

THE 36TH POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

The 36th Polish Malacological Seminar (12–14 May 2022) was organised in the old city of Toruń, by The Association of Polish Malacologists and the great malacological team of Nicolaus Copernicus University: ELŻBIETA ŻBIKOWSKA, JAREK KOBAK, ANNA NOWAKOWSKA, and ANNA CICHY, supported by a group of enthusiastic doctoral students. The attendance was good: 42 people arrived for the seminar and presented more than 30 scientific contributions (Fig. 1). Among speakers we heartily welcomed OLENA UVAYEVA, malacologist from Żytomierz, Ukraine, who

found a shelter and a job at the Nicolaus Copernicus University since the beginning of the war in Ukraine.

The scientific program was divided into six oral sessions and a poster session. Roughly counting, the gastropod studies predominated over bivalve ones (ratio 2 : 1), and freshwater taxa over terrestrial snails and slugs (3 : 2). Surprisingly, the authors of posters clearly preferred land snails over any other molluscs (2 : 1).

The contributions represented all disciplines identified in the previous reports, from *Fossil molluscs*



Fig. 1. Participants of the 36th Polish Malacological Seminar (photo: JAROSŁAW MAĆKIEWICZ)



Fig. 2. On the streets of Toruń (photo: ANNA DROZD)

to *Physiology. Ecology & Conservation, Applied malacology & parasitology*, and *Miscellaneous: behaviour, archaeology, education* were each represented by five contributions. More details about all studies can be found below this report, however I would like to mention here “hot” research topics which possibly appeared for the first time in our seminars: 1. modelling climate-change related shifts of distribution ranges of land snails by MAŁGORZATA PROČKÓW, and 2. the importance of microbiome for snail winter survival by PAULINA IDCZAK. We were also very lucky to listen to a talk of ANDRZEJ LESICKI on the new species of tropical slug, family Rathouisiidae (its name must be kept in secret before the proper publication¹). During Friday sessions we had to solve two possibly criminal mysteries (according to the book of abstracts). The first, “Stefania’s death – the accident or murder” by WITEK ALEXANDROWICZ hopefully seems to be solved already. For the second puzzle “what happened to the young malacologist interested in Hydrobiidae, ALEKSANDRA RYSIEWSKA” the outcome

¹ The name *Barkeriella museensis* can now be revealed, see paper “A small slug from a tropical greenhouse reveals a new rathouisiid lineage with triaulic tritrematic genitalia (Gastropoda: Systellommatophora)” published in *Zoological Journal of the Linnean Society* DOI 10.1093/zoolinnean/zlac054 (online 07-25-2022) by GIUSTI, LESICKI, BENOCCI, BARBATO, MISEROCCHI, PIEŃKOWSKA & MANGANELLI (editor’s note).

was even better. We were informed that she had been recently married and changed name to JASZCZYŃSKA.

During the General Assembly, the new Council of Association was elected with MARCIN SZYMANEK (University of Warsaw) as a President, and four people, all devoted to rearing land snails (MAŁGORZATA PROČKÓW, ELŻBIETA KUŹNIK-KOWALSKA, TOMASZ K. MALTZ, and the author of this report) as a supporting team.

Both scientific sessions and the meals were delivered in a historic building, owned by an uncle of



Fig. 3. Participants of the seminar were in an excellent good mood (photo: ANNA DROZD)



Nicolaus Copernicus a long time ago. This venue, situated around 150 m from the Main Square of Toruń, was an easy start for morning and evening walks in the city centre (Fig. 2) in search for the most delicious ginger-bread cakes, which are the famous local delicacy. During the gala dinner, we thanked the organisers of the seminar, as well as the retiring management board of the Association of Polish Malacologists. Everyone was in a good mood (Fig. 3).

Due to the Covid-19 pandemic we missed our annual meetings in 2020 and 2021, thus the Toruń seminar was for most of us the first opportunity to present our latest research in front of the real audience and have vivid discussion, which is a much better experience than giving a speech via Teams/Zoom. Hopefully, the next seminar, which has to be

organised by hydrobiological team from Katowice (University of Silesia), will not have any delays.

Not all who planned to attend the seminar could appear in Toruń. This refers to BEATA POKRYSZKO who sent the abstract about intentional and accidental abuse in taxonomy and nomenclature (published in the book of abstract and translated below). It was her last malacological contribution. BEATA POKRYSZKO passed away in Wrocław on 5 June 2022. We shall miss her much.

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ABSTRACTS OF THE 36TH POLISH MALACOLOGICAL SEMINAR

STEPHANY'S DEATH: AN ACCIDENT OR INTENTIONAL ACT?

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During the construction of expressway S-3 near Gorzów Wielkopolski, a profile of Quaternary deposits has been exposed. Their till is composed of fluvioglacial deposits dating back from Saalian glaciation. They are overlaid by lake deposits: calcareous gyttja, sands, and peats, which represent the Eemian (the last interglacial). The uppermost deposits are fluvioglacial sands of the Vistulian (Weichselian) glaciation. The whole sequence is about 22 m thick, including about 10 m of lake deposits. The gyttja contains a nearly complete skeleton of forest rhinoceros *Stephanorhinus kirchbergensis* and one bone of fallow deer *Dama dama*. Our malacological analysis was based on about 50 samples representing the whole profile. Shells of molluscs (bivalves and gastropods) were present in 29 samples. In the upper part of the profile, the fauna was very poor, represented by only 2 species of aquatic snails: *Bithynia tentaculata* and *Valvata piscinalis*. In the lower part, especially in the region where rhinoceros bones were found, the mollusc community was rich. It consisted of nearly exclusively aquatic taxa. Both species mentioned above were represented by very numerous individuals and dominated the community. They were accompanied by other aquatic species characteristic of shallow water bodies: *Valvata cristata*, *Gyraulus crista*, *Anisus contortus*. Bivalves were represented mainly by eurytopic forms, especially *Pisidium casertanum*. Terrestrial species were infrequent. The composition of the mollusc community near rhinoceros bones indicates that a shallow, permanent water body was located there. In that place, its littoral zone was devoid of reedbeds, as indicated by the large numbers of opercula of *B. tentaculata*. The species composition of the community also reflects climatic, especially thermal conditions. The lack of shells of aquatic taxa typical of cold waters suggests that the sediments were interglacial. However, we did not find any shells of *Belgrandia marginata*, typical of the optimum part of the Eemian. It

can be concluded that the analysed palaeolake was filled before or after the climatic optimum.

GASTROPOD MIGRATIONS: ABIOTIC FACTORS AFFECTING VERTICAL MIGRATION OF *VERTIGO MOULINSIANA* (DUPUY, 1849) (GASTROPODA: VERTIGINIDAE)

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Vertigo moulinsiana is a vulnerable terrestrial snail species, inhabiting infrequent European and North American wetlands that were not modified by human activity. This poorly-studied species migrates vertically on leaves of wetland plants. Its migration patterns were reported to vary between seasons but it was unclear which factors affect them. To identify the factors affecting the vertical migration of *V. moulinsiana*, the influence of light or darkness, humidity, and temperature was investigated in 2 age groups: adult and juvenile snails. During 3 experiments, in total 180 individuals were placed individually in lower parts of transparent tubes (150 cm long) and subjected to the tested abiotic factors for 24 h. After exposure to various light, humidity or temperature conditions, the distance between the starting point and the final location after 24 h was measured. Both adult and juvenile snails kept in light for 24 h climbed much higher than gastropods kept in darkness. The compared levels of humidity and temperature did not affect the height of the final location of adult and juvenile individuals. The distance of migration in the same conditions did not differ between age groups. Thus, in contrast to temperature and humidity, continuous light results in *Vertigo moulinsiana* individuals climbing higher distances. Further research will verify if photoperiod can be a major factor that determines vertical migration of this species.

EFFECTS OF TEMPERATURE ON SURVIVAL RATE AND INVASIVENESS OF CERCARIAE OF *ECHINOPARYPHIUM ACONIATUM* DIETZ, 1909 (PLATYHELMINTHES: ECHINOSTOMATIDAE)

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The crucial factors determining parasite transmission to hosts are: (1) survival rate of motile stages in the environment; and (2) invasiveness, defined as the ability of parasites to settle in a host and produce successive developmental stages. The trematode *Echinoparyphium aconiatum* is a parasite with a complicated life cycle. Its first intermediate host is the great pond snail *Lymnaea stagnalis* (source of cercariae), while second intermediate hosts for metacercariae are other mollusc species, but also amphibians and fish. Waterfowl are definitive hosts for sexually mature trematodes. This study aimed to investigate the influence of temperature on survival rate of cercariae of *E. aconiatum* and to assess its invasiveness in relation to a native host (*Radix* sp.) and an alien one (*Potamopyrgus antipodarum*). In both experiments, 4 thermal variants were compared: 4 °C, 10 °C, 20 °C, and 30 °C. The results showed that survival rate and invasiveness of cercariae of *E. aconiatum* depended on temperature: survival rate decreased, while invasiveness increased with growing temperature. There were no significant differences in the ability of cercariae to settle in a native or alien host and transform into metacercariae. The presented results suggest that successful transmission of parasites with complicated life cycles is highly dependent on thermal conditions. Besides, an increase in diversity of trematode hosts, as a result of biological invasions, can cause a dilution effect, protecting the native malacofauna against invasions of parasites.

