

THE 32ND POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

The 32nd Polish Malacological Seminar (13–15 October 2016) was held in Spała near Łódź. Spała is a surprisingly good location for the – more or less – centre of Poland which we all imagine as flat and boring. In a sense, the village is weird. It is only a five minutes walk from the sign saying “Spała” to the sign saying “end of Spała”. It has (it says so on the Internet) only 300 inhabitants, and what you see when you get there is mainly hotels, B&Bs and restaurants (some of them bloody good). It has a shop, a bank, a post office, a pharmacy and a souvenir kiosk (shut). It is surrounded by quite nice forests (there are rumours of good mushrooms, but we had no

time to look) and has two rivers, both quite natural; there exist bivalve publications to prove it. It is also bloody difficult to get to, unless you have a car. We were lucky enough to go to Łódź first, and then the Main Organiser took us there in her car. The weather was rather lousy, cold and rainy, there was only one day with some sunshine but we had to sit in the sessions (I suspect the Organisers arranged it so, to prevent terrestrial people from skipping aquatic sessions and vice versa).

The organising institutions were the Faculty of Biology and Environment Protection, University of Łódź and the Association of Polish Malacologists.



Fig. 1. Nearly all of us, for the youngest generation see bottom left. Courtyard of the Rezydencja Spalska

