is the author of a UK identification guide to land snails and a book of approximately 500 pages on slugs and snails for a general audience. He has also written two dystopian novels: "Ground" and "Bestowal" published by Austin Macauley in 2022 and 2024.

In recognition of his contributions to the field, a snail species, *Imeretiopsis cameroni*, was named in his honour.

Professor Robert Cameron's commitment to science also includes his work as a reviewer. In recent years, he has reviewed manuscripts for prestigious journals such as Nature, Journal of Animal Ecology, Journal of Molecular Evolution, Molecular Ecology, Proceedings and Philosophical Transactions of the Royal Society of London, Journal of Biogeography, Diversity and Distributions, European Journal of Soil Biology, Functional Ecology, Ecography, Biologia, Malacologia, American Malacological Bulletin, Journal of Molluscan Studies, Journal of Conchology, Folia Malacologica, ZooKeys, and others. He has reviewed grant proposals for organisations like the UK Natural Environment Research Council, the Polish and Czech Academies of Science, the Leverhulme Foundation and the Rufford Foundation. Additionally, he has served as an external Examiner for Bachelor's and Master's Courses in six Universities, and an external examiner of 16 PhD theses, from the UK, France, Czechia and Portugal.

Professor Robert Cameron is not only an excellent researcher, he is also an outstanding teacher. Those of us who have had the opportunity to attend his conference presentations are always impressed by the exceptional clarity with which he conveys his findings and ideas.

Professor Robert Cameron is a highly international figure in the field of malacology. His work has taken him to various locations, including Australia, Canada, Greece, Madeira, the Azores, Georgia, Crimea, Romania and Poland. Throughout his career, he has collaborated and published with researchers from at least 20 countries. His current activities include analysis of Romanian land mollusc faunas, research on the dynamics of island mollusc faunas in Greece and the Azores, and population genetics of *Cepaea* populations in England, Sweden and Poland.

For the Association of Polish Malacologists, Professor Cameron is a special person. His involvement with our Association has been very lively. He joined us in 2001 and has since engaged in extensive research in collaboration with Polish malacologists. On his impressive list of publications, there are 34 papers co-authored with Polish scientists. Thirty-three of us have had the honour of co-authoring papers with Professor Robert Cameron. Of those papers, 10 were published in the scientific journal Folia Malacologica, which our Association publishes. Folia Malacologica is an open-access journal indexed in the Scopus database, featuring articles from malacologists across the globe. Professor Cameron serves on the Advisory Board of the journal. As the Language Editor, he ensures the linguistic accuracy of all published texts. He has been involved with Folia Malacologica since 2012, initially collaborating with Professor Beata Pokryszko on linguistic proofreading. After her passing in 2022, he took on full responsibility for proofreading, significantly enhancing the editorial and substantive quality of the published works.

Over the past 20 years, Professor Cameron has visited Poland on numerous occasions. He has participated in person in eight of our annual Seminars. Those of us who had the pleasure of working with him in the field know how joyful, relaxed and intellectually stimulating his company is. Being a highly respected, world-famous scientist, and a keynote speaker at the most prestigious conferences Professor Robert Cameron remains modest, unpretentious, approachable, and helpful. Many of us, myself included, consider him a friend.

It is with great pleasure that we honour Professor Robert Andrew Duncan Cameron with the title of Honorary Member of the Association of Polish Malacologists. Dear Robert, it is our privilege to have you among us.

Dr hab. Małgorzata Ożgo, Prof. UKW
Krobia, 9 May 2025

ABSTRACTS OF THE 39TH POLISH MALACOLOGICAL SEMINAR

MIDDLE PLEISTOCENE LOESSES MALACOFAUNA OF SOUTHEASTERN POLAND AND WESTERN UKRAINE

Witold Paweł Alexandrowicz[1], Maria Łanczont[2], Roman Dmytruk[3], Andriy Bogucki[3], Andriy Yatsyshyn[3], Olena Tomeniuk[3], Paulina Laskowska-Piekoszewska[1]

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In southeastern Poland and western Ukraine, many loess profiles representing the Middle Pleistocene (loesses L2 and L3) have been identified. Remains of a unique mollusc fauna have been preserved in 13 of them. In total, the analyses were based on over 21,000 individuals of 26 species of molluscs (15 taxa of land snails, 10 taxa classified as water snails and one taxon of bivalves). Malacological analyses enabled the distinction of six faunal communities, characterising the diversity of deposition conditions in these loesses. The malacofauna was dominated by species typical of loess that represents dry habitats (*Pupilla loessica, Pupilla muscorum, Vallonia tenuilabris*) and humid habitats (*Trochulus hispidus, Succinella oblonga elongata*). In some profiles, shells of hygrophilous molluscs (*Vertigo genesii*, *Vertigo parcedentata*) and even aquatic molluscs (*Galba truncatula*, *Gyraulus laevis*) were also found. A striking feature is the similarity of the taxonomic composition and ecological structure of the communities present in the Middle Pleistocene loess (L2 and L3) to the faunas described from the youngest loess deposits (L1). This indicates similar climatic and environmental conditions, considered on a subcontinental scale (Central Europe on the northeastern foreland of the Carpathians) during the last three glacial periods. In this context, the main reasons for the differentiation of malacocenoses are regional geographical factors (the existence of orographic/morphological climatic barriers, the varied influence of climates with oceanic and continental features) and local conditions prevailing in individual geographical regions or even near the analysed profiles (terrain morphology, exposure of sites). It should be emphasised that in Europe, loess sites with malacofauna representing L2 and L3 coverages are rare and have been described from only a few to a dozen or so sites.

AND WHAT ABOUT TRANSPORT?

Witold Paweł Alexandrowicz[1], Sylwia Soczylas-Śniaz[2]

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The problem of transport of shell material is of fundamental importance for paleoenvironmental considerations conducted based on malacological analysis. The possibility of determining its range and intensity allows for the assessment of the degree of mixing of same-age mollusc communities, which in turn affects the accuracy of the reconstructions. Studies of shell thanatocenoses provide the most promising and useful data. Such accumulations of empty mollusc shells most often appear in river flood deposits and at the foot of rock walls, especially those built of carbonate rocks. Within river valleys, the movement of shell material can occur along the valley or across it. Studies on longitudinal transport were conducted in the Ponikiewka stream valley in the Beskid Mały Mountains. More than 20 flood deposit samples were collected along the valley (along a section of about 6 km). The identified mollusc communities in them, along with their quantitative and ecological structure, were compared with the environmental features at the deposition site. Based on these analyses, it was found that in the conditions of flood transport of shell material in a high-energy environment, the elimination of shell material occurs over a distance of up to 500 m. Studies on transverse transport were carried out in the Manikowska Valley near Kraków. This is a narrow ravine surrounded by steep limestone walls. On the one hand, thanatocenoses in flood deposits of the stream were analysed, and on the other hand, shell accumulations in rock walls were analysed. Very significant differences in the species composition of rock and river thanatocenoses were observed. This leads to the conclusion that the associations from these sites mix only to a limited extent, which in turn indicates a very limited range of transverse transport within the valley. The width of the Manikowska Valley typically does not exceed 100 m, suggesting that material transport from the slopes is very limited and occurs over distances of up to several dozen meters.