The research was funded by the National Science Centre (grant no. 2018/02/X/NZ8/02716 and partly 2017/25/N/NZ8/01345).

DIVERSITY OF FRESHWATER GASTROPODS IN ANTHROPOGENIC WATER-BODIES VARYING IN POLLUTION LEVEL

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Anthropogenic water bodies created in industrial areas with varying degrees of human impact differ also in pollution levels. Their shoreline is modified because of waste disposal, e.g. mining waste from gangue, pollution linked with industrial development and littering or discharge of wastewater from farmlands, industrial areas, and communal dumping sites, in the form of landfill leachates. This leads to changes in the profile of the shore zone and can be a reason of destruction of habitats of aquatic animals due to devastation of waterside vegetation as well as changes in physicochemical properties of the water bodies. In addition to progressing climate change, anthropogenic water pollution is one of the causes of degradation of aquatic ecosystems in the global context.

Malacological research was conducted in human-made water bodies varying in pollution level and salinity, located in Upper Silesia, where coal is mined. Samples were collected using quantitative hydrobiological methods. Field measurements included water temperature, pH, electrolytic conductivity, and total soluble solids, while the other analyses were performed in the laboratory. The anthropogenic water bodies were characterised by e.g. different values of water conductivity, chloride concentrations, and water pH. The study detected the presence of 16 gastropod species, including 3 alien ones. The analysis of the collected material showed that the most numerous were eurytopic species, with a wide range of ecological tolerance, e.g. the alien *Physa acuta*, *Potamopyrgus antipodarum*, and some native ones: *Radix balthica* and *Bathyomphalus contortus*. Our results show the influence of anthropogenic water pollution and their salinity on gastropod community structure. Human-made water bodies form various and unoccupied niches, which allow alien gastropods to settle there. Our findings indicate that gradually the number of water bodies colonised by alien and invasive species increases, depending on the level of their pollution and urbanisation of their vicinity.



OPTIMUM OFFSPRING NUMBER IN UNIONID BIVALVES: DO LARGER FEMALES INVEST MORE IN THEIR OFFSPRING?

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Bivalves of the family Unionidae are large and long-lived freshwater animals with a complicated life cycle. Adult females produce from several thousand to several million parasitic larvae (glochidia), which have to attach to tissues of a suitable fish species (host) to transform into a juvenile mussel. Glochidia develop within marsupium of the female, so their number is limited by the size of marsupium, which – in turn – is limited by female body size. However, larger mussels can have greater energy reserves, which can be invested into a larger size of glochidia, a larger number of glochidia or simultaneously a larger number of larger glochidia. Besides, the high level of specialisation observed in many mussel species can limit the size and shape of glochidia around a narrow optimum, while less specialised species, which use a broad range of fish host species, can show a greater plasticity of glochidium size. This study aimed to assess the association between female body size and both size and shape of the offspring. We analysed interspecific and intraspecific variation in glochidium body size and shape in relation to female body size in 4 bivalve species that are common in Poland: *Anodonta anatina*, *Anodonta cygnea*, *Unio crassus*, and *Unio tumidus*. Glochidium body size significantly differed between the studied species within the genus *Anodonta* but not within the genus *Unio*, where the differences were small and not significant statistically. In contrast, differences in glochidium body shape between the analysed species were significant both within the genus *Unio* and within the genus *Anodonta*. Moreover, intraspecific variation in glochidium body size was small and not significant statistically in all the analysed species, and glochidium size did not depend on the mother's body size.

ALTERNATIVE REPRODUCTIVE STRATEGIES (OVIPARITY/VIVIPARITY) IN A SPECIES-RICH GROUP OF LAND SNAILS: A PROJECT SUMMARY

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In 2017–2021, a research project funded by the National Science Centre (Opus grant 2016/21/B/NZ8/03086) investigated many aspects of reproductive strategies of door snails (Clausiliidae, subfamily Phaesusinae), which inhabit eastern and southeastern Asia and the Pontic-Caspian region. Observations of laboratory reared specimens and analysis of preserved materials show that in the analysed group oviparity prevails, while 20–30% of taxa are viviparous. A small number of species use an intermediate strategy, i.e. temporary embryo retention. The evolution of the above reproductive strategies was reconstructed using mitochondrial markers (COI, 16S) and nuclear ones (28S, ITS1, ITS2, H3, H4). Thanks to dating of the phylogenesis with the use of molecular clock, the probable period of separation of groups Phaesusini + Serrulinini and later of the 8 main phylogenetic lineages within the Phaesusini was estimated. The reconstruction of ancestral reproductive strategies showed that the transition from oviparity to viviparity in the studied group took place independently and repeatedly. In one case, a return to the oviparous strategy was recorded. Using micro-computed tomography (μ CT) and 3D visualisation, the shape and shell structure in viviparous gastropods of the subfamily Phaesusinae were analysed, with particular reference to the structure of the clausilial apparatus, and many adaptations associated with the development of viviparity were described, which facilitate the movement of the hard embryo shell through the parental shell's canal and aperture. This study shows that shell structure is shaped by contradicting selection pressures: on the one hand, a tendency to produce as large offspring as possible, which requires broadening of the aperture, but on the other hand, protection of the parent through strong shell apertural barriers, which probably helps to prevent predators' attacks. Additionally, in 2 unrelated species an atypical, organo-mineral structure of embryo shells was described, as they remain flexible and compressible till birth. In this project, a broad spectrum of recent research methods was used, which allowed the remarkable progress in understanding the evolution of reproductive strategies in terrestrial gastropods.

DISTRIBUTION AND ABUNDANCE OF *HELIX POMATIA* L. (GASTROPODA: HELICIDAE) IN WIELKOPOLSKA PROVINCE

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In June–July 2020, the Regional Directorate of Environmental Protection in Poznań funded research on the distribution and abundance of *Helix pomatia* in Wielkopolska Province. Using orthophotomaps (Google Earth, geoportal.gov.pl), preliminary localisation of habitats preferred by this species was determined. On this basis, study sites were selected and verified during field research.

The location of each individual found in the field was recorded using GPS, and the coordinates noted in the ppx format were used for visualisation of the distribution of individuals and determination of population boundaries.

Biometric characteristics measured in the field (shell diameter and height, snail weight), age structure of the population (numbers of adult and juvenile individuals, and empty shells), as well as the percentage contribution of commercially valuable individuals (shells ≥ 30 mm) made it possible to assess the condition of local populations of the studied species.

All 226 communes located in Wielkopolska Province were investigated. Only in 6 of them (Chodzież, Drawsko, Zbąszyń, Słupca, Kramsk, Koło) the species was apparently absent. In total, 15,414 individuals were found, including 8,330 living ones at 351 sites. The mean weight of a mature specimen measured in 2020 was 20.54 g. In respect of age structure, about 50% of individuals were live adults, 4% were juveniles, and 46% were empty shells. Among adults, 23.6% were commercially valuable, whereas among juveniles, no specimens had shells ≥ 30 mm.

The findings indicate that *H. pomatia* in Wielkopolska Province is generally evenly distributed and its population size is stable.

VERTIGO MOULINSIANA AND *VERTIGO ANGSTIOR* (GASTROPODA: VERTIGINIDAE) IN THE KOZIENICE FOREST (CENTRAL POLAND)

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In 2020 and 2021, the distribution of *Vertigo moulinsiana* and *V. angustior* was investigated on a large scale in the Area of Habitat Protection ‘Puszcza Kozienicka’ (Kozienice Forest, code: PLH140035). Study sites were selected on the basis of satellite images and included primarily meadows (most of them dominated by sedges: both mown and unmown), temporarily flooded areas, and wetlands associated with alder carrs. Out of the 96 investigated sites, 33 were inhabited by *V. moulinsiana*, while 61, by *V. angustior*; at 14 of them, both species coexisted. Although the former species was recorded less often, its populations and habitats were markedly better preserved. As many as 26 of the 33 sites were scored the highest, as favourable (FV), according to the recommendations of methodological guides (published by the Chief Inspectorate of Environmental Protection, GIOŚ). In contrast, only 2 of the 61 localities of the latter species were scored as FV, whereas a majority (39) were scored as unfavourable (U1). The major threat for both species was ecological succession: colonisation by woody vegetation (which is not suitable for both species) or the spread of alder (which is particularly unfavourable for *V. angustior*). In the localities of *V. moulinsiana*, water level seemed to be suitable during field research, while in the localities of *V. angustior* we observed their drying or just the opposite: periodically excessive water level, which does not meet the requirements of this species. Another threat factor was often too intensive mowing, unsuitable for this species. In the case of other localities, mowing was abandoned, which permitted their gradual colonisation by species from neighbouring habitats. For both species, also climate change is a real threat, contributing to rapid variations in weather conditions (e.g. local floods) and relatively long periods of drought and high temperatures. In conclusion, Kozienice Forest is a valuable refugium for both protected snail species. Adoption of proper active protection measures corresponding to the above threat factors will probably help to restore their local populations and improve habitat quality.