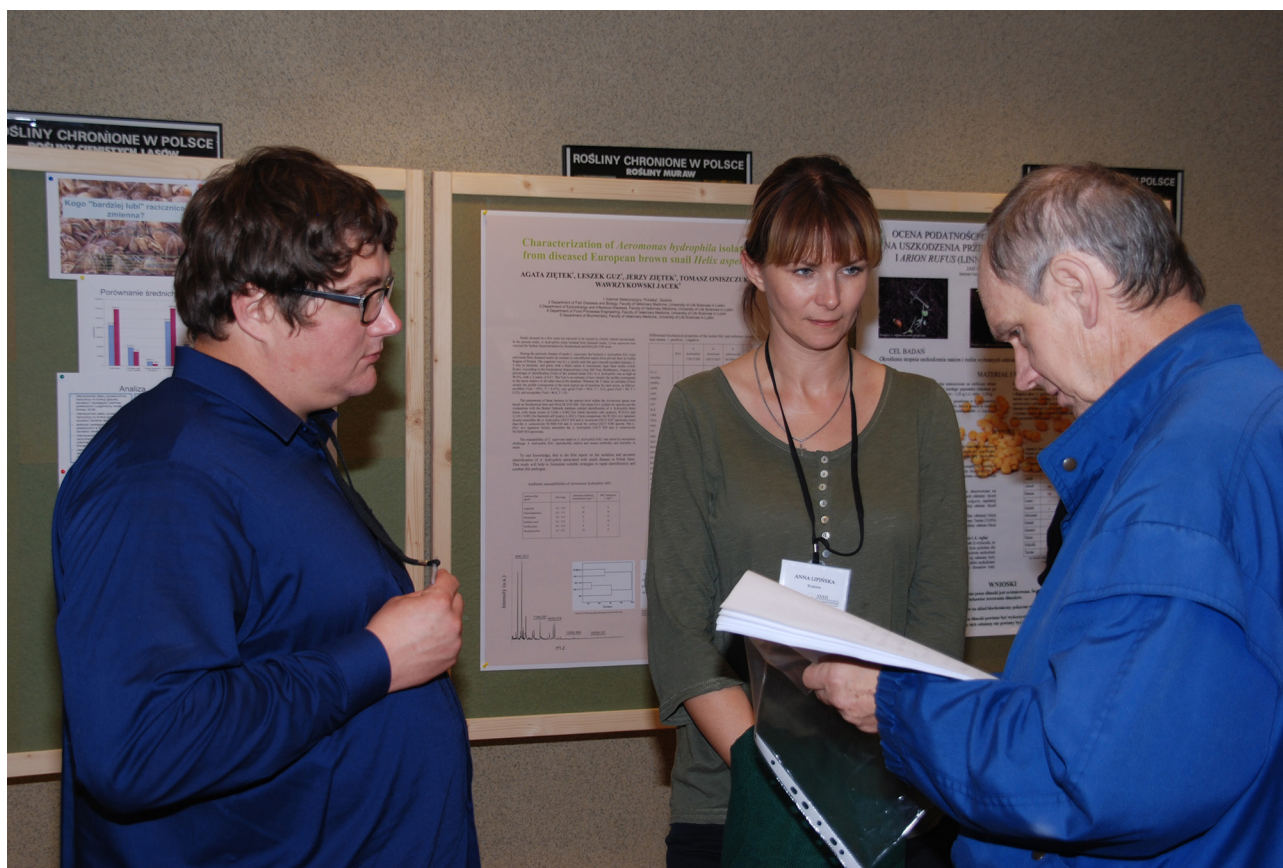


Fig. 2. Poster session. Photo A. SUŁIKOWSKA-DROZD

The Organising Committee, listed officially on the inside of the Abstract Book cover, included ANIA SUŁIKOWSKA-DROZD (Main Organiser) as well as ANNA ABRASZEWSKA, MARIA BRZOZOWSKA, KAROLINA CHANIECKA and JAROSŁAW MAĆKIEWICZ. We know, however, that many students were involved and we could see them carrying things, helping everybody, packing and unpacking, and they were all very nice and friendly. Thank you all! The Abstract Book was edited by TOMASZ K. MALTZ, TOMASZ KAŁUSKI and ANNA SUŁIKOWSKA-DROZD, and published by our Folia publisher JAROSŁAW BOGUCKI. The Abstracts had bivalves on the cover, some would have preferred snails but sometimes you have to take things as they are... As usual, the Organisers managed to seduce some sponsors in the form of Carl Zeiss, State Forests (Forest District Spała), Landscape Parks of Łódź Voivodeship and the Regional Management of Environment Protection in Łódź.

We were stationed in two places: in the field station of the University where the sessions took place and in a small hotel across the street (Rezydencja Spalska) where we had meals. That is except one meal, the Banquet, which was in a restaurant next door called Pod Żubrem [The Bison]. On the walls of the restaurant there are innumerable antlers and

horns, from animals allegedly shot by the tsar long ago.

The opening ceremony was brief but nice. Many VIPs spoke (Main Organiser, Dean, Department Head, Regional Director of Nature Conservation) but what we liked especially was the very good presentation about the region's nature with great photos (by Dr. ADAM ŚWIĆ from the region's Landscape Parks).

The attendance was good or more than good: at the maximum there were 67 people (or so the story goes) (Fig. 1). On the list of participants there are 59 people, but when we add the unlisted students from Łódź, some unlisted VIPs, one non-malacological wife, two (possibly malacological, who knows?) kids and a dog, the number seems within the realm of possibility. Two foreign guests were present (but not so foreign any more, considering that they have attended our seminars for ages): TEREZA KOŘINKOVÁ and ROBERT A. D. CAMERON. As usual, there were FTAs but we sent them post-cards; we also sent some to those who had said they couldn't come.

The Abstract Book contains 49 abstracts, 16 of them being posters (Figs 2 & 3). All the presentations and posters were good and, as usual, we liked some of them particularly. Among the serious ones we liked "An eternal sea or a periodic puddle? The history of *Pseudamnicola*, *Daphniola* and *Ecrobia*" (ANDRZEJ FALNIOWSKI & co-authors), "The zebra



Fig. 3. Poster session. Photo A. SULIKOWSKA-DROZD



Fig. 4. Three Presidents. From left to right: ex-ex-President, present President, ex-President (now vice-President). For some reason the boys seem bored (left) or angry (right). Photo A. SULIKOWSKA-DROZD