ISOTOPIC ANALYSIS OF SELECTED LAND SNAIL SPECIES FROM THE SMOLEŃ III SITE (KRAKÓW-CZĘSTOCHOWA UPLAND)

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The shelter in Smoleń III is a cave site located in the Kraków-Częstochowa Upland. It preserves an almost two-metre-deep sequence of Upper Pleistocene and Holocene clastic sediments, one of the longest and most complete of its kind in Central Europe. These deposits are rich in faunal remains, particularly molluscs. Previous research at the site has included lithological analysis, radiocarbon dating, archaeological investigations, and studies of the taxonomic composition of fossil fauna. Current research has been extended to include stable oxygen and carbon isotope analyses of land snail shells. These analyses were carried out on five species: *Discus ruderatus, Discus rotundatus, Isognomostoma isognomostomos, Laciniaria plicata* and *Vallonia tenuilabris*. Molluscs are highly sensitive indicators of climatic and environmental changes recording such shifts in their shells. Through isotopic analysis, this information can be extracted and interpreted. While $\delta^{18}O$ and $\delta^{13}C$ values are influenced by a variety of factors and can be challenging to interpret clearly, oxygen isotopes are used primarily to reconstruct the isotopic composition of precipitation and temperature changes. On the contrary, carbon isotopes provide information on the snail's diet and the surrounding vegetation. The well-documented stratigraphic profile from the shelter in Smoleń III, along with data from nearby cave sites, enables a comprehensive interpretation of the results. Integrating previous findings with the new isotopic data allows for a detailed reconstruction of environmental and climatic changes occurring at the end of the Pleistocene and throughout the Holocene. This research offers a significant contribution to understanding the long-term dynamics of environmental transformation in the Kraków-Częstochowa Upland over the past several thousand years.

STASIS AND CHANGE IN URBAN POPULATIONS OF *CEPAEA NEMORALIS* IN ENGLAND AND POLAND OVER 5–6 GENERATIONS

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In 2023 and 2024 we resurveyed the shell polymorphism in populations of *Cepaea nemoralis* in Sheffield (UK) and in Wrocław and its neighbourhood (PL) last sampled between 2006 and 2010. In both regions, snails were harder to find, and while some sites had been destroyed, others that were apparently suitable were no longer occupied. Where we could resample, the overall pattern is of stasis in morph-frequencies and in the overall pattern of genetic diversity. There were, however, some striking changes in particular populations, but these were not consistent in direction. While errors in relocation are possible, a combination of bottlenecks and extinction/recolonisation seems more likely. In Sheffield, there was a slight decline in the frequency of yellow shells; while many sites have become more shaded, there is no site-by-site correlation with the change in morph frequency. Given the apparent decline in the number and sizes of populations, the results are as expected over such a relatively short time; certainly, we have no evidence of any systematic selective effect operating across either region. We compare these results with others; there are profound statistical difficulties in detecting selective effects that are not consistent across populations. Studies over longer periods may overcome these.

RISK OF SWIMMERS' ITCH AT SELECTED BATHING AREAS IN THE DRAWSKO LAKE DISTRICT

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Bird schistosomes are parasitic flatworms of the Schistosomatidae family, characterized by a complex

life cycle. Waterfowl are definitive hosts of these parasites, while snails from the Lymnaeidae and Planorbidae families are intermediate hosts. Humans may be definitive accidental hosts as a result of a penetration of bird schistosome cercariae directly through the skin during bathing in lakes or during work related to the aquatic environment. The consequence of cercariae penetration through human skin is the appearance of a persistently itchy rash known as "swimmer's itch".

The study aimed to assess the risk of "swimmer's itch" in people who use bathing areas in the Drawsko and Czaplino lakes in the Drawsko Lakeland in the West Pomeranian Voivodeship. Malacological material, including lymnaeids and planorbids, was collected in July and August, i.e. during intensive summer recreation, from three study sites in the lakes mentioned above. In the malacofauna samples analysed, eight species of molluscs were recorded, including four lymnaeids and four planorbid snails. The presence of bird schistosomes representing the genus *Trichobilharzia* spp. and the species *Bilharziella polonica* was recorded in four species of snails. *Trichobilharzia* spp. were present in *Lymnaea stagnalis*, *Stagnicola palustris*, and *Radix auricularia*, while *Bilharziella polonica* was present in *Planorbarius corneus*. The overall prevalence was 1.1%. In July, the infection with bird schistosomes ranged from 0.4% to 3.1%, while in August, it ranged from 1.1% to 2.3%, depending on the mollusc species.

The low percentage of snails infected with bird schistosomes may pose a risk of swimmer's itch in people bathing in lakes, because the number of bird schistosome cercariae released by a single snail in just a few days can reach tens of thousands of larvae. Therefore, the key role in the prevention of "swimmer's itch" on beaches and in their vicinity is played by regularly collecting snails from the beach and its surroundings during the recreational period, trimming reed beds adjacent to the beach, not feeding and scaring away waterfowl from the beach area, using a shower directly at the bathing area and using protective creams before bathing in the lake.

LONG-TERM HYDROLOGICAL CHANGES IN LOBAU (DONAU-AUEN NATIONAL PARK, VIENNESE PART) – EFFECTS ON THE REGIONAL SPECIES COMPOSITION OF MOLLUSCS

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The mollusc fauna of Lobau, a floodplain area of the Donau-Auen National Park, which is situated also within the borders of Vienna (Austria), underwent several changes since the Danube regulation around 1870. After the regulation, many side arms, which were originally running waters, became stagnant water bodies. This reduced the habitat quality of mollusc species typical for Danubian flowing water, but triggered the increase of species specialized on still water and swamp habitats. However, even this habitat type was, after some time, negatively affected by human influences. The regulation of the river and the hydroelectric power plants reduced the downstream transport of gravel and, therefore, triggered the drop in the water level. Additionally, drought events led to unfavourable conditions, including complete desiccation of oxbow lakes and wet reed beds. Here we present the results of a malacological survey of the area performed in the years 2020 and 2021. We compared the results with data compiled from the literature from the early 20th century to 2019 and found a severe decrease in species numbers. Altogether 127 species (66 land snails, 38 aquatic snails and 23 mussels) were recorded in the investigated area up to this day. Of these, 121 species were found until 2019, while 6 others were recorded after 2019 for the first time. The number of species found in the last survey (2020/2021) was only 86, of which 63 were found alive and 23 were recorded as empty shells. Especially unionid mussels, some freshwater snails, and wetland species typical for Danubian forests were missing. However, several introduced molluscs have become more common in this protected area. More intense release of freshwater, which is long overdue, could stabilise the hydrological situation and preserve or even improve the remaining freshwater and wetland fauna.

PIEZOELECTRIC EFFECT ON SHELL REGENERATION PROCESS IN SNAIL MODEL (*HELIX POMATIA* L.)

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The influence of electromagnetic field (EMF) on living organisms is widely analysed within the academic community. The extremely low frequency electromagnetic field is of particular interest, due to its common occurrence and increasing levels of exposure in the environment (e.g. power lines, household appliances) as well its documented use in medical therapies. Despite numerous studies on the influence of the EMF, only the influence of the magnetic component (MF) is well documented, while the importance of the electrical component (EF) is much less discussed. Moreover, the available research results on the effects of EF are often inconsistent, which may result from differences between model organisms, exposure parameters or experimental protocols. The aim of our project was to compare the influence of exposure to electric and magnetic fields on the mineralized tissue regeneration process in a snail after previous damage. We verified the assumption that very low frequency EF (50 Hz) stimulates tissue mineralization and regeneration more effectively than MF of the same frequency. The experiment was conducted on three groups of adult *Helix pomatia* L. individuals (C – control, E – exposure to electric field, M – exposure to magnetic field; n=10). In all individuals, a minimum 1 cm wide damage to the shell was mechanically induced, then the animals were exposed to EF or MF daily for 1 h/day for 10 days, to simulate a rehabilitation schedule. The control group was subjected to an identical procedure, but without the presence of EMF. The regeneration process was monitored daily using callipers, photographic documentation and image analysis in ImageJ software. Additionally, to better visualize newly mineralized tissues, calcein solution was used. The results obtained showed that exposure to EF and MF boosts the early stages of the regeneration process. After reaching a threshold of 50% damage reduction, the regeneration rate slowed down significantly, which suggests that both components of EMF may play an important role in the initial stages of repair processes, probably by stimulating cellular metabolism or modulating calcium ion flow. By the end of the experiment, the differences between groups had evened out, suggesting that in the long term the body recovers at a similar rate regardless of exposure to EMF.