IDENTIFICATION OF THE MICROBIOME IN *HELIX POMATIA* L. (GASTROPODA: HELICIDAE): POTENTIAL ROLE DURING WINTERING

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Snails originating from the temperate zone are seasonally subjected to extreme environmental conditions, with temperatures below the freezing point. Since water is necessary for all metabolic processes, animals have developed 2 adaptive mechanisms: freezing avoidance and freezing tolerance. Before hibernation, terrestrial gastropods defecate, lower the water content of their organisms and produce cryoprotectants, which prevent uncontrolled ice formation in their cells. However, the role of cryoprotectants in response to frost in *Helix pomatia* is still uncertain. We suppose that in spite of emptying of their guts in autumn, also during hibernation some bacteria remain there, particularly those capable of ice nucleation, as gut bacteria participate in both mechanisms linked with cold resistance. To verify if freezing tolerance in the wild population of *H. pomatia* is associated with their microbiome, we conducted a series of experiments on animals collected during their seasonal activity (every 2 months, starting from spring, immediately after the end of hibernation). Additional experimental groups were animals acclimated to autumn conditions in summer (8D:16N, 5 °C) and to summer conditions in autumn (16D:8N, 25 °C). The gut microbiome samples from their digestive system were incubated at 10 °C for 14 days on selection media containing colloidal chitin, cellulose, and MRS agar, and next the 16S rRNA gene and whole genome were sequenced. The analysis of 16S rRNA gene sequence permitted us to identify psychrophilic gut bacteria of this gastropod species, which differed markedly between seasons. Besides, in the winter experimental groups, the gut microbiome differed between the animals that formed a properly developed epiphragm and those that did not form it at all. The presented results indicate that the factors signaling the need for hibernation are both photoperiod and temperature. The experiments also enriched the collection of in vitro cultures.

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OVOVIVIPARITY OF THE VIVIPARIDAE (GASTROPODA) AS A PLASTIC CHARACTERISTIC OF THEIR LIFE HISTORY

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The great diversity of freshwater gastropod species results from the varied environmental conditions in which they live. To adapt to them, they have developed many physiological, morphological, and behavioural adaptations.

One of them is the type of sexual reproduction – ovoviviparity. It is observed in the family Viviparidae, representing the freshwater subclass Caenogastropoda. Earlier research on *Viviparus viviparus* and *V. contectus*, carried out in 1995–2008, in various freshwater habitats (dam reservoir, ecotones, ox-bow lakes more or less associated with the river) made it possible to distinguish some constant life history characteristics, independent of the environment, and variable ones, depending on environmental conditions and various limitations. Constant characteristics guaranteed the maintenance of a relatively stable population size and were subject only to seasonal variation. These included: a tendency to aggregate in the same places and at the same time, sex structure (dominance of females), size structure (presence of all size classes, but mostly the oldest ones), and a high share of females with embryos in the population. Gastropods adapted to environmental changes in respect of fertility (number of embryos per female) and size of reproducing females. In highly variable habitats, such as ox-bow lakes connected with the river, gastropods started reproduction at an early stage of development. Their reproductive effort did not depend on body size. Young viviparids invested in reproduction as much as adult individuals, and thus increased the chance to maintain a stable population in the environment.

The observed lowering of water level in most of Polish rivers, caused by a lack of snow cover in winter, low precipitation, and high temperature in summer, may significantly affect the adaptations of organisms. Gastropods of ox-bow lakes (located in river valleys) can be particularly sensitive to such changes.

A few years ago, observations of *Viviparus* populations in ox-bow lakes in the Bug valley confirmed a hypothesis that ovoviviparity, as a characteristic of the reproductive strategy of the Viviparidae, allows them to maintain a stable population size in habitats varying in area, depth or trophic state.

Observations made in 2014–2019 showed clearly that fertility depends on female size. It seems that

the gradual lowering of water level in the river Bug has greatly reduced the risk of periodical flooding, which stabilised the living conditions of *Viviparus* species. The gastropods, by controlling their reproduction, maintain a stable population size in various environmental conditions.

PHYLOGEOGRAPHY AND DISTINGUISHING
BETWEEN *BYTHINELLA* SPECIES
(CAENOGASTROPODA: TRUNCATELLOIDEA)
OF CENTRAL EUROPE AND THE BALKANS

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Bythinella Moquin-Tandon, 1855 is a genus of small-sized gastropods, including more than 250 nominal species, which inhabit springs in Europe and Asia Minor, from the Pyrenees to the Caucasus and from southern Poland to southern boundaries of Europe. The high variation of shells and only partly justified assumption of isolation of populations inhabiting individual springs are the causes of chaos in systematics of this genus. Taking into account the features describing the morphology and anatomy of soft parts did not resolve doubts and indicated the morphostatic character of *Bythinella* evolution. Phylogeographic and phylogenetic research conducted for several years also did not allow drawing unambiguous conclusions. We compared *Bythinella* species from Central Europe and western Balkans on the basis of sequencing of the cytochrome oxidase (COI) gene and 5 fragments of nuclear genes, as well as morphological and anatomical examination. The analyses allowed us to reconstruct the phylogenesis of this genus and to distinguish molecular operational taxonomic units (mOTU). The gastropods were collected from 84 sites that were not studied earlier. COI sequences were identified for 151 individuals and for 92 of them also 5 nuclear fragments were sequenced. In some analyses also GenBank sequences were used. For over 1,400 sequences of *Bythinella*, 359 haplotypes were distinguished. The 3 applied methods of species delimitation grouped the haplotypes into 85–110 mOTUs (depending on the method), which formed 19 distinct evolutionary lines. For the new sequences, the analysis of 5 nuclear markers confirmed the results based on the fragment of mitochondrial DNA. At many sites, we detected sympatric occurrence of 2–3 mOTUs, which proves that the hypothesis ‘different spring – different species’ was false. Individual groups were compared also in respect of morphology, considering shells (overlap-

ping ranges of variation, confirmed by principal component analysis, PCA), radulas (overlapping ranges of variation, unique lateral tooth in *B. robiciana*), renal and palial section of female reproductive organs (overlapping ranges of variation), and penes with tubular glands (high variation). The results confirm the high variation at the species level within this genus, also for the populations that were not studied earlier, and indicate the morphostatic character of *Bythinella* evolution.

MODULATION OF MOBILITY PARAMETERS
AND FOLDING OF THE FOOT EPITHELIUM
OF *ACHATINA FULICA* (GASTROPODA:
ACHATINIDAE) AFTER CISAPRIDE
APPLICATION

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Cisapride is an active ingredient of medicines stimulating gastrointestinal motility, a so-called prokinetic agent. It is used mostly to treat functional disturbances of the upper section of the gastrointestinal tract (oesophagus, stomach, duodenum).

Cisapride stimulates serotonin receptors 5 HT₄ and thus affects acetylcholine release from the nerve plexuses in smooth muscles of intestinal walls. Acetylcholine, affecting appropriate receptors of the smooth muscles, causes their contractions and accelerates peristalsis. It is assumed that cisapride can modulate gastropod mobility and the associated phenomena observed then on the animal’s foot, so these interactions were analysed in this study. The experiments were conducted on 16 giant African land snails *Achatina fulica* (weight 13–29 g, shell length 40–57 mm) reared in our Department. Video-based observations of the snail foot during adhesive, spontaneous, and rectilinear movement on a horizontal glass pane using a DFK 41AU02.AS camera (The Imaging Source, Germany) equipped with a zoom lens (CCTV 5-50 mm F/1, 8 Pentax), and IC Capture.AS 2.0 software for image recording. Parameters of gastropod movements and folding of the foot epithelium were analysed in controlled conditions and after injection of cisapride (10 and 0.1 µg/g of body weight) at the end of the dorsal part of the foot (30–60 min after injection). Statistical significance was assessed using the Wilcoxon test ($p < 0.05$). After treatment with the higher dose of cisapride (10 µg/g of body weight), gastropod movement was accelerated. Foot length and interwave length declined, while



foot width and wavelength remained the same. The number of pedal waves, ratio of wave surface to total foot surface, and wave frequency increased. The lower dose of cisapride (0.1 µg/g of body weight) did not accelerate gastropod movement. Only a decrease in foot length and interwave length was observed. The results show that cisapride increases the snail's pace at the higher dose (10 µg/g of body weight) and modulates phenomena taking place in the foot.