Fig. 5. Banqueting. Photo A. SULIKOWSKA-DROZD

mussel: feeding ground for benthophagous gobys or protection for their prey? (JAROSŁAW KOBAK & a multitude of co-authors; this time there was no disneyan *Dreissena* but instead there was a fantastic fish who tried to attack a mussel bed and couldn't decide), and (even though I say it) one by my ex-students and their molecular friend: "Phenotypic plasticity and absence of reproductive barriers between two morphological forms of *Trochulus hispidus* (Gastropoda: Hygromiidae)". Among the less serious we liked "What do kids' books tell us about mol-

luscs? Analysis of malacological themes in childrens' literature" (JAROSŁAW MAĆKIEWICZ). The sessions were chaired by (in the order of the sessions): BEATA M. POKRYSZKO (instead of EWA STWORZEWICZ who had twisted her ankle a few days before the Seminar), ANDRZEJ FALNIOWSKI, ELŻBIETA ŻBIKOWSKA, ANDRZEJ KOŁODZIEJCZYK (poster session), KAROLINA BĄCELA-SPYCHALSKA, MICHAŁ GRABOWSKI, ANDRZEJ PIECHOCKI, MAŁGORZATA OŹGO and JAROSŁAW KOBAK. Now to the annual statistics (see Table 1).

Table 1. Number of papers/posters in consecutive years

No.	Discipline	Number of papers/posters in consecutive years									
		2007–2010	2011	2012	2013	2014	2015	2016	Total	Mean	
1	Ecology & conservation	94	22	10	13	16	12	20	197	19.7	
2	Applied malacology & parasitology	34	11	4	4	8	7	9	77	7.7	
3	Miscellaneous: general, behaviour, archaeology, collections, history, education, methodology	26	9	3	6	13	6	4	63	6.3	
4	Life histories	32	8	7	5	2	5	1	60	6.0	
5	Biogeography & faunistics	20	11	9	8	1	1	3	53	5.3	
6	Fossil molluscs	19	6	4	5	5	2	4	43	4.3	
7	Systematics/phylogeny (including molecular)	19	2	2	6	1	2	7	39	3.9	
8	Structure (histology, cytology, shell) & variation	13	3	3	5	6	2	1	34	3.4	
9	Physiology	5	7	4	2	6	4	2	30	3.0	
Total		262	79	46	54	58	41	51	591	59.1	