MODELING THE BEHAVIORAL RESPONSE OF THE INVASIVE SLUG *ARION VULGARIS* MOQUIN-TANDON TO REPETITIVE DIRECT CURRENT STIMULATION: A LABORATORY STUDY

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In recent decades, climate change has significantly altered weather patterns, creating more favourable environmental conditions for slugs. As a result of milder autumn and winter periods, slug populations have increased markedly, posing a substantial threat to agricultural systems. The mass occurrence of slugs has serious negative consequences for the cultivation of various plant species, including agricultural crops, vegetables, fruits and ornamentals. Damaged plants are more susceptible to fungal and bacterial infections, compounding the issue.

Chemical control methods, particularly when slug densities are high, often prove ineffective and inadequate. Moreover, the widespread use of chemical agents may negatively impact the natural environment and harm non-target organisms. Therefore, the development of alternative, environmentally friendly strategies for the management of invasive slug species has become a priority. The aim of our study was to develop an effective method of protecting plants from *Arion vulgaris* by inducing avoidance behaviour through exposure to a negative stimulus—direct current. Specifically, we investigated whether repetitive exposure to an electric current (10 mA, 10 V) could elicit a learned aversive response in slugs.

A series of laboratory experiments were conducted under controlled conditions in a climatic chamber. The behavioural response to electric stimulation was examined using T-mazes. One arm of each maze contained a conductive tape delivering electric current, while the other, identical in structure, remained current-free. Infrared cameras were installed above each maze, and a computer system with dedicated

image-recording software was used to monitor and analyse slug behaviour.

Over several months, we conducted repeated trials and analysed the recorded footage. We assessed behavioural changes by measuring the time slugs spent in predefined zones of the T-maze and by counting how often they crossed the electrified tape, thus exposing themselves to the stimulus. Additionally, we evaluated whether exposure to the current affected slug feeding behaviour by comparing the percentage of food consumed in the current-on and current-off arms of the maze. All results were statistically analysed. Our findings demonstrated that slugs exposed to electric stimuli learned to avoid the electrified arm of the maze. Over time, they increasingly chose the current-free path and consumed significantly more food in that arm. Notably, the learned avoidance behaviour persisted for up to three weeks. In contrast, control slugs (from current-free mazes) exhibited no arm preference and fed equally on both sides. In conclusion, while electric barriers have previously been suggested to repel slugs, there is still a lack of scientifically validated methods to condition behavioural responses in *A. vulgaris*. Our research provides evidence that slugs are capable of learning and remembering the location of an aversive stimulus, which can be leveraged to develop more sustainable plant protection strategies. This approach holds promise in reducing crop damage while minimizing environmental impact.

BALKAN HYDROBIIDAE – SMALL CREATURES, BIG QUESTIONS

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The Dinaric Alps are one of the most well-known regions with exceptionally high animal biodiversity (so-called biodiversity hot spot). This phenomenon is particularly evident in freshwater snails, including those belonging to the superfamily Truncatelloidea. This is one of the largest groups of aquatic snails, comprising over 300 species, most of which are stygobionts (organisms adapted to subterranean aquatic habitats). At the same time, snails from this group are endangered due to the destruction of their main habitats – springs. The remarkable diversity of Truncatelloidea in the Dinarides has been greatly influenced by the complex geological history of the region. Since the Middle Miocene, the Dinarides formed a land bridge between the Mediterranean Sea to the south and the Paratethys to the north, which was separated from the eastern part about 12 million years ago to become the Pannonian Lake. Over the following 7 million years, this lake gradually became brackish, then freshwater and increasingly shallow. Furthermore, the Mediterranean Sea almost completely dried up during the so-called Messinian Salinity Crisis, when the sea level dropped by more than 1,000 meters. This opened a pathway for animal invasions from Western Europe, the Apennines and Asia Minor. However, the Mediterranean was later restored by the Pliocene flood. During the Pleistocene, its water level fluctuated by around 120 meters, contributing to repeated invasions of marine and freshwater fauna onto land and into freshwater and cave habitats. As a result, colonization of the Dinarides region occurred from various directions, and the Pannonian Lake, inhabited by a large number of snail species, served as an additional source of migrants. Moreover, the distribution of taxa on different sides of the mountains may be a result of snails being preadapted (at least facultatively) to subterranean life, using underground waters as pathways for expansion. Consequently, the fauna of the Dinarides is expected to consist of species related to Pontic, Danubian, Alpine and Mediterranean species. To resolve fundamental questions regarding the complex evolutionary and demographic history of the animals inhabiting the Dinarides, morphological and molecular studies of small and inconspicuous freshwater snails from the family Hydrobiidae, within Truncatelloidea, are playing a crucial role.

ADAM BOCHENEK – MALACOLOGICAL BASIS OF POLISH ANATOMY

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Adam Wawrzyniec Bochenek is a Polish physician, anatomist, histologist, and anthropologist. He was born on August 10, 1875 in Kraków. He was the son of Mieczysław (1838–1887), professor of economics at Jagiellonian University, and Helena (nee Klicka). Adam graduated from the 3rd Gymnasium in Kraków; in the years 1892–1898 he studied medical sciences at the Jagiellonian University, obtaining a doctorate in medical sciences on March 5, 1898. From 1899 to 1901, he lived abroad; he studied anthropology at the Schwalbe Institute in Strasbourg and neuroanatomy at the University of Leuven. In 1901 he obtained his habilitation at Jagiellonian University based on his dissertation "On the structure of the nerve cell of the snail *Helix pomatia*" (in Polish: O budowie komórki nerwowej ślimaka *Helix pomatia*). In the years 1903–1904 he stayed at the zoological station in Naples. From 1906 he was an associate professor at the Jagiellonian University. He lectured on descriptive anatomy and organized a research laboratory dealing with the structure and course of the nerve fibres. He was the author of 28 scientific papers, mostly in the field of invertebrate histology and embryology. He also conducted anthropological research on the rural population of Kutno, Łęczyca and Mława district. His most famous work is the multi-volume textbook „Human Anatomy" (in Polish: Anatomia człowieka). Volume I of the planned four was published in 1909 by the Academy of Learning. After his death and before the war, the remaining volumes were published. „Human Anatomy", taking into account the changes of successive editors, remains in print, currently as a 5-volume work. Adam Bochenek died on May 25, 1913 in Kraków and was buried at the Rakowicki Cemetery in the family tomb (section 21). Titles of malacological works: On the maturation and fertilization of the egg in the snail *Aplysia depilans* (in Polish: O dojrzewaniu i zapłodnieniu jaja u ślimaka *Aplysia depilans*); The maturation and fertilization of the egg *Aplysia depilans* (in German: Die Reifung und Befruchtung des Eies von *Aplysia depilans*); Contribution to the study of the nervous system of gastropods (*Helix pomatia* Lin.) fine anatomy of nerve cells (in French: Contribution à l'étude du système nerveux des gastéropodes (*Helix pomatia* Lin.) anatomie fine des cellules nerveuses); On the structure of the nerve cell of the snail *Helix pomatia* (in Polish: O budowie komórki nerwowej ślimaka *Helix pomatia*); Studies on the structure of the central nervous system in molluscs, tunicates and echinoderms (in Polish: Badania nad budową systemu nerwowego centralnego u mięczaków, osłonic i szkarłupni).

DEVIL IS IN THE DETAILS: ZEBRA MUSSEL BED AS PREFERRED OR AVOIDED HABITAT FOR THE PONTO-CASPIAN CRUSTACEAN *DIKEROGAMMARUS VILLOSUS*

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The invasive Ponto-Caspian gammarid *Dikerogammarus villosus* (Crustacea, Amphipoda) commonly reaches high numbers in colonies of the invasive, habitat-forming zebra mussel (*Dreissena polymorpha*). This relationship is often considered an element of the „invasional meltdown" phenomenon, when invasive species support each other's spread and impact. However, existing experimental evidence contradicts field observations: *D. villosus* was observed to avoid mussel scent, and prefer similarly sized gravel particles. Thus, an important factor must have been overlooked in laboratory experiments failing to explain field observations. We tested two additional factors that may modulate gammarid choice: predation pressure (potentially shifting gammarid preferences towards mussel colonies), and quality of surrounding bottom (hard or soft). Alarm cues did not affect gammarid selection. However, gammarids did select mussel colonies over gravel particles when exposed on the soft substratum, but not on the hard bottom. Thus, mussel beds can constitute suitable habitats for *D. villosus*, but life among mussels comes with costs. Mussels consume oxygen and excrete waste materials, worsening local conditions and making gammarids select alternative hard surfaces. However, living mussels can actively re-emerge to the surface from soft sediments, whereas non-animate objects sink gravitationally and get buried by sedimentation. Moreover, mussels provide effective anti-predator shelters (3-D structures interconnected by byssal threads) and food resources (pseudofaeces). In nature, gammarids will face an alternative between mussel colonies and loosely scattered gravel particles on soft sediments, rather than in rocky habitats. Therefore, gammarid preferences

for mussels are likely to explain the distribution and relationships between these two species in the field.