CAN ATYPICAL BEHAVIOUR OF *MONACHOIDES VICINUS* (GASTROPODA: HYGROMIIDAE) BE ASSOCIATED WITH THE PRESENCE OF PARASITES?

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The Carpathian snail *Monachoides vicinus* (Rossmässler, 1842) is distributed mostly in montane and submontane parts of Ukraine, Poland, Slovakia, Czechia, and in isolated localities in Hungary and Germany. It lives in moist broadleaved forests and thickets along streams up to 1,900 m above sea level.

During research on the biology and ecology of *M. vicinus* in the buffer zone of nature reserve 'Muszkowicki Las Bukowy', we observed atypical behaviour of some individuals: twists of the visceral sac in various directions and its shaking, lasting a few minutes. It may be associated with infection by digenean flatworms (Platyhelminthes: Trematoda: Digenea) – a group of parasites whose life cycle always includes gastropods as intermediate hosts. Additionally, they are known to cause relatively often some morphological or behavioural changes in their hosts, so that the infected organism is easily noticeable by a potential predator, which is most frequently also the definitive host of these trematodes. As a result of observations of gastropods in the field, seasonal parasitological research was initiated. In June–October 2021, in total 142 individuals of *M. vicinus* were examined, including 10 showing distinct behaviour. The gastropods were subjected to standard parasitological section, which allowed us to detect trematodes in 22 individuals (prevalence = 15.5%), but among the atypically behaving individuals, prevalence reached only 10%, compared to 16% in normally behaving gastropods. The collected metacercariae (1–24 in one snail) were subjected to molecular species identification using 2

markers: 28S rDNA and COI mtDNA. Preliminary analyses detected the presence of trematodes of the families Brachylaimidae Joyeux & Foley, 1930 and Panopistidae Yamaguti, 1958.

Unfortunately, the studies conducted so far do not allow unambiguous linking of the atypical gastropod behaviour with the presence of parasites. For this reason, we will be grateful for discussions and any suggestions that could help us formulate new research hypotheses.

THE DIGenea (PLATYHELMINTHES) IN FIRST VS. SECOND INTERMEDIATE HOSTS

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Lake Małe Czyste is a small but deep water body (area 36.3 ha, depth 4 m) located in the Chełmno Lakeland (Pojezierze Chełmińskie). The lake is characterised by exceptionally rich flora and fauna, with abundant waterfowl and various invertebrates, including gastropods and leeches. Since these groups of organisms are part of digenean life cycles, Lake Małe Czyste was chosen as a favourable area for research on the transmission of larvae of these parasites in an aquatic ecosystem. The level of infestation of leeches by metacercariae was assessed to estimate the efficiency of transfer between first and second intermediate hosts. In total, 63 gastropods were examined (15 *Lymnaea stagnalis*, 6 *Bathynomphalus contortus*, 12 *Radix* sp., 6 *Bithynia tentaculata*, 6 *Anisus vortex*, 2 *Physa* sp., 16 *Stagnicola palustris*) as well as 179 leeches (161 Erpobdellidae, 18 Glossiphoniidae). In 43.7% of the analysed leeches, trematodes were found and they represented only the family Strigeidae. Their metacercariae were present in 40.7% of individuals of the Erpobdellidae and in 73.7% of the Glossiphoniidae. The proportion of infected molluscs was much lower, as it reached 17.46%, and none of them were infested by the Strigeidae. Preliminary research shows that leeches of both families are very important as hosts for transmission of the Strigeidae. On the one hand, as hosts of metacercariae, they are less burdened than gastropods are (which results from the nature of the host-metacercaria relation). On the other hand, leeches can accumulate numerous invasive stages for definitive hosts. The lack of any gastropods infested by larvae of the Strigeidae may indicate a strong exploitation of first intermediate hosts by the parasites.

ROLE OF MOLLUSCS IN THE TRANSMISSION OF ECHINOSTOMIASIS

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Echinostomiasis is an endemic disease of humans and animals (24 species in humans and about 60 in animals), in Asian countries, but it can be also transferred to other regions by migratory birds, international transport of animal and plant products or changes in eating habits. The aim of this study was to assess the role of freshwater molluscs from selected water bodies in the Polish lowlands in the transmission of echinostomiasis to monitor the species diversity (on the basis of morphological characters) and prevalence of members of the Echinostomatidae in host molluscs, as compared with trematodes representing other families of the Digenea. Parasitological analyses of molluscs from 8 water bodies (in Brodnica, Dobrzyń, Drawsko, Hawa, and Szczecinek Lakelands) were conducted in July and October 2020. Out of the 493 examined gastropods, 86 were infested by trematodes representing 5 families: Echinostomatidae, Diplostomidae, Plagiorchiidae, Brachylamidae, and Notocotylidae. A high proportion (64%) of the examined mollusc species were infested by trematodes of the family Echinostomatidae, namely cercariae of various species, and cases of pre-patent invasion were observed. The rate of infestation was the highest in *Radix* sp. (42.86%), *Viviparus contectus* (28.57%), *Planorbarius corneus* (28.0%), and *Lymnaea stagnalis* (20.1%). In *Anodonta anatina*, *Dreissena polymorpha*, *Potamopyrgus antipodarum*, and *Unio pictorum*, no cases of infestation by trematodes of this family were detected. Results of this study show that the Lymnaeidae, Planorbidae, and Viviparidae play an important role as first intermediate hosts in the life cycle of the Echinostomatidae. The presented results indicate that it is necessary to monitor the presence of trematodes of the family Echinostomatidae, as they pose a real threat to both human and animal health.

ABOUT DIMENSIONS OF THE SWAN MUSSEL *ANODONTA CYGNEA* (L.) (BIVALVIA: UNIONIDAE)

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The swan mussel (*Anodonta cygnea*) is the largest freshwater invertebrate in Poland. The longest specimen (26 cm) was found before World War II in a pond in Siemiatycze and described by FELIKSIĄK in 1930. This species is partly protected and classified as endangered in the Polish Red Data Book of Animals. It is commonly believed that in the last few decades the population of *A. cygnea* was gradually declining but very little is known about dimensions of individuals. During our malacological studies of various aquatic habitats (1972–2020), we measured live specimens of *A. cygnea* and their empty shells. We collected them in 40 lakes of the Masurian, Suwałki, and Łęczna-Włodawa Lakelands, in 4 rivers, 17 ox-bow lakes, 2 ponds, 2 dam reservoirs, and in the Vistula Lagoon. In the first group of habitats, the longest specimens of live *A. cygnea*, exceeding 100 mm, were recorded in 15 lakes, i.e. in 37.5% of the studied lakes where the species was present. The largest specimens collected in the lakelands were: 145 mm long in the large but shallow and silty Lake Oświn (Masurian Lakeland), 127 mm long in Lake Wigry, and 125 mm long in Lake Okrągłe (Suwałki Lakeland). Considering ox-bow lakes, the largest length of *A. cygnea* also reached 145 mm, but the second and third highest values for individual water bodies were higher than in the other types of lakes (136 and 135 mm). The longest live specimens of *A. cygnea*, exceeding 100 mm, were recorded in 11 ox-bow lakes (65% of the studied ox-bow lakes). In rivers, the largest individuals were 97–112 mm long. During the 48 years of our research, the largest live individual of this species (160 mm long) was collected in a pond near Kałuszyn, where we also found the largest empty shell of this species (175 mm long). Ponds and ox-bow lakes, i.e. small, shallow, and silty water bodies, appear to be the most favourable habitats for *A. cygnea*. In some of them, the species is the only member of the family Unionidae.