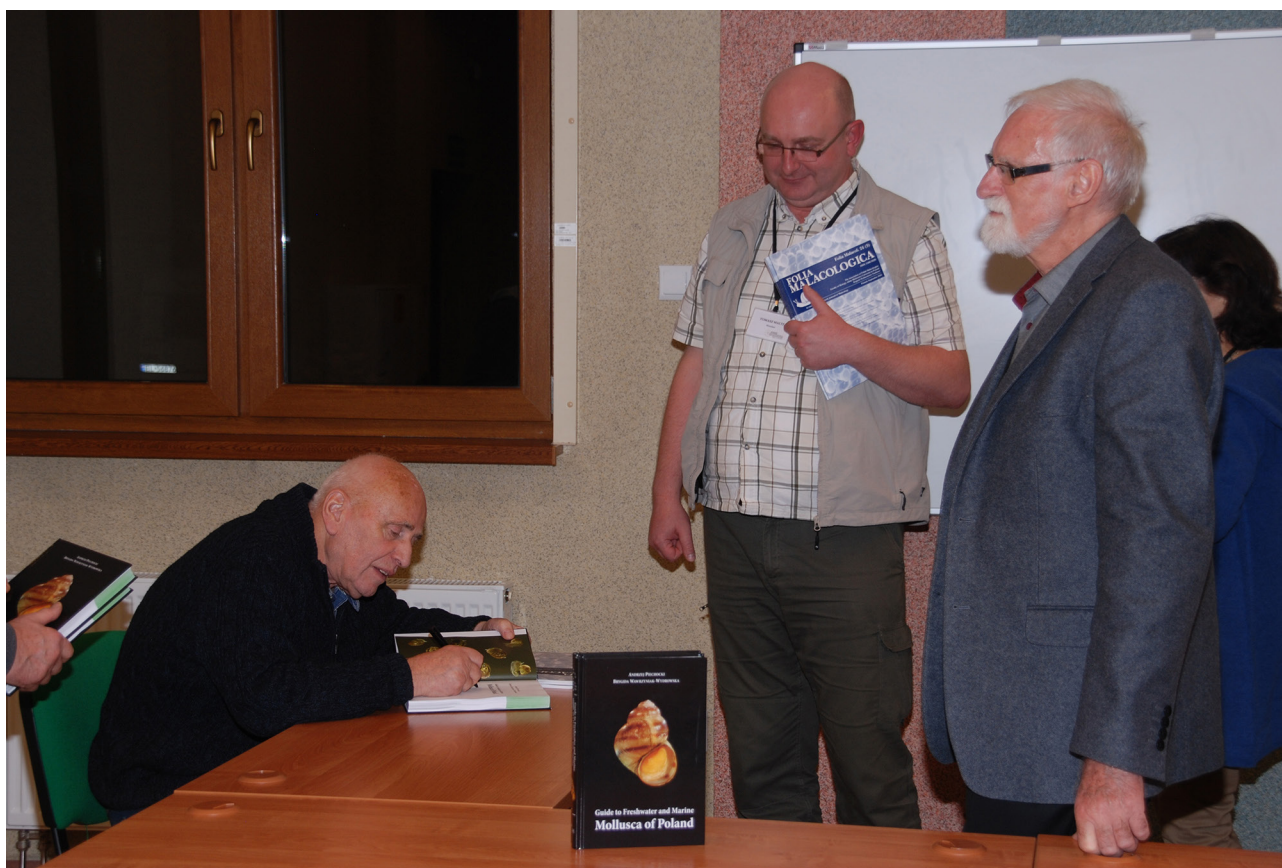


Fig. 6. ANDRZEJ PIECHOCKI signing his book. The co-author was not there

The snail : bivalve ratio was roughly 2.25 : 1 (1.35 : 1 in 2015, 2 : 1 in 2014, 3.3 : 1 in 2013, 4 : 1 in 2012, 3.5 : 1 in 2011, 2.3 : 1 in 2010, for more ratios from earlier years see earlier volumes of *Folia Malacologica*), the land : water ratio was roughly 1 : 1 (1 : 1 in 2014 and 2015, 1.9 : 1 in 2013, 2.8 : 1 in 2012, 1.5 : 1 in 2011 and 2010). The ratio of one-author presentations to presentations with two or more authors was 1 : 5 (1 : 3 in 2014 and 2015, 0.4 : 1 in 2013, 0.6 : 1 in 2012, 0.4 : 1 in 2011, 0.9 : 1 in 2010), and the number of papers/posters presented by girls versus boys was: girls only 7, boys only 6, mixed teams 36.

The handouts included (as usual) Abstract Book, programme, local map, notebook, pen and (for the first time) a 2017 calendar with great snail photos. Besides, the Łódź team got a splendid idea: they organised a stall with ceramic snails (well, some untorted, like bellerophonitids and thus technically not snails proper, but still beautiful) which everybody bought (some bought outrageous numbers).

Due to the good attendance (quorum!) the General Assembly could elect the new Council of the Association. ELŻBIETA ŻBIKOWSKA became President (Fig. 4). Vice-president is now TOMASZ KAŁUSKI (ex-President), Treasurer JAROSŁAW KOBAK, Secretary ANNA CICHY and Council Member ANNA NOWAKOWSKA. The Auditors include ANDRZEJ

LESICKI, JOANNA PIEŃKOWSKA and MONIKA JASKULSKA, and the Arbitration Commission KRZYSZTOF LEWANDOWSKI, TOMASZ K. MALTZ and MAŁGORZATA PROČKÓW. The Prize Committee consists of JAROSŁAW MAĆKIEWICZ, MAŁGORZATA OŹGO and WITOLD P. ALEXANDROWICZ. The Editorial Board of the *Folia* remains unchanged (sure, who else would want this job?). Two funny problems were also discussed by the Assembly. Firstly, any change in our Statutes requires an unattainable majority, and thus we can not change the rule about changing the Statutes since we never attain that unattainable majority. Secondly, the Statutes do not consider the possibility of an Association's member dying (which may be noble and tactful), and thus the deceased person can be deleted from the members' list only as a punishment: for not paying the membership (less tactful perhaps). Discussions of the General Assembly were continued during evening activities (Fig. 5).