Our results show how seemingly minor details of the experimental setup can considerably affect and even reverse the outcome. This indicates that exceptional care must be taken during planning and interpreting experimental results, which anyway can be a valuable source of knowledge on mechanisms driving ecological processes in the wild.

GROWTH RATE OF *PERFORATELLA VICINA* (ROSSMÄSSLER, 1842) (GASTROPODA: EUPULMONATA: HYGROMIIDAE)

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Perforatella vicina (Rossmässler, 1842) is a representative of the family Hygromiidae, living mainly in deciduous forests of central and southeastern Europe. Its growth rate was observed in the laboratory and in the field, i.e. in the beech forest in Muszkowice near Henryków, on the border of the "Muszkowicki Las Bukowy" nature reserve (50.6409, 16.9508). Field studies were carried out once a month during the snail activity period, i.e. May-October in 2020–2021, and in May 2022. At each inspection, the size of all caught individuals was determined, i.e. the number of whorls with an accuracy of 0.05 whorls. The current size of the shell was marked with nail polish – a different colour was used each month. A total of 822 individuals were marked; 336 individuals were re-captured, including 208 that grew between subsequent observations, and 128 that did not grow (mainly subadults that were already at the stage of building a lip). Laboratory observations were based on 40 individuals that hatched in August 2020 from eggs laid by adults collected in the field. Juveniles were cultured in Petri dishes kept in a climate chamber under constant temperature conditions (22˚C during the day and 18˚C at night), 80% humidity and 12:12 photoperiod. Growth was recorded monthly throughout the year, following the same methodology as in the field. Of the 40 individuals from the laboratory, 21 reached their final size and developed a lip, the remaining 19 individuals died earlier. Growth of individuals that reached their final size varied from 3 to 25 months (average 20 months). The average growth rate of *P. vicina* in laboratory conditions was 0.24 whorls/month. Snails from natural conditions showed an average higher growth rate (0.3 whorls/month) and also achieved greater maximum monthly growth. Thanks to this, in favourable conditions, they are able to complete building the shell and reach maturity in the third year of life (after two winters). Both in natural conditions and in the laboratory, smaller individuals grew faster, slowing their growth rate with increasing size (expressed as the number of whorls). In natural conditions, there were also seasonal differences. The largest growth was achieved by snails from all age classes at the beginning of the growing season, i.e. between May and June.

ANALYSIS OF ECOLOGICAL CHANGES IN THE VICINITY OF ALWERNIA BASED ON SUBFOSSIL MALACOFAUNA OF GAUDYNOWSKIE SKAŁKI

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The aim of the research was to reconstruct environmental changes based on mollusc assemblages identified in sediments filling small karst forms developed within limestone rocks in the vicinity of Alwernia, on Garb Tenczyński. Limestone formations occurring in this area are attractive in the context of malacological studies, mainly due to the common occurrence of small karst forms (small caves, open karst fissures, rock niches and subsurface shelters) filled with clay-rubble sediments. These sediments are characterized by a high calcium carbonate content, which is why they create favourable conditions for the preservation of mollusc shells. Detailed malacological studies were carried out on samples taken from Gaudynowskie Skałki, a group of rocks composed of Upper Jurassic rocky limestones. The analysis was based on material obtained from 36 samples. The presence of a rich and taxonomically and ecologically diverse malacofauna was identified here. The shell material revealed the presence of 57 species of land snails represented by over 20,000 specimens. Such a rich and diverse fauna allowed for the reconstruction of changes in the natural environment of the studied area. Malacocenoses mainly represent the late Holocene period, and most of the identified fills accumulated over the last several hundred years. The diversity of species composition and ecological structure of mollusc communities indicate the presence of neighbouring microhabitats, often with clearly different features.

DOES CLIMATE CHANGE FAVOR THE PARASITE OR THE HOST? A CASE STUDY OF *DIPLOSTOMUM PSEUDOSPATACEUM* IN *LYMNAEA STAGNALIS*

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Flukes of the genus *Diplostomum* are characterized by a complex life cycle involving two intermediate hosts. The first are pulmonate snails, including *Lymnaea stagnalis*, and the second are fish, in which the parasite localizes in the lens, causing its opacity and ultimately leading to blindness. The definitive hosts are water birds. The aim of the study was to compare the prevalence of *Diplostomum* sp. in *L. stagnalis* from lakes with different thermal regimes and to assess the impact of temperature on the survival of the first intermediate host. Between April and October, 800 *L. stagnalis* individuals were collected from lakes with a natural thermal regime and 625 snails from thermally elevated lakes (Konin Lakes system). All collected specimens were first exposed to shedding to observe the active release of cercariae, then dissected. The isolated larvae were preserved in alcohol and identified morphologically; selected samples were subjected to molecular analysis. DNA was extracted from individual larvae, followed by PCR amplification of the ITS, 28S rRNA, and COI regions. Sequencing and comparative analysis revealed that all isolates belonged to the same species – *Diplostomum pseudospataceum*. The percentage of infected individuals was higher in warm lakes (43.7%) than in cold lakes (24.1%), and the prevalence of *D. pseudospataceum* was 16.6% and 4.4%, respectively. A laboratory experiment was also conducted, in which 32 uninfected and 10 *Diplostomum* sp.-infected snails were kept individually at 19 °C, with parallel groups maintained at 25 °C. The experiment continued until the death of all individuals. The mean survival time was 17.0 days at 19 °C and 15.2 days at 25 °C, with no statistically significant differences ($t = -0.577$; $p = 0.567$). Previous reports suggested that a constant rearing temperature above 25 °C significantly reduced the lifespan of *L. stagnalis* infected with *D. pseudospataceum* collected from lakes with a natural thermal regime. This relationship was not confirmed in the present study. The results suggest that, in the case of *L. stagnalis* originating from populations in thermally elevated lakes, increased environmental temperatures lead to higher parasite prevalence but do not shorten the lifespan of infected hosts. This may indicate increasing thermal tolerance in *L. stagnalis* and suggest that the intermediate host is adapting to ongoing climate change.

LAPIDARY SNAIL *HELICIGONA LAPICIDA* (L.) – DISTRIBUTION, ECOLOGY, THREATS

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The Lapidary Snail *Helicigona lapicida* is western and central European species. It inhabits Portugal and northwestern Spain, where it has only few localities, northwestern Italy and the countries of Western and Central Europe (except Slovenia, Slovakia and Hungary). It also occurs in southern England and Ireland (one locality) and in southern Scandinavia (Norway, Sweden and Finland), where it reaches its northern limit. The eastern border is limited by the areas of Moravia, Poland, the Königsberg region and Latvia (three localities). In Poland, the snail mainly inhabits the north-western and south-western parts of the country, with an isolated area in the Jura and single sites in the Świętokrzyskie Mountains. This typical forest species prefers moist deciduous and mixed forests; it is mesophilic and calciphilic, but rock substrate is not essential, so it is not a petrophilic species. It can be also found in the ruins of medieval castles, in quarries and on rocks, which are often overgrown with deciduous trees, creating island habitats in an environment transformed by man (arable fields, coniferous forests, meadows, etc.). Therefore, the current distribution of *H. lapicida* in Poland was determined, and a mitochondrial marker – cytochrome oxidase subunit I (COI) was used to assess genetic variation between isolated populations (individuals from 20 sites from different parts of the country). The sequences obtained allowed to determine a relatively close relationship between them (average and maximum genetic distance of the barcode sequences were 2.08% and 4.63%, respectively). The main factors causing the extinction of the populations of this species were also analysed. They include changes in water conditions (steppe formation, long-term droughts), logging deciduous forests, especially old ones, disposal of rotten tree trunks or, observed in recent years, renovation of castle ruins. Until 2013, the snail was under strict protection in Poland, whereas since 2014 it has been a species under partial protection (there is no information about the reasons for the change in protection status).