EFFECTS OF INVASIVE *CORBICULA* MORPHOSPECIES ON SITE PREFERENCES AND BEHAVIOUR OF NATIVE BIVALVES OF THE FAMILY UNIONIDAE

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Invasive, thermophilous bivalves of the genus *Corbicula* have spread widely in Europe recently, also in waters with natural thermal conditions. These clams reach densities of up to 7000 ind./m², and are known as ‘ecosystem engineers’, as they modify the habitats by forming aggregations of shells on the bottom. For native bivalves of the family Unionidae, which live under the surface, buried in the substrate, such a change in substrate texture and quality can be another serious threat factor, which together with other negative factors contribute to classification of this group as globally endangered. That is why this study aimed (1) to assess the avoided density of live *Corbicula* clams and their empty shells by native bivalves of the family Unionidae: *Anodonta anatina* and *Unio tumidus*; and (2) to investigate changes in behaviour of the native Unionidae in relation to the presence of live *Corbicula* and their shells in a sandy substrate. We assumed that the native Unionidae (i) avoid substrates contaminated with *Corbicula* clams, (ii) bury in the substrate slower and to smaller depths, and (iii) display more intensive horizontal activity on those substrates, as compared to pure sand. Individuals of the tested species (invasive and native ones) were collected from the rivers Oder and Vistula. The experiments were conducted for 24 h in aquaria: (a) divided into 2 equal parts, containing different substrates (substrate selection) or (b) filled with one substrate type: preferred or avoided (assessment of behaviour, recorded by CCTV cameras). The Unionidae avoided live *Corbicula* clams and their empty shells: unionids buried to smaller depths and displayed more intensive horizontal activity on the avoided substrates, as compared to pure sand. Thus the presence of *Corbicula* can be a factor limiting the occurrence of the native Unionidae, by reducing the available habitats.

EFFECTS OF FROST ON SURVIVAL RATE OF A RARE SNAIL SPECIES, *VERTIGO MOULINSIANA* (GASTROPODA: VERTIGINIDAE)

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Freezing tolerance is a basic factor influencing species distribution. The rapid on-going climate change can, however, cause changes in species limits, which is particularly relevant with reference to threatened taxa. *Vertigo moulinsiana* is a small terrestrial gastropod classified as vulnerable in Europe and listed in Annex II of the Habitats Directive. To assess the freezing tolerance of this species, we first measured the height (above ground) of its occurrence in November and May, i.e. soon before the snow cover and soon after snow melt, and the vertical profile of temperatures from the ground level, through the leaf litter and above it, to 140 cm above the ground surface. This allowed us to observe the wintering of *V. moulinsiana* in the buffer zone, composed of leaf litter (dry and decomposing plants) as well as the snow cover, where air temperature was much higher and more stable than above it. Next, we determined the survival rate of *V. moulinsiana* at low temperatures 3 times a year: in June 2019, October 2019, and February 2020, in 2 sessions, differing in time of exposure (6 h and 12 h), to various temperatures: –15, –10, –5, 0, 5, and 20 °C. We also measured the temperature of crystallisation (T_c) in both juvenile and adult individuals of *V. moulinsiana*. Mean T_c reached –9.71 °C, but the range of recorded T_c values was relatively wide (from –15.0 °C to –5.6 °C). Mean T_c did not differ significantly between juvenile and adult snails. Time of gastropod sample collection was a significant factor affecting survival rate: the highest for gastropods collected in February and the lowest for those collected in October. Our results suggest a freezing-avoidance strategy in *V. moulinsiana*, and the seasonal mechanism of pre-freezing mortality may be part of this overwintering strategy.

WHEN SHOULD WE START TO TELL CHILDREN ABOUT MOLLUSCS? A REVIEW OF MALACOLOGICAL MOTIVES IN PUBLICATIONS FOR CHILDREN AND ADOLESCENTS

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On the basis of presence of malacological motives, 170 books for children and adolescents as well as board games for children were analysed. The publications were selected by searching the catalogues of the Polish National Library, other libraries, search engines, and online auction sites. The keywords used included Polish nouns and adjectives referring to various kinds of molluscs, shells, and fossils, e.g. *mięczak*, *ślimak*, *ślimaczek*, *ślimaku*, *ślimakowe*, *ślimaczy*, *ślimacze*, *ślimaczku*, *małż*, *ostryga*, *muszla*, *muszelka*, *ośmiornica*, *ośmiorniczka*, *kałamarnica*, *mątwą*, *skamieniałość*. Publications based strictly on a cartoon brand were excluded.

Considering the topic, the publications were divided into the following categories: popular scientific, handbooks, textbooks, graphomotor, colouring books, literary works, nursery rhymes, musical, early developmental as well as multisensory and board games. The category of literary works included moralistic religious ones, collections of poems, novellas, and short stories. This category excluded nursery rhymes, but variations on the rhyme '*Ślimak, ślimak, pokaż rogi*'¹ deserve a special category. The category 'multisensory' included e.g. hand puppets, high-contrast baby books, bath books, rattles, mascots, foam books, water colouring books, also with moving elements.

In the analysed publications, a mollusc can be a title character, leading character, supporting character, episodic character, motive on the cover without any association with the contents, or a chapter of a longer work.

The most often explored motive was a snail or slug (*ślimak* and separately the diminutive *ślimaczek*) as well as shells (*muszla* and separately the diminutive *muszelka*). The least frequent in Polish literature were cephalopods, represented by squids (one title) and cuttlefish (one title). Bivalves were not represented in any title but were found in the contents of 2 publications (and several popular scientific ones). In one publication, anthropomorphism of a bivalve was detected, which was absent in earlier research (Agata Pótorak, *Bajki z dna Bałtyku*). Characterological attri-

bution of the characters created on the basis of malacological motives was analysed.

The most often published Polish authors using such motives are: Jan Brzechwa, Wanda Chotomska, Małgorzata Strzałkowska, Liliana Bardijewska, and Renata Piątkowska. Małgorzata Strzałkowska has authored 3 booklets in which a mollusc is the main character, and in another, she uses its motive.

Since new titles are appearing continuously (original, translations or reprints), the research will be continued.

PHAEDUSINAE VERSUS CLAUSILIINAE AND ALOPINAE (GASTROPODA CLAUSILIIDAE) – SIMILARITIES AND DIFFERENCES IN STRUCTURE AND FUNCTION OF THE REPRODUCTIVE SYSTEM

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Our anatomical study of the reproductive system in selected snail species of the Phaedusinae did not detect any significant differences in reproductive system structure between members of this subfamily and other subfamilies studied so far, like the Alopinae or Clausiliinae. However, a basic difference between the Phaedusinae and the other 3 subfamilies was noted in species with embryo retention.

Histological examination of the reproductive structure of selected species of the Phaedusinae (paraffin sections, staining with haematoxylin and eosin) showed that in oviparous species and in those with embryo retention, the histological structure of the spermoviduct and the free oviduct is very similar. In the spermoviduct, the prostate is visible, with epithelial cells and subepithelial secretory cells, containing abundant granulation (serous cells). It is accompanied by a partly open autospermoviduct, composed of the epithelium and a partly open oviduct, consisting of epithelial cells and a subepithelial layer of mucous cells. However, there is no partly open allospermoviduct (parallel to the autospermoviduct), composed of an epithelial layer and subepithelial serous cells, as observed in the other subfamilies of the Clausiliidae. Instead, a new structure, located opposite to the lumen of the autospermoviduct is noticeable: a partly open duct, which probably corresponds to the allospermoviduct of the Clausiliinae and Alopinae.

¹ Polish nursery rhyme translated means 'Snail, snail put out your horns I'll give you bread and barleycorns' (editor's note).



More precise histological examination (semi-thin sections, Epon sections, methylene blue) and ultrastructural analysis (TEM) allowed us to determine the structure of epithelial cells of the autospermiduct. We found that typical ciliated epithelial cells are accompanied by mucous cells and cells accumulating a homogeneous secretion. This cell layer of the autospermiduct is an extension of the epithelial layer of the allospermiduct, which proliferate and form a pool of cells producing/accumulating numerous filled vesicles, and next transform into giant cells filled with a transparent liquid.

A NEW SPECIES OF THE FAMILY
RATHOUSIIDAE (GASTROPODA:
SYSTELLOMMATOPHORA) FOUND IN A
TROPICAL GREENHOUSE OF THE SCIENCE
MUSEUM OF TRENTO (ITALY)

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A small slug was found in a tropical greenhouse of the Science Museum (MUSE) in Trento (Italy). Preliminary attempts at its identification on the basis of morphology (presence of soleoles – transverse ridges on the foot) and molecular features (COI gene sequences) indicated unexpectedly that it belongs to the relatively small systelommatophoran family Rathousiidae. Members of this family have an East Asian and Australasian distribution. Since the literature on the family Rathousiidae is relatively old and incomplete, and the GenBank contains very few sequences of this family, we also studied a few fresh specimens of *Rathousia sinensis* Heude, 1882 obtained from China for our research. Anatomical analysis showed that the MUSE slug and *R. sinensis* share unusual triaulic tritrematic genitalia, i.e. with a separate male duct for autosperm release and 2 separate female ducts: one for intake of allosperm (vagina) and the other for egg release (oviduct). Each of these ducts has a separate opening: penial, vaginal, and oviductal, respectively. Nevertheless the MUSE slug

differs in many anatomical details, e.g. in the structure of the multiacinous gonad, hermaphrodite duct, seminal receptacles, albumen gland, vagina, bursa copulatrix, prostate, Simroth's gland, penis, and internal penial structure. An analysis of the nucleotide sequences of several mitochondrial (COI, 16S rDNA) and nuclear (18S rDNA, ITS2 flanked by 5.8S and 28S rDNA, H3) gene fragments confirm assignation of the MUSE slug to the family Rathousiidae, but also prove that it is distinct from other rathousiid genera, such as *Rathousia*, *Granulilimax*, *Atopos* and an undescribed one from the Ryukyu islands (Japan). We therefore decided to describe the MUSE slug as a new species of a new genus in a forthcoming publication.