After a few years' break we again gave prizes for the best presentations and posters by young malacologists (the break was because, being a poor society, some years we had nothing to give them). The prizes for the best presentations went to MONIKA MIODUCHOWSKA, and to ANNA DZIERŻYŃSKA-BIAŁOŃCZYK. JAROSŁAW MAĆKIEWICZ and MICHAŁ WINCZEK got prizes for the best posters. Which does not mean that the other people's productions were



worse and, as the President of the Prize Committee said, it was difficult to decide who was the best and also who was young.

This year we had no official excursion, and very well since the weather was mostly atrocious and anyway everybody (who skipped some sessions) could gallop across the forest and along the rivers on their own.

During the Seminar it was possible to buy a very good and brand-new book, the "Guide to freshwater and marine Mollusca of Poland" by ANDRZEJ PIECHOCKI and BRYGIDA WAWRZYŃIAK-WYDROWSKA (Fig. 6). It is really something we need. Congratulations!

The next Seminar will be combined with the EUROMAL 2017 and will be held in Kraków, September 10–16, 2017.

The abstracts below include all the abstracts from the Abstract Book, even those by the FTAs, most of them translated and some slightly abbreviated by the author of this report.

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ABSTRACTS OF THE 32ND POLISH MALACOLOGICAL SEMINAR

MALACOFAUNA OF THE HOLOCENE DEPOSITS IN THE VALLEY OF GLINNE STREAM SOUTH OF ŁAŃCUT

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The valley of Glinne stream, located in the Carpathian Foothills south of Łańcut, is deeply incised into soft deposits. Neogene clays and silts, usually calcium-poor, prevail in the substratum. However, in its upper section the Glinne and its small right-bank tributary cut a bed of Miocene limestones. As a result, calcium-rich deposits – calcareous tufts and carbonate silts – form in their lower course. They contain numerous mollusc shells which represent different development phases of the valleys. We studied seven profiles of the deposits, with 70 mollusc-bearing samples. Eight radio-carbon dates were done to ascertain the age. The assemblage included 76 species (65 terrestrial snails, 7 freshwater snails and 4 bivalves) represented by nearly 14,000 specimens. Six assemblages of different composition and structure were distinguished. The assemblage with *Vertigo genesii* showed a considerable species diversity. Besides the index taxon, it included cold-loving forms (*Columella columella*, *Semilimax kotulae*, *Vertigo geyeri* and *V. modesta*), as well as shade-loving species (*Discus ruderatus* and *Perforatella bidentata*) and euryoecious species (*Euconulus fulvus*, *Cochlicopa lubrica*). The assemblage represents a shaded habitat on a damp or even wet substratum, and a cold continental climate.

The rich and diverse assemblage with *D. ruderatus* showed a high proportion of shade-loving species, especially *D. ruderatus* and *P. bidentata*. Mesophiles: *Nesovitrea hammonis* and *Punctum pygmaeum*, were also present. The assemblage is typical of the expansion of coniferous forests and represents a cool continental climate with much shaded, damp habitats. The assemblage with *P. bidentata* was characterised by a high abundance of that species which was accompanied by shade-loving forms, both cool-adapted (*D. ruderatus*) and more demanding (*Aegopinella minor*, *Ae. pura*). Mesophiles also occurred, and a significant part was played by hygrophilous snails. Aquatic species, especially drought-resistant, were also common. The assemblage represented shaded and very damp habitats. The considerable proportion of *P. bidentata* indicates development of alder carrs. The assemblage with *Discus perspectivus* was very rich and diverse, with the dominance of shade-loving species and great abundance of stenoecious forms. Mesophiles and much less abundant hygrophiles also occurred. The association is characteristic of the expansion of deciduous trees and a warm, rather damp climate under considerable oceanic influence. The association with aquatic species was dominated by freshwater snails, especially those typical of small, periodic water bodies: *Galba truncatula*. They were accompanied by terrestrial forms of damp and wet, more open habitats: *Vertigo antivertigo*, or of shaded habitats: *P. bidentata*. The proportion of other ecological groups was much smaller. The assemblage represents a periodically flooded flat valley bottom, for the most part covered in alder carr.