DENSITY OF *CAUCASOTACHEA VINDOBONENSIS* IN RIPARIAN HABITATS WITH DIFFERENT CALCIUM CARBONATE CONTENT IN SOIL LOCATED ON FLOOD TERRACES OF THE VISTULA RIVER

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Within the geographical range of *Caucasotachea vindobonensis* in Poland, six riparian sites located on flood terraces of the Vistula River were selected. The sites were divided into two categories: (1) continuous riparian forests (Kazimierz Dolny, Słupia Nadbrzeżna, Zawichost) and (2) insular riparian forests (Zakroczym, Górki near Otwock, Warsaw). The soils at all sites, classified as fluvisol by the Institute of Cultivation, Fertilization and Soil Sciences – National Research Institute, are overgrown with willow-poplar forests. Sites from categories 1 and 2 were compared in terms of $CaCO_3$ content in the soil, density of young and adult *C. vindobonensis*, as well as the age structure of populations of this species. The studies were carried out over two years (twice in the spring season and twice in the autumn season). The determination of $CaCO_3$ content in the soil was carried out using the Scheibler volumetric method, and the density was conducted using the quadrat method. In each season, 30 soil samples were taken at each site and the density of the species was examined within 5 quadrats with a total area of 125 m^2. The Mann-Whitney U test analysis showed statistically significant differences between category 1 and 2 in terms of the following: (1) $CaCO_3$ content in soil, the average $CaCO_3$ content was 8.01% (6.31–10.52% SD = 1.08) in category 1 and 2.09% (0.29–5.39% SD = 1.15) in category 2, the $CaCO_3$ content in category 1 was statistically significantly higher compared to category 2 ($Z = -23.222$, $p<0.001$); (2) densities of adults, the mean density was 0.53 ind./m^2 (0.4–1 ind./m^2 SD = 0.15) in category 1 and 0.22 ind./m^2 (0–0.36 ind./m^2 SD = 0.11) in category 2; the density in category 1 was statistically significantly higher in comparison to category 2 ($Z = -9.490$, $p<0.001$); (3) densities of juveniles, the mean density was 0.11 ind./m^2 (0–0.48 ind./m^2 SD = 0.11) in category 1 and 0.03 ind./m^2 (0–0.12 ind./m^2 SD = 0.03) in category 2; density in category 1 was statistically significantly higher compared to category 2 ($Z = -9.490$, $p<0.001$). The age structure showed that the share of adults and young individuals was 80.13% and 19.87%, respectively, in category 1, while 85% and 15% in category 2. This means that the populations of both categories are in the aging phase. Despite the higher values of the densities of young and adults, as well as the higher share of young individuals in category 1 compared to category 2, the state of the *C. vindobonensis* populations in the two categories is unsatisfactory. This is primarily due to the periodic destruction of populations living on the Vistula flood terraces caused by high water levels. The population status is influenced by the frequency of flood episodes (over the last 60 years, the intervals between successive floods on the Vistula River ranged from one to 17 years) and the time needed to reconstruct populations from a small group of individuals (mainly adults that survived the floods or were redeposited from the upper reaches of the river).

NEW MOLECULAR DATA ON THE SNAILS OF THE GENUS *MONACHA* FITZINGER, 1833 (GASTROPODA: EUPULMONATA: HYGROMIIDAE) AND SOME OTHER HYGROMIID SPECIES OCCURRING IN THE SPANISH PROVINCES OF ASTURIAS, CANTABRIA, VIZCAYA AND ÁLAVA

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In Spain (on the Iberian Peninsula and the Balearic Islands), there are 27 species of the family Hygromiidae Tryon, 1866 classified into 11 genera. So far, only 3 species of the genus *Monacha* studied by us have been identified in this European part of Spain: *M. cartusiana* (Müller, 1774), *M. cantiana* (Montagu, 1803) and *M. atacis* Gittenberger et de Winter, 1985 (= *M. samsunensis* (Pfeiffer, 1868)). Only the first of these species occurs throughout Spain, while the other two are known from a few localities. At the turn of April and May 2024, MP collected material for research in the north-western provinces of Spain. However, at this time of year, mainly juveniles were present, which prevented species identification based on shells and reproductive organs. However, thanks to the sequences deposited in GenBank for representatives of Spanish malacofauna, molecular identification was possible. Nucleotide sequences of two fragments of mitochondrial genes: cytochrome c oxidase subunit 1 (COI) and ribosomal 16S RNA (16SrDNA), and fragments

of four nuclear genes: histone 3 (H3) and a sequence encompassing the entire internal transcribed spacer 2 (ITS2) with flanking fragments of ribosomal RNA genes (5.8SrDNA and 28SrDNA) were used for the study. DNA from 26 specimens was isolated and amplified. One hundred and four sequences of the studied genes from Spanish populations were obtained (26 COI: PV463401-PV463426; 26 16SrDNA: PV470019-PV470024, PV470033-PV470044, PV470050-PV470057; 26 H3: PV477007-PV477012; PV477014-PV477025, PV477029-PV477036; 26 ITS2 with flanking genes: PV463504-PV463509, PV463518-PV463529, PV463535-PV463542). These sequences together with sequences from GenBank and 54 newly obtained sequences from comparative species (6 COI PV463427-PV463432; 19 16SrDNA PV470025-PV470032, PV470045-PV470049, PV470058-PV470063; 10 H3 PV477013, PV477026-PV477028, PV477037-PV477042; 19 ITS2 with flanking genes: PV463510-PV463517, PV46330-PV463534, PV463543-PV463548) were used for phylogenetic analyses. *M. cantiana* s.s. was found in two populations from Vizcaya (País Vasco) and one from Cantabria. On the other hand, *M. cartusiana* was found in two populations from Asturias and one from Álava. Among other representatives of Hygromiidae, specimens of *Mengoana jeschaui* (= *M. brigantina*) were identified in three populations from Cantabria, although in one of them specimens of *Hygromia limbata* co-occurred. The results confirm the validity of molecular identification of juveniles with not fully developed anatomical features, especially when one has extensive comparative material at one's disposal.

ALIEN VS PREDATOR: SELECTIVE PREDATION OF INVASIVE CRAYFISH ON DREISSENID MUSSELS

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We tested consumption of two invasive Ponto-Caspian dreissenids: *Dreissena polymorpha* and *Dreissena rostriformis bugensis* by the invasive North American crayfish *Faxonius limosus*. Recently, spreading *D. rostriformis bugensis* has been proven to replace the earlier invader, *D. polymorpha,* in European and North American habitats, therefore potentially changing available food resources for molluscivores. *Dreissena rostriformis bugensis,* with its softer shell and narrower body, might be easier to consume by crayfish. We tested crayfish consumptions on (1) intact mussels of both species, (2) injured mussels with crushed shells (to simulate individuals already attacked, but not consumed by other predators), and (3) only soft tissue removed from the shell. Crayfish did not show any significant preferences for mussel species, but did consume *D. rostriformis bugensis* more efficiently than *D. polymorpha*, irrespectively of treatment. Successful consumption of intact *D. rostriformis bugensis* took less time than consumption of *D. polymorpha*. Crayfish that were unable to consume mussels gave up on *D. polymorpha*, but kept trying to consume *D. rostriformis bugensis*. The handling of crushed mussels was longer compared to healthy and soft tissue variants. Our results show that the ongoing replacement between the two dreissenid species taking place in Europe might change the conditions for crayfish co-invasions in the same waters, as *D. rostriformis bugensis* are more susceptible to crayfish predation, and likely to improve feeding conditions for predators.