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STRUCTURAL AND MECHANICAL
PROPERTIES OF SHELLS OF *CAUCASOTACHEA*
VINDOBONENSIS (GASTROPODA: HELICIDAE)

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Shells of *Caucasotachea vindobonensis* have a crossed-lamellar structure, which has a hierarchical character. This means that many levels of organisation can be distinguished in its mineral structure: at the microstructural level they are layers formed by biocrystal assemblages, while at a lower, nanostructural level of biocrystal formation, crystalline domains associated with organic matrices can be identified. On this basis it is believed that shells are biocomposites. Within the Helicidae, the crossed-lamellar structure was also observed in shells of e.g. *Helix pomatia*, *Cornu aspersum*, *Arianta arbustorum*, and *Cepaea nemoralis*. In our study, strength parameters of shells of *C. vindobonensis* were assessed.

Compressive strength was tested using Shimadzu EZ-LX testing machine. The shells were placed on a compression plate and next compressed by a load (30 mm in diameter) at a rate of 1 mm/min. The mean value of the Young modulus reached 254.4 [N/mm²], while maximum force [N], which caused the first crack of the shell, was 63.086 N. Shell microhardness was tested using the Vickers method and a Wilson hardness tester. These tests consisted in pushing an indenter in the form of a regular, square diamond pyramid with a dihedral angle = 136° into the flat surface of the wall of the last shell coil under a load of $F = 0.025$ HV perpendicular to this surface. The average microhardness of the shells was 338 HV.

The mechanical properties of shells of *C. vindobonensis* are associated mostly with features like compositeness and hierarchic structure. Compositeness is reflected in the presence of various compounds: inorganic (mostly in the form of calcium carbonate) and organic (contained in the protein-polysaccharide matrix), while hierarchic structure consists in the presence of many layers, and each of them is internally structured and oriented differently. Thanks to the combination of these features, the material forming the shell is a durable biocomposite, characterised by good mechanical properties and an ability to diffuse cracks.

NEW DATA ON OCCURRENCE OF *SINANODONTA WOODIANA* (BIVALVIA: UNIONIDAE) IN THE MIDDLE VISTULA

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Sinanodonta woodiana, of the family Unionidae, is an alien species in the Polish fauna. Its natural range of distribution includes the catchment areas of the Amur and Yangtze rivers. Transportation and culture of Asiatic fish species has contributed to the spread of *S. woodiana* in East and Southeast Asia. In Europe this species was first recorded in the 1960s in Romania and Hungary. Currently, *S. woodiana* is found in Sweden, Ukraine, Moldova, Poland, Slovakia, Czechia, Austria, Germany, the Netherlands, Belgium, France, Spain, Italy, Croatia, Serbia, Montenegro, and Greece. It is reported that the cause of the spread of *S. woodiana* in many European water bodies was their stocking with Asiatic fish. In Poland this bivalve was first recorded in the 1980s in lakes and canals of Konin, where it probably originated from fish introduced from Hungary. Localities of *S. woodiana* were reported from the rivers Narew, Odra, Warta-Gopło Canal, Postomia, and Vistula, and in fish ponds in the river valleys of the Barycz, Bug, Narew, Noteć, San, Warta, Wisłok, and Vistula. In recent years, localities of this species were recorded in Warsaw and its vicinity. In 2016, shells and live specimens of *S. woodiana* were found on both banks of the Vistula near the Bridge of General Stefan Grot-Rowecki. In the same year, shells of this species were collected also on the right bank of the Vistula in a sedimentation tank near the Żerań Heat and Power Station, while on the left bank, downstream from the Siekierki Power Station. In 2017, shells of *S. woodiana* were observed on the left bank of the Vistula at the mouth of the discharge channel of heated water from the Koźienice Power Station, whereas shells and one live specimen near

the village of Wólka Dworska near Góra Kalwaria. On 16 June 2019, this species was recorded on the right bank of the Vistula near the Świętokrzyski Bridge in Warsaw (52°14'30.7"N; 21°02'05.8"E). In water, live specimens were observed, whereas partly in water and on the sandy bank, 37 shells were found. Mean dimensions of the largest shells (n = 7) were: length (L) 166 mm, height (H) 113 mm, and width (W) 61 mm. The presence of *S. woodiana* in Poland was initially limited to heated water bodies, but later it was noted also in rivers and fish ponds with natural thermal regimes of water. Although the spread of *S. woodiana* in Poland is favoured by human activity, we do not exclude the possibility of its natural spread along watercourses, such as the Vistula.

TAXONOMIC AND NOMENCLATURAL ABUSES, INTENTIONAL OR ACCIDENTAL: CAUSES AND CONSEQUENCES

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The causes of taxonomic and nomenclatural chaos have been and still are various but they have changed since the time when the binomial naming of species began. Initially, the creation of an excessive number of species names and, as a result, of a large number of synonyms resulted only from a slow and imperfect flow of information (particularly important in the case of widely distributed and variable species), a lack of precision of description and illustration, the fact that the number of necessary diagnostic features increases with the number of species described, and no obligation to specify the type specimen, coupled with a fairly intuitive approach to the concept of genus. It seems that the introduction of at least 3 different concepts and definitions of species, conceptual rather than operational, and the introduction of the International Code of Zoological Nomenclature (first edition in 1958), regulating only legal, although not practical aspects of nomenclature, followed by the rapid progress in information flow with the development of new research techniques (SEM, DNA sequencing, microtomography, etc.), have done little to improve the quality and honesty of taxonomic practices. Apart from plain negligence and carelessness, numerous cases of taxonomic abuse (resulting mainly in an excessive number of new names) are caused by psycho-sociological factors: trends or 'fashions' in taxonomy, which in turn arise from certain concepts of species (Nouvelle École, Westerlund, Starobogatov, and recently CLECOM). Currently, publishing policy seems to be another important factor: in some parts of the world, scientific output is judged by the num-

ber of publications, not by their quality. Publishing at the author's expense and so-called open-access journals exacerbate this, already serious, situation. Some very surprising cases of so-called taxonomic vandalism seem to result from ill will or very thoughtless jokes (a series of herpetological works by Wells and Wellington or a recent series of Thach's publications on Southeast Asian snails). Besides the obvious consequences for the next generation of taxonomists, who sometimes spend 90% of their time tidying up the nomenclature rather than reconstructing the phylogenesis, this has serious implications for biodiversity assessment and thus biogeographic inference and conservation. Ironically, some of these acts of taxonomic vandalism occurred precisely when the taxonomic community became fully aware of the importance of biodiversity assessment and conservation, which depend directly on decent and fair taxonomic practice.

CONTRASTING EFFECTS OF CLIMATE CHANGE ON POTENTIAL DISTRIBUTION OF ALIEN GASTROPOD SPECIES: *CERNUELLA VIRGATA* (DA COSTA, 1778) AND *HYGROMIA CINCTELLA* (DRAPARNAUD, 1801)

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Prediction of the impact of global climate change on current and future distribution of alien or threatened species is often the essence of macroecological research. Many analyses were devoted to various animal and plant species but few of them concerned terrestrial gastropods. Using the method of distribution modelling, we have constructed potential ranges of 2 terrestrial gastropods – *Cerनुella virgata* and *Hygromia cinctella* – on the basis of current and future climatic scenarios. Distribution ranges of both species continuously extend northwards from the Mediterranean region. They have also been introduced to several regions outside Europe. In the present climatic scenario, we conclude that most of the currently occupied areas in Europe are characterised by a high probability of occurrence of these species also in the future. However, in the 4 compared possible variants of anticipated climatic conditions the snails will be subject to contrasting scenarios. *C. virgata* may markedly extend its potential distribution range, probably because of the rise in temperature and its

small fluctuations. Thus global warming, with the morphological and physiological adaptations to dry conditions and the ability to disperse passively, probably will facilitate the colonisation of new regions of the world by this species. By contrast, in *H. cinctella*, no remarkable changes in geographic areas prone to colonisation are predicted. Precipitation in the driest season and greater variation in temperatures will be the key factors limiting its distribution in the future. Understanding the mode of colonisation may help us manage alien/invasive species more effectively, and formulate the principles of their control. This applies particularly to *C. virgata*, which is a serious problem in southern Australia, where it causes economic losses in cereal fields because of its high abundance. It leads to, e.g., lower yields, obstruction of harvesters or grain pollution. Cattle in pastures avoid plants covered in snail slime. Thus it is crucial to implement effective controlling strategies focused on limiting the dispersal (often by humans) and expansion of this species, also of its strict monitoring and prevention measures. Some measures have been developed and implemented in the USA, Canada, and China, where *C. virgata* is included in lists of species subjected to quarantine. Also shipments contaminated with this species are not accepted by other countries.