HOLOCENE MALACOFaUNA IN THE CALCAREOUS TUFA PROFILE IN ŁAPSZE NIŻNE ON PODHALE

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Podhale is a mountain basin, in the south bordered by the Tatra massif, and in the north by the Beskid range. The high carbonate content in the bedrock favours development of calcareous tufas, often holding mollusc remains. The locality in Łapsze Niżne is located in the valley of Łapszanka stream between the villages Niedzica and Łapsze Niżne. The mollusc-bearing deposits (tufas and peats) form a fan ca. 100 m long and 50 m wide. Its internal structure was studied in several profiles from which samples were taken for malacological analyses and for radiocarbon dating. Malacological analysis was based on 25 samples, and radiocarbon dating on seven. The molluscs included 42 taxa represented by nearly 11,000 shells. The malacofauna was relatively poor in species. The lower part of the profile was dominated by forms of rather cold, continental climate: *Discus ruderratus* and *Perforatella bidentata*, accompanied by the relic *Semilimax kotulae*. In the higher part of the profile the only abundant shade-loving species was *Vitrea crystallina*. Open-country snails were represented by four species, *Vallonia pulchella* being the only abundant one. Mesophiles, especially *Vertigo substriata*, *Euconulus fulvus*, *Punctum pygmaeum* and *Perpolita hammonis*, were common. The presence of the relic *Columella columella* is noteworthy. Hygrophiles were mainly *Vertigo antivertigo*, *Succinea putris* and *Carychium minimum*. The occurrence of the tundra, cold-loving *Vertigo genesii* is noteworthy. Aquatic molluscs were abundant only in the highest intercalation of calcareous tufa, with characteristic *Bythinella austriaca*. Four faunal assemblages were distinguished. The assemblage with *V. substriata* included also euryoecious forms: *P. hammonis*, *P. pygmaeum* and *E. fulvus*; *D. ruderratus* and *P. bidentata* were also frequent. Shells of cold-loving species (*S. kotulae*, *V. genesii* and *C. columella*) were present. The assemblage with *V. substriata* is indicative of somewhat shaded habitats of considerable dampness in cool continental climate, corresponding to the Boreal and older Atlantic phases (¹⁴C dates: 8,820±120 years BP and 8,150±110 years BP). The assemblage with *V. crystallina*, with the dominance of

that species, included also mesophiles (*P. hammonis*, *Cochlicopa lubrica*). The fauna represents shaded habitats with patches of forest and scrub, and damp substratum; it corresponds to the Subboreal phase (¹⁴C dates: 3,850±100 years BP and 3,300±100 years BP). The assemblage with *V. antivertigo* showed a considerable proportion of hygrophiles of open habitats: *V. antivertigo*, *C. minimum* and *S. putris*. Mesophiles: *C. lubrica* and *P. hammonis*, were also numerous. The assemblage is typical of open damp habitats of the early Subatlantic phase (¹⁴C dates: 1,880±70 years BP, 1,570±100 years BP and 1,080±70 years BP). The assemblage with *B. austriaca*, dominated by that species, is typical of calcareous tufas of historic period. The mollusc assemblages from Łapsze Niżne make it possible to reconstruct the environmental changes during the deposition. The bottom of the sequence contains peats and the lower layer of calcareous tufa with the assemblage with *V. substriata* of the Boreal and older part of the Atlantic phases. It represents slightly shaded habitats of considerable dampness and rather cool, continental climate. Erosion traces are marked in the upper interval of the calcareous tufa; erosion is also indicated by the sand intercalation above the tufa. The peats above it contain a different malacofauna – the assemblage with *V. crystallina* which inhabits more shaded and somewhat drier habitats. It represents the Subboreal phase. The sand intercalation in the higher peat layer marks the second phase of erosion and separates the upper part with the assemblage with *V. antivertigo*. A distinct increase in dampness combined with disappearance of shaded habitats is marked in this interval; ¹⁴C analyses indicate deposition in an older part of the Subatlantic phase. In the proximal part of the fan the peats are covered by another sand intercalation which marks the third interruption in deposition, of probably a few hundred years. The calcareous tufas situated above, containing the assemblage with *B. austriaca*, represent the last few hundred years. In Łapsze Niżne local factors were superimposed on the regional trend of environmental changes, mainly generated by climate fluctuations, and introduced considerable modifications. The latter are the main reason for the significant differences compared to the sequences in other profiles of the Podhale tufas. The observations indicate that Podhale, both today and formerly, constituted a mosaic of habitats of different conditions, holding different faunal and floral communities. Today, the pattern is observed in all geographical regions and no doubt was true in the past.