EXPLORING DIVERSITY OF EUROPEAN LAND SNAILS: CASE OF *HYGROMIA* RISSO, 1826

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Recent molecular studies show that the true diversity of land snails in Europe is still unknown. In the genus *Hygromia*, three or four species and one subspecies has typically been recognised based on morphology. To assess the taxonomic boundaries of species, we used an integrative approach, combining analyses of shell (including microsculpture) and reproductive system (including love darts) with genetic data of 205 individuals from 90 populations, distributed mainly in France. Differences in the morphology of the shell, reproductive system and love darts allowed us to distinguish two subgenera comprising five nominal taxa: *Hygromia* (*Hygromia*) *cinctella*, *Hygromia* (*Riedelia*) *limbata* s. str., *Hygromia* (*Riedelia*) *limbata hylonomia*, *Hygromia* (*Riedelia*) *tassyi* and *Hygromia* (*Riedelia*) *pyrenaica* sp. nov. The taxonomic affiliations of two independent evolutionary lineages within *Riedelia* remain uncertain. Additionally, *H. odeca* and *H. veprium* were conspecific with *H. limbata*, and *H. gofasi* with *H. tassyi*. Morphometry alone remains useless in determining *Hygromia* species, and microsculpture shows only

minor differences. Polymorphism observed in populations of certain taxa additionally complicates their identification. It refers both to the shell colouration (light/dark) and to presence or absence of a lighter band on the periphery. Among genitalia characters, the appearance of the love dart has the greatest taxonomic value. The majority of the recognized taxa and genetic clades have narrow ranges in the Pyrenees and their foothills. Such large number of endemics restricted to a relatively small area, the presence of distinct taxa in neighbouring sites and their high level of genetic diversity suggest a complex evolutionary history of the genus *Hygromia*, which should be proven by population genetic studies. Our results encourage taxonomic verification of native *Hygromia* populations in Spain and those introduced to Great Britain and Belgium.

PALAEOENVIRONMENTAL CHANGES IN THE AREA AROUND THE VILLAGE OF BISKUPICE, FROM THE LATE VISTULIAN GLACIATION TO THE PRESENT DAY (WIELICZKA FOOTHILLS, SOUTHERN POLAND)

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A cross-section through the valley of the Królewski Stream was made approximately 2 km from Biskupice (Wieliczka Foothills). One of the profiles studied underwent a detailed paleoenvironmental analysis and represents the Late Glacial and Holocene phases. During the Allerød period, there was a water body in the area, as evidenced by the presence of *Batrachium* sp. seeds and *Galba truncatula* shells. Initially (L MAZ B4-1), open, tundra-like habitats developed around the water body on moist substrates, as indicated by the presence of *Vertigo genesii*, *Columella columella* and *Succinella oblonga*. Subsequently (L MAZ B4-2), the area was colonised by sparse birch woodland and there was a significant diversification of faunal assemblages in terms of species composition. Towards the end of the Allerød period, the reservoir became overgrown with peat-forming vegetation and various *Carex* species, a process which later encompassed the entire valley floor. The Preboreal and Boreal periods (L MAZ B4-3) were characterised by an increase in malacofaunal remains and a sharp, simultaneous decline in plant macrofossils. Moist habitats were primarily inhabited by hygrophilous snails, such as *Carychium minimum* and *Vallonia enniensis*. Numerous open-habitat and mesophilic species were also present, with *Vertigo alpestris* dominating in the semi-open woodland. The composition of the aquatic mollusc fauna (*Anisus leucostoma*, *Galba truncatula* and *Pisidium obtusale*) suggests the presence of a shallow, temporary reservoir or a floodplain area with silty peat accumulation. In the overlying layer, which was composed of clayey, carbonate-free sands, the malacofauna disappeared completely, while the presence of plant remains increased significantly (L MAZ B4-4). Ruderal and meadow plants predominated, with sporadic occurrences of *Sambucus nigra* and *Alnus glutinosa*. Wet habitats were colonised by *Urtica dioica* and *Mentha pulegium*. In the final stage (L MAZ B4-5), a low peat bog persisted, with moisture-loving vegetation growing along its edges. The development of vegetation in the upper part of the profile (L MAZ B4-4 and 5) indicates a late Holocene phase with a moderately warm climate, suggesting human activity in the area under study.

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THE FIRST MOLECULAR IDENTIFICATION OF THE GREY SNAIL *CORNU ASPERSUM ASPERSUM* IN POLAND

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The grey snail (*Cornu aspersum aspersum* (O. F. Müller, 1774)) is one of the most widespread land snails in the world. Although it is considered a Mediterranean species, its current range extends from northwestern Africa and the Iberian Peninsula to Asia Minor and Egypt in the east, and from Great Britain in the north to South Africa in the south. Its presence in various European countries results from

both natural expansion and human introduction, such as through ornamental plants. It is a native species in ten countries along the southern and northern shores of the Mediterranean Sea, including its islands. In other European countries, the grey snail is considered an introduced species and its records are sporadic. However, the population in Vienna has been observed for over 30 years. This species is recognized as a significant pest of garden and agricultural crops. For culinary purposes (meat for consumption and eggs for "caviar") and cosmetics (mucus as an ingredient in creams), this species, along with the large grey snail, *C. aspersum maxima*, is currently farmed in many countries, including France, Greece, Spain, Ukraine, Morocco, Tunisia and Poland. Currently, six large companies in Poland have been breeding, processing and exporting these two taxa of *Cornu aspersum* for many years. However, aside from breeding, they have not yet been documented in any scientific literature. A single specimen of an unknown snail was discovered in Szczecin, and molecular studies based on DNA barcoding revealed that it belongs to *C. aspersum aspersum*, which is also known as *Helix aspersa* in genetic sequence databases.

OCCURRENCE OF THE GENUS *PERPOLITA* (STYLOMMATOPHORA, GASTRODONTIDAE) IN POLAND

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Perpolita is a genus of terrestrial snails in the family Gastrodontidae, occurring in the Holarctic region in areas with temperate and boreal climates. Until recently, it was believed that only two species of this genus occurred in Central Europe, including Poland: *P. hammonis* and *P. petronella*. The former is a very common eurytopic snail, while *P. petronella*, found only in cold and wet habitats, was considered a relatively rare and threatened species (Polish Red List – category NT). According to the Catalogue of the Fauna of Poland (Riedel 1988), both of these taxa were also recorded under the name *P. radiatula*, which was treated therein as a synonym. A recent revision of the genus *Perpolita* (Saito et al. 2024), based on molecular data and shell morphology, indicates the taxonomic distinctiveness of *P. radiatella* and the presence of three species in Central Europe. The ranges of all the mentioned snails overlap: *P. radiatella* is distributed from the Atlantic coasts of Scandinavia through Central Europe and Siberia to Alaska; *P. hammonis* inhabits the area of Europe from the Atlantic coasts (including Iceland and the Azores) to the Urals; *P. petronella* occurs from the Atlantic coasts in the west to the Altai Mountains in Central Asia. In Eastern Europe and Scandinavia, all three species may occur sympatrically. In light of these new findings, existing literature data on the occurrence of the *Perpolita* snails in Poland are unreliable and require revision based on shell collections. Saito et al. (2024) have already confirmed the presence of the "true" *P. radiatella* in Poland (Sarnetki; sphagnum bog), although the publication does not allow for a more precise determination of the western boundary of its range, which likely runs through Poland. Proper identification of *Perpolita* snails, in view of the new taxonomic revision, should take into account the shape and colour of the shell as well as the microsculpture on its umbilical side.

LONG-TERM FIELD EXPERIMENT: DO INVASIVE CLAMS OF THE *CORBICULA* COMPLEX POSE A THREAT TO NATIVE UNIONIDAE?