MALACOLOGICAL INDICATORS OF HISTORICAL HUMAN SETTLEMENT DEVELOPMENT IN PODHALE AND THE PIENINY MOUNTAINS IN SOUTHERN POLAND

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Human impact on the environment includes deforestation, associated with a need for new areas suitable for agricultural production. Research was conducted in terrestrial limestone deposits around mineral springs (22 profiles) and fluvial deposits (22 profiles) in the Podhale Basin and Pieniny. The stratigraphic position of these sediments was determined thanks to radiocarbon dating (27 dates). In the material, 2 types of mollusc communities were distinguished: F-FAUNA, dominated by shade-tolerant species, and O-FAUNA, dominated by species of open habitats. The sequences of communities allowed us to define 3 types of succession: (F-F)

dominance of shade-tolerant species throughout the profile; (F-O) one shift of mollusc communities – in the lower sections, shade-dominant species prevail, while the upper sections are dominated by gastropods of open habitats; (F-O-F-O) presence of 2 intervals with a large contribution of shade-tolerant species and 2 dominated by gastropods of open habitats. Mollusc communities indicate several phases of environmental change. Phase I – till the 13th century – was a period of a low intensity of human settlement development (no traces of human impact). Phase II – from 13th to 15th century – was a period of warm climate (Medieval Climate Optimum) and intensified development of settlements. Extensive areas were then deforested in the flat, northern part of Podhale and broad valleys within the Pieniny. Characteristics of mollusc communities changed: F-FAUNA was replaced by O-FAUNA. In areas with more variable relief, human impact was less strong. Phase III – from 16th to mid-19th century – was a colder period (Little Ice Age). In Podhale and the Pieniny, depopulation and weaker human impact were noticeable. The resultant reforestation was linked with richer mollusc communities, with shade-tolerant species. Phase IV – from mid-19th century till today – is a period of progressing climate warming and rapid growth of the human population. Strong human impact is evident throughout the study areas. The natural, wooded habitats have been preserved only in locations with particularly unfavourable conditions.

CURRENT UNDERSTANDING OF THE PHENOMENON OF DOUBLY UNIPARENTAL INHERITANCE OF MITOCHONDRIAL GENOME IN EUROPEAN SPECIES OF FRESHWATER BIVALVES

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Doubly uniparental inheritance (DUI) is different from the most common strict maternal inheritance (SMI) of mitochondrial DNA. The phenomenon of DUI was described in 12 families of marine bivalves (9 families) and freshwater ones (Hyriidae, Margaritiferidae, and Unionidae). Out of the 17 species of freshwater Unionidae found in Europe, DUI was recorded in 8 species of dioecious bivalves. In the DUI system of freshwater bivalves, 2 very different genetically mitochondrial genomes can be distinguished: female (F genome) and male (M genome), coexisting in male individuals but in different tissues. That is why males are heteroplasmic, while

females are homoplasmic, as the latter have exclusively F-type mtDNA. The F genome is present in all tissues of females and in somatic tissues of males, and is inherited in the maternal, typical way. The M genome is located primarily in gonads and generative cells of males, so it is transmitted from generation to generation in the male line. In freshwater bivalves, the M genome is up to 5–7% longer than the F genome of the same species. The M genome evolves faster than the F genome, e.g. because of looser selection, higher mutation rate, and smaller population size of M-type mtDNA. Dioecious unionid bivalves have exceptional features, associated with them for more than 200 million years: high precision of transmission of F and M genomes in DUI, and 2 pathways of spermatogenesis: typical, producing sperm with F-type mitochondria and atypical, producing sperm with M-type genome in mitochondria. Mitogenomes of freshwater bivalves have unique features, absent in other animals, such as an additional, sex-specific gene (M and F ORF) and an extended *cox2* gene, present only in male gonads. Because of these features, mitochondria – apart from their major function, i.e. energy production – are involved also in sex determination of these bivalves.

POTAMOPYRGUS ANTIPODARUM (GRAY, 1843) (GASTROPODA: TATEIDAE) AS A POTENTIAL FACTOR OF BIOLOGICAL CONTROL OF SWIMMERS' ITCH

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Female schistosomes, depending on species, produce hundreds or even thousands of eggs per day. In the external environment, after contact with water, the first larval form is released – miracidium, which infects molluscs – and its transmission depends on many factors. Gastropods infected with schistosomes originating from birds, expel during their lifetime hundreds or even thousands of cercariae. Those larvae actively search for definitive hosts, by using chemoreception. The similarity of some lipid components of body cover of mammals and birds allows cercariae to penetrate also the skin of people bathing in water. A symptom of such an invasion is swimmers' itch, known also as cercarial dermatitis or schistosome dermatitis. Its increasing incidence and the disturbing data indicating a possibility of survival of bird schistosome larvae in mammals, motivate to undertake research on biocoenotic methods leading to elimination of the threat, especially in recreational areas. This study aimed to verify if the presence of



a New Zealand non-host snail, *Potamopyrgus antipodarum*, in recreational water bodies can be a natural protective measure against swimmers' itch. We performed 3 laboratory experiments: (i) experimental infection of *Lymnaea stagnalis* with miracidia of schistosome *Trichobilharzia szidati*, in the presence of an increasing density of *P. antipodarum*; (ii) attempt at experimental infection of individuals of *P. antipodarum* with miracidia of *T. szidati*; and (iii) assessment of preferences of miracidia of *T. szidati* and *T. regenti* in relation to chemical components of water conditioned with individuals of species representing the Lymnaeidae or *P. antipodarum*. The presented results indicate that the presence of *P. antipodarum* disturbs the transmission of bird schistosomes and it is not a source of cercaria of these parasites, infecting vertebrate hosts. In conclusion, the a dilution effect caused by an alien mollusc species can be useful as a non-standard strategy of control of diseases transmitted by molluscs, but each parasite-host-solvent system requires a careful analysis of the costs and benefits.

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SUBSTRATE SELECTION, LOCOMOTION, AND BURYING BEHAVIOUR OF MORPHOSPECIES OF INVASIVE BIVALVES OF THE GENUS *CORBICULA* (BIVALVIA: CYRENIDAE)

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Bivalves of the genus *Corbicula* are regarded as some of the most invasive mollusc species. They have spread widely in both Americas and Europe. For 20 years they have been recorded also in Poland and their distribution range is extending, so currently they are subject to the Alien Species Act.

Our study aimed to determine site preferences and behaviour of *Corbicula* morphospecies living in various habitats. We selected *C. leana* and *Corbicula* sp. (formerly known as *C. fluminalis*, now with an unclear taxonomic position) from waters heated due to human impact (centre of invasion) and *C. fluminea* and *Corbicula* sp. from waters with normal temperatures for Poland (front of invasion). We assessed preferences for substrate types, as important for estimating the potential competition with other native bivalves, and differences in burying behaviour and locomotion, as crucial for understanding the possibility of active dispersal of invasive bivalves. We assumed that (1) *Corbicula* clams prefer fine-grained substrates, which enable them to bury easily; (2) cover longer distances on avoided, coarse-grained substrates, by actively searching for suitable microhabitats; (3) cold-water *Corbicula* clams show greater plasticity in substrate selection and mobility, which facilitates searching for new habitats in new areas. The experiments concerning substrate selection were conducted in containers with the bottom divided into 2 parts containing different substrates. Bivalve behaviour was determined in the same containers filled with substrate of one type, earlier classified as preferred or avoided by the clams. We found that *Corbicula* individuals preferred fine-grained substrates (and avoided coarse-grained ones), very much like the protected and endangered native species *Anodonta cygnea*. Besides, *Corbicula fluminea* and *Corbicula* sp. from heated waters were more plastic in respect of substrates and more active (longer locomotion and time of burying), which indicates their explorative behaviour. These clams buried deeper and for a longer time, which can protect them better from unfavourable environmental factors; they also showed greater mobility on the avoided coarse-grained substrates. These features (plasticity and explorative behaviour) can help accidentally introduced bivalves to find an optimum microhabitat. Preferences similar to those of *A. cygnea* indicate a potential new threat for this protected species.