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Invasive *Corbicula* clams are considered a threat to European bivalves. To assess their impact on two Unionidae species, *Anodonta anatina* (Aa) and *Unio tumidus* (Ut), we conducted a field experiment in the Włocławek Reservoir on the Vistula River. Four experimental variants were used: two control treatments (8 and 4 Unionidae individuals, representing high and low biomass) and two test treatments, where 4/8 or 1/4 Unionidae individuals were replaced by an equivalent mass of *Corbicula* (150 or 38 individuals, respectively). Aa exhibited better growth in the presence of *Corbicula* compared to conspecifics of equivalent mass. In the presence of *Corbicula,*

smaller Aa individuals showed lower physical condition, while larger ones exhibited higher condition relative to controls. Growth and condition of Ut were unaffected by the exposure conditions. Biochemical parameters indicated better physiological condition of Unionidae in the presence of *Corbicula* compared to conspecific controls. Aa showed reduced lipid membrane damage (TBARS) and oxidant levels (TOS), as well as enhanced antioxidant defence (TAS) in the digestive gland. Conversely, presence of *Corbicula* increased TBARS in Aa foot tissues, potentially indicating local stress associated with increased locomotion or substrate burrowing activity. Ut individuals exhibited lower TBARS levels in the presence of *Corbicula* compared to controls (conditional on simultaneous high TOS or TAS levels), decreased TAS, and elevated glycogen content. These findings suggest that *Corbicula* presence may help reduce oxidative stress in Unionidae, although the underlying mechanisms might vary between species. Mortality among Unionidae was low and showed no differences across experimental variants, indicating no severe environmental stress from *Corbicula* presence. Conversely, *Corbicula* survival was notably lower in the presence of Ut compared to Aa, suggesting potential limiting factors such as trophic competition. In conclusion, *Corbicula* presence did not unequivocally negatively impact Unionidae. These results highlight the possibility of local coexistence and underscore the need for further studies under diverse environmental conditions.

RECORD OF CLIMATIC AND ENVIRONMENTAL CHANGES IN THE LATE PLEISTOCENE AND HOLOCENE IN THE MOLLUSC ASSEMBLAGE OF THE SHELTER IN SMOLEŃ III (KRAKÓW-CZĘSTOCHOWA UPLAND)

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The Shelter in Smoleń III is located in the Wodąca Valley, in the central part of the Kraków-Częstochowa Upland, circa 4 km SE of Pilica and 75 km SE of Częstochowa. The almost 2-m thick cave infilling is composed of 15 layers of Late Pleistocene and Holocene sediments. Most of them comprise well-preserved mollusc shells. The multi-layered sequence of Holocene sediments lying in sedimentary continuity is unique within the area under study. The mollusc assemblage in the Shelter in Smoleń III contains 63 species of land snails represented by 10,121 specimens. They represent 4 ecological types including: F – shade-loving taxa (31 species); O – open-country taxa (7 species); M – mesophilous taxa (14 species); H – hygrophilous taxa (1 species). The number of taxa per sample varies from 2 to 43, whereas the number of specimens per sample is between 2 and 1499. The studied sequence is bipartite, which is highlighted by the diversity of the mollusc assemblage. The lower part of the sequences represents the end of the Pleistocene and contain less diverse and scarce mollusc assemblage. It is characterised by the species typical of a cool continental climate and a mosaic of open and forested habitats with patches of coniferous forests (*Vallonia tenuilabris*, *Semilimax kotulae* and *Discus ruderatus*). In the Holocene, a gradual amelioration of the climatic conditions was observed, as well as the expansion of shade-loving taxa and the development of forests. The open-country species, which were numerous in the lower part of the profile, become an accessory element. During the climatic optimum of the Holocene, the mixed and deciduous forests predominated in the vicinity of the cave, which was documented by the rich mollusc assemblage with *Discus rotundatus* and *Aegopinella pura*. For the past 5000 years, the malacofauna of the Shelter in Smoleń III has been dominated by shade-loving and mesophilous species. The latter are gaining importance in the highest part of the profile (assemblage with *Laciniaria plicata*). The increasing number of snails with a wide ecological tolerance at the expense of shade-loving taxa may indicate gradual deforestation and exposure of rock faces around the cave, which is noted in other Subboreal and Subatlantic sequences from caves and rock shelters of Central Europe.

ATTEMPT TO ANALYSE UNIONIDAE MORTALITY AS A RESULT OF MAINTAINING WORKS ON THE SĄSIECZNICA RIVER

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The Sąsiecznica river is the left tributary of the Barycz river measuring 43.7 km. Its springs are located near the area of Białe Błoto, whereas the mouth is located close to Żmigród. Its main tributaries are: Lipniak, Jesionka, Brzeźnica, Olszak, Kanał Przetocki, Czarna Woda, Głęboki Rów, Struga, Kanał Trzebnicki and Kątna. In the system of surface water bodies, it is classified as a sandy-clay lowland stream. In November 2024, the section from Przeworów to

Żmigród was subject to maintenance works, which consisted of elimination of silt and reed vegetation, mainly common reed. The output was deposited along the bank and spread out in a 10 m wide strip. In March 2025, shells of Unionidae were searched for there. They were continuously found on the section from the Zielony Dąb pond complex to Żmigród. A 0.6 km section from the mouth of Struga (left tributary) to the mouth of Brzeźnica (right tributary) was searched for greater detail. Shells of the following species were found: *Unio tumidus* (the most numerous), *Unio pictorum*, *Anodonta anatina* and *Anodonta cygnea* (the latter two species occurred sporadically). In the described section of the river, material was also collected from the stream bed, which at this point is 6 m wide and 0.5 m deep. Every 60 m, 10 stations were designated and also from transects of 1 m wide and 6 m long, mussels were manually collected from the bottom. On the other hand, from thicker sediment layers, bivalves were racked. The occurrence of *U. tumidus* and *U. pictorum* was confirmed. Then, the material was analysed and compared. Based on the analysis it can be deducted that the maintenance work affected the number of Unionidae populations. However, Unionidae have not been eliminated completely, allowing partial survival and perhaps a chance to rebuild in the long term.

MARINE SHIPPING AS A VECTOR OF AQUATIC BIOLOGICAL INVASIONS

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Global maritime transport constitutes one of the principal vectors for the introduction of non-native aquatic species, including molluscs and the parasites and pathogens they may carry. The opening of shipping canals (e.g., the Suez Canal) and the intensification of international trade have resulted in the large-scale translocation of aquatic organisms far beyond their native ranges. Waterborne expansion has occurred, and continues via two main pathways: ballast water tanks and ship hull surfaces. The former can be exploited by a wide range of mobile organisms, whereas the latter primarily facilitates the spread of species with sessile life stages. Among the non-native, and frequently invasive organisms that have proliferated through these mechanisms are molluscs such as *Dreissena polymorpha*, *Corbicula fluminea*, *Limnoperna fortunei*, *Potamopyrgus antipodarum* and *Mieniplotia scabra*. Some of these species inflict considerable economic losses – in Europe amounting to tens of millions of euros per year – for example, through the 'overgrowing' of water infrastructure, damage to power plant cooling systems and adverse impacts on aquatic ecosystems. An additional and often underestimated aspect of non-native mollusc introductions is their role in the transmission of both endemic and introduced parasitic species. Notable examples include *Bonamia ostreae*, *Perkinsus marinus* and *Mytilicola orientalis*, which are responsible for mass oyster deaths and collapses of aquacultures in New Zealand, the USA and Europe. The protozoan *Perkinsus marinus*, initially identified in the Gulf of Mexico in the 1940s, is now distributed along the entire eastern seashore of the United States. *Bonamia ostreae*, in turn, was introduced from North America to Europe in the 1960s and 1970s via the unregulated trade of oysters. *Mytilicola orientalis*, a copepod of Asian origin, is now increasingly reported in European waters. Given the anticipated growth of global trade and ongoing impacts of climate change, the implementation of international regulations, the establishment of effective ballast water and hull monitoring protocols, and the promotion of ecological awareness may prove critical in mitigating the risk of further biological invasions.

EXPANSION OF *RANGIA CUNEATA* (G. B. SOWERBY I, 1831), A NEW NON-INDIGENOUS BIVALVE, IN THE SOUTHERN BALTIC SEA (POMERANIAN BAY AND THE RIVER ODRA MOUTH AREA)

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Rangia cuneata is a species native to sub-tropical estuaries of the American Atlantic coast. The bivalve was first recorded in Europe (in Belgium) in 2005, and then rapidly expanded its range in numerous water bodies in western Europe. In Polish marine areas, it has been present since the end of 2010, when it was recorded in the Vistula River delta (Wisła Śmiała and Martwa Wisła), as well as in the Vistula Lagoon.

As part of the regularly conducted monitoring of macrobenthos in the Odra Estuary area since 2010 for the purpose of assessing the impact of investments (construction of the LNG port in Świnoujście and dredging of the Szczecin-Świnoujście waterway), in November 2017, the first individuals of *R. cuneata* were found in the coastal zone of the Pomeranian Bay. Subsequently, *R. cuneata* individuals were collected from the Świna Strait (in August 2018) and from the Szczecin Lagoon (in 2021). In 2024, this species expanded further towards the south of the Odra riv-

er mouth area (Roztoka Odrzańska). Currently, the species is a permanent component of the Odra estuary macrobenthos, occurring there at considerable abundances (more than 3.5 thou. individuals/m^2) and biomass (more than 10.6 thou. g/m^2). *R. cuneata* is a typical brackish species inhabiting river mouth areas; it features a number of traits that predispose it to extend its range to new marine and brackish water areas. In this light, in 2022, the species' distribution, biometric structure and health status were examined in detail on individuals acquired from the Świna Strait and the Szczecin Lagoon. The material was collected from 90 stations covering a range of environmental conditions (physico-chemical parameters of water and bottom sediments). The individuals examined represented several age groups, from juveniles (less than 1 year) to those aged 6 years. Higher abundances and biomass as well as larger sizes and a better condition were typical for individuals collected in the northern part of the study area (Świna Strait and the Szczecin Lagoon), compared to those sampled in the southern part. Owing to the colonisation potential of the bivalve, the research should be continued, since the presence of non-indigenous species may have various consequences for the ecosystems they enter.

IMPACT OF INVASIVE SIGNAL CRAYFISH *PACIFASTACUS LENIUSCULUS* (DANA, 1852) ON NATIVE AND INVASIVE UNIONIDAE BIVALVES

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The number of Unionidae mussels is declining worldwide, and the cause of this is environmental pollution, climate change, the destruction and modification of aquatic ecosystems by humans and the spread of invasive species. One of them is the invasive crayfish *Pacifastacus leniusculus*, which occurs naturally in North America. It was brought to Europe to replace the dying European crayfish, but due to its carriage of crayfish plague, wide tolerance of environmental conditions and voracity, it contributed to the further extinction of native species. This species negatively affects all benthic organisms, including Unionidae mussels, on which it can feed. Therefore, the aim of our study was to determine how the direct and indirect presence of crayfish affects the behaviour of native mussels *Anodonta anatina* and *Unio tumidus* and the invasive *Sinanodonta woodiana*. During the experiments, the crayfish had direct access to the mussels (placed together in one arena) or was separated from them by a net (indirect contact). We analysed changes in the behaviour of the mussels (locomotion and burrowing in the substrate) in the presence of the crayfish predator, and the behaviour of the crayfish – the frequency and duration of attacks. Direct contact contributed to the delay of the mussels' activity – they remained inactive on the substrate surface longer. The presence of crayfish also reduced the degree of burrowing of *U. tumidus*, and in indirect contact shortened its burrowing time. We did not demonstrate any adaptations of *S. woodiana* to defend against crayfish. On the contrary, this mussel was attacked most often and for the longest time. Our research fills the gap in knowledge about the defence mechanisms of mussels in contact with predatory crayfish, and also shows the impact of spreading crayfish on mussels, whose numbers are decreasing worldwide.

GENETIC VARIABILITY OF *FAUSTINA CINGULELLA* (ROSSMÄSSLER, 1837) – AN EVOLUTIONARY PUZZLE OF THE TATRA SNAIL

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Endemic species adapted to specialised habitats often exhibit substantial genetic diversity due to geographic isolation and limited gene flow. *Faustina cingulella*, a rare and protected land snail, is found on limestone rocks in the Tatra Mountains. To assess its genetic diversity and population structure, a preliminary genetic analysis was carried out using mitochondrial (COI and 16S rRNA) as well as nuclear markers. Specimens were collected from sites that differed significantly in elevation and environmental conditions – ranging from shaded rocks in valley bottoms to sun-exposed and warm locations near mountain summits. Surprisingly, the results revealed no significant genetic differences between individuals from different sites, indicating extreme genetic homogeneity. This finding raises intriguing questions about the evolutionary history and dispersal mechanisms of this species. Is *F. cingulella* a relic of an ancient population that went through a severe demographic bottleneck? Or is it a relatively recent-

ly differentiated species that has not yet undergone genetic divergence? Alternatively, could passive dispersal mechanisms be maintaining genetic connectivity between populations despite the fragmentation of its limestone habitat? Our findings highlight the need for further phylogenetic and genomic research to clarify the evolutionary history of the *Faustina* genus and to assess potential risks associated with low genetic variability. This study represents a first step toward understanding the genetic dynamics of limestone-adapted snails and their importance for conservation biology.

PARASITIC IMPLICATIONS OF THE ALIEN MOLLUSC INVASION

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Molluscs play a key role in the transmission of trematodes. Inside snails, the first intermediate hosts, tens of thousands of cercariae, larvae that actively infect vertebrates and invertebrates, are produced. Additionally, snails and bivalves serve as second intermediate hosts, accumulating metacercariae transported through the food chain to the final hosts – vertebrate animals and humans. Relatively rare, molluscs may also play the role of final hosts of trematodes. The key role of molluscs in the life cycle of Digenea results from the high specificity between the parasite and the first intermediate host species. This fact means that the spread of host molluscs determines the extent of parasite species. Interest in the interaction between alien molluscs and parasites in the invaded areas from a short-term perspective does not produce fruitful results. However, the detailed search for traces of new associations allows a better understanding of the long-term effects on the ecosystem. We have been studying natural and experimental invasion of trematodes to molluscan species alien in Europe: *Potamopyrgus antipodarum, Sinanodonta woodiana, Dreissena polymorpha, Dreissena bugensis* and *Corbicula fluminea*. We checked whether individuals of these species collected in Europe (outside the limits of their natural range) may be infected with some trematodes. We studied both natural and experimental invasion. All tested species were invaded by Aspidogastrea or Digenea forms. Infected molluscs were first or second intermediate hosts and, in some cases, were infected with pre-adult forms of parasites. Some experiments with parasite invasion have succeeded. Only the use of echinocercariae has resulted in an effective invasion. The results show a potential and real possibility of building associations between alien species of molluscs and native parasite fauna. Knowing new associations' long-term effects requires including the parasitic thread in environmental monitoring studies.

DOES LIGHT REACHING THE BOTTOM OF WATER RESERVOIR AFFECT THE STRUCTURE OF MALACOFAUNA?

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The aim of the study was to assess the effect of light on the bottom of a water reservoir on the structure of malacofauna and selected physicochemical parameters of water and bottom sediments. The study was carried out in a shallow, flooded part of the Włocławek Reservoir near the town of Dobiegniewo. Samples were taken at monthly intervals, from April to October. Two research sites were designated. One of them was located slightly shallower (depth of approx. 1.5 m), at a distance of about 80 m from the shore of the reservoir, the light reached the bottom, while the other was deeper (approx. 2.7 m), at a distance of about 150 m from the shore, the light did not reach the bottom. The number of taxa, diversity (assessed on the basis of the Shannon index) and the density of Mollusca were higher at the shallower site, where light reached the bottom. The sites also differed in terms of dominance structure assessed based on density. However, the abiotic parameters of the bottom water (temperature, oxygenation, pH, conductivity) measured 2–3 cm above the bottom, as well as the parameters of the bottom sediments (hydration, organic matter content, oxygen absorption) were very similar at both sites. Possible explanations for the differences found in the structure of the malacofauna will be presented.