MOLLUSC COMMUNITIES AT ARCHAEOLOGICAL SITES IN THE JABRON VALLEY (PROVENCE, FRANCE)

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A malacological study was conducted at 3 archaeological sites in the Jabron stream valley in Provence (south-eastern France). In Les Prés de Laure, the river sediments were dated as 27,000–23,000 calibrated years before the present (cal. BP), in Les Condamines-sur-Trigance the accumulated lake series dated from

18,000 cal. BP, and in a small rock shelter La Baume de Monthiver, Pleistocene and Holocene deposits dated from between 14,000–13,600 cal. BP to 8,200–7,900 cal. BP (or younger). In total, 21 mollusc species were represented there by 816 individuals and 3,332 shell fragments. In spite of the low abundance, mollusc communities from Upper Pleistocene sediments (Les Prés de Laure, Les Condamines-sur-Trigrance) seem to indicate a dominance of dry and open habitats around the investigated sites, reflected in the presence of *Xerocrassa geyeri* and *Granaria variabilis*. In La Baume de Monthiver, the most frequent species were *Solatopupa similis*, *Chondrina avenacea*, and *Chondrina megacheilos*, but also *Cepaea cf. nemoralis* and *Cepaea* sp. In the lowermost part of the profile, *Pyramidula pusilla*, *Truncatellina cylindrica*, and *Pagodulina cf. pagodula* were present. Apparently, during human presence in the shelter, its vicinity included some dry, open habitats with thickets, perhaps also with clumps of trees. Preliminary results of this pilot study open perspectives for further research in the geoarchaeological context at the studied sites, indicating also points for further, deeper malacological analyses.

FRESHWATER MALACOFUNA IN UKRAINE UNDER CONDITIONS OF INCREASING ANTHROPOGENIC ENVIRONMENTAL POLLUTION

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The late 20th and early 21st centuries were characterised by the expansion of human impact on the environment and intensification of its scale. A sad consequence of this phenomenon was the publication of a ‘Second Warning to Humanity’ (in the journal *BioScience*), signed in August 2017 by more than 15,000 scientists from 184 countries, who indicated that because of disturbance of environmental conditions, damage to the biosphere is unavoidable, due to the excessive use of resources by humanity, which exceeds its potential for self-regulation. It is a death sentence for the Earth’s biosphere according to famous scientists of our times, e.g. astrophysicist Stephen Hawking and ecologist James Lovelock. They believe that currently the most dangerous factor for the biosphere is global warming, which has already

reached an irreversible level. Concern about the condition of the biosphere was echoed in the speeches of participants of the World Economic Forum (21–24 January 2020, Davos).

How has climate change affected freshwater molluscs in Ukraine? Remarkable climate warming has influenced all the geographic regions of our country. The number of water bodies, their area, and depth decreased, and – consequently – also the number of local mollusc populations, their abundance, and biomass declined. Species that were common about 30–50 years ago, are now classified as rare and threatened. This applies primarily to some Unionidae, Bithyniidae, Melanopsidae, and Lithoglyphidae. The changes impacted also widely distributed species, such as *Lymnaea stagnalis* (L.) and *Planorbarius corneus* (L.).

The influence of global warming on hydrobionts is combined with another very strong factor: pollution of water bodies with heavy metal ions, detergents, radioactive elements, fertilizers, organic substances, etc.

Anthropogenic pollution, resulting from direct impact on hydrobionts or from indirect influence (because of changes in environmental conditions caused by them) affect the course of biological processes in water bodies. Depending on physicochemical type, concentration, and duration of the damaging factor, in freshwater molluscs some changes are observed in heart rhythm and diel respiratory rhythm, measured on the basis of volume of absorbed air by the Pulmonata and oxygen dissolved in water by gill-breathing species. The intensity of food intake, digestion, and excretion of nitrogen metabolism products are also altered. Depending on environmental conditions, the rate of locomotion of aquatic animals varies. Reproduction and development indices depend on many environmental factors. Their importance depends on age of reaching sexual maturity, successful mating, fertility, survival rate of juveniles, etc. In unionid species, adaptation to new environmental conditions leads to a decrease in population density, and thus limitation of dioecy, as some individuals switch to hermaphroditism. This is a protective physiological adaptation, which allows to maintain population size at a suitable level, sufficient for species survival.

Remarkable disturbance of environmental conditions in Ukraine was not, however, any obstacle for invasion of alien species: the widely distributed *Sinanodonta woodiana* (Lea) and *Micromenetus dilatatus* (Gould) – a species from North America, which successfully colonises more and more habitats along the northern Ukrainian border with Belarus.



IMPACT OF AN INVASIVE BIVALVE,
SINANODONTA WOODIANA (LEA 1834), ON SITE
PREFERENCES OF SELECTED NATIVE SPECIES
(UNIONIDAE)

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Sinanodonta woodiana is an invasive unionid bivalve originating from Southeast Asia. It was accidentally introduced to Europe in the 1960s, and to Poland in the mid-1980s. Initially it was observed in waters heated because of human impact. Currently it colonises ponds, rivers, and lakes with normal temperatures for Poland. This bivalve reaches large dimensions and forms large local populations and shell aggregations, modifying bottoms of water bodies, which can negatively affect native bivalve species, by limiting favourable habitats available to them. Our study aimed to determine effects of live individuals and empty shells of *S. woodiana* on substrate selection by native bivalves: *Anodonta cygnea* (Linnaeus 1758) and *Unio tumidus* Philipsson 1788. *Anodonta cygnea* is partly protected in Poland and – according to our earlier findings – has a relatively narrow range of site preferences, which partly overlap with those of *S. woodiana*. *Unio tumidus* is more abundant, thanks to the broader range of tolerance to environmental conditions. We assumed that native bivalves avoid both live individuals and empty shells of *S. woodiana*. Experiments were conducted in aquaria (30 cm × 30 cm) with a sandy substrate. On half of the substrate surface, various densities of live individuals or small (length about 7.6 cm) and mean-sized (ca 12.6 cm) empty shells of *S. woodiana* were distributed. In the aquaria, single individuals of *A. cygnea* or *U. tumidus* were placed, and after 24 hours their location was recorded. *Anodonta cygnea* and *U. tumidus* did not avoid live individuals of *S. woodiana* even if their densities were high, like in heated waters (67 ind./m²). Both species avoided small shells (both lying on the ground and buried) only if their density exceeded 200 shells/m². Medium-sized shells were avoided by *U. tumidus* at a density of 133 shells/m², while by *A. cygnea*, at a density of 133 (if buried in the substrate) or 200 shells/m² (on the substrate

surface). The results are particularly important in the light of global warming, as it is linked with the risk of further spread and growth of local populations of *S. woodiana* and competition with native bivalves.

GLOBAL WARMING AND TRANSMISSION OF
DIGENEAN TREMATODES ASSOCIATED WITH
PLANORBARIUS CORNEUS (GASTROPODA:
PLANORBIDAE)

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The temperature growth resulting from climate change certainly will affect interactions between organisms, including host-parasite systems. The most probable scenario in the case of invertebrate-invertebrate systems is an acceleration of parasite transmission with increasing ambient temperature, based on the commonly known van't Hoff rule. We analysed the patterns of cercaria release of 4 trematode species using *Planorbarius corneus* as the first intermediate host: *Echinostoma spiniferum*, *Notocotylus ephemera*, *Bilharziella polonica*, and *Tylodelphys* sp. Two of these species have in their life cycles stages encapsulated in gastropods or in the external environment, whereas cercaria of the other 2 species infect vertebrates. The experiments were carried out at 2 temperatures: 15 °C and 25 °C. Naturally infected gastropods were divided into 2 groups of 40 individuals each, and kept in incubators. For a week, every day, the number of cercariae released from the gastropods to water was assessed by placing for 1 h individuals in small beakers exposed to cold light. Next, the mean daily number of released larvae was estimated. We also compared the lifespan of cercariae (or metacercariae) in water temperatures of 15 °C and 25 °C.

At 25 °C, as expected, the dynamics of cercaria release from the snail body was higher than at 15 °C, and in all the analysed species it was more than 4 times higher. In contrast, the lifespan of the released cercariae (or encysted metacercariae) at the higher temperature was shorter than in colder water. The findings indicate a positive relationship between temperature and the rate of cercaria release, and the observed differences between species probably resulted from differences in the model of transmission to successive hosts.

Species-specific patterns of productivity, activity, and longevity of parasite larvae can have far-reaching consequences for disease dynamics in the changing ecosystems, as temperature rise can change the spe-



cies composition or dominance structure of parasites in biological communities. That is why construction of a scenario of the impact of climate warming on the

spread of parasitic diseases requires a deep knowledge of the models of parasite transmission in the environment.