DEATH ON THE DESERTAS: A MINOR MOLLUSCAN CATASTROPHE

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The three Deserta Islands (Chão, Deserta Grande and Bugio) are a part of the Madeiran Archipelago. At the present time, they have an aggregate area of about 13 km², and the highest point is ca. 470 m a.s.l. They are naturally semi-arid, but they are now much more sparsely vegetated than in the past as a result of grazing by introduced rabbits (now exterminated) and goats. There has been massive soil erosion. The terrain is very rugged, and many areas are inaccessible to all but the most intrepid and skilled workers. The modern snail fauna consists mainly of species endemic either to one or more of the Desertas themselves or to the Archipelago as a whole. With more recent work and some environmental recovery the number of species known living has slowly increased, including some known only as fossils or not seen since the 19th century. Until recently the only evidence of earlier faunas came from undated fossil records from deposits at the summit of Bugio made in the middle of the 19th century. These contained a few species now thought to be extinct. Now we have much more material both from the summit of Bugio and from numerous deposits scattered across Deserta Grande. While these samples have not yet been fully analysed, we know that some of the deposits contain shells dated to between 8 and 45+ kya (with consistent results at each site, although these are colluvial deposits). Although there are some unresolved taxonomic problems, there are 43 species-level taxa in the deposits. The individual site faunas are much richer than those found today, with up to 26 species found at a site. At least 20 of these species are now extinct on the Desertas; 10 of these are new species to be described, including some giant forms and four species of the tiny *Leiostylia*. Allowing for some uncertainties, it looks as though around half the species in these deposits are now extinct. This is a much higher rate of extinction than found earlier on Madeira itself or on Porto Santo. Many species have affinities with others typical of much more forested habitats on Madeira itself. While we may not be able to draw definite conclusions, it looks probable that the drastic reduction in the richness of the fauna may owe more to changes in the size and topography of the islands in the very late Pleistocene and Holocene than to the effects of human use, though the latter has certainly had a major impact, at least on the density and continuity of snail populations. Apart from taxonomic work and the analysis of faunal change, consideration of changes in isotope ratios may give

indications if changing climate. This programme is a team effort: Klaus Groh, Beata Pokryszko, Isumberto Silva, Dinarte Teixeira, Yurenas Yanes and me.

PRELIMINARY RESULTS OF STUDIES ON DIGENEAN INFECTION IN PULMONATES FROM THE KONIN LAKES

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The Konin Lakes are thermally polluted reservoirs with discharge of cooling waters from the power plants Pątnów and Konin. The water temperature never drops below 7°C; in summer it exceeds 30°C. The thermal conditions in the lakes significantly affect the species diversity of free-living organisms and parasites as well as the interactions among them. We aimed at ascertaining the species diversity of digeneans in pulmonates of the families Lymnaeidae and Planorbidae in the lakes of the Konin System, and at assessing the degree of infection of the gastropod hosts. Malacological-parasitological studies were conducted from May to August 2015 and from June to August 2016 in the warmest lakes: Pątnowskie, Gośławskie and Licheńskie. A total of 1,051 pulmonates representing seven species were collected – *Lymnaea stagnalis*, *Radix* spp., *Stagnicola palustris*, *Planorbarius corneus*, *Menetus dilatatus*, *Anisus vortex* and *Gyraulus albus*. The molluscs were infected by 13 species of digeneans. The number of digenean species found in the lymnaeids (13) was twice greater than that recorded in the planorbids (6 species). Likewise, individual lymnaeid species were more strongly infected with digeneans (*L. stagnalis* – 39.3%; *Radix* spp. – 33.5%; *S. palustris* – 38.0%) than the planorbid species (*P. corneus* – 13.2%; *G. albus* – 10.5%; *A. vortex* – 3.3%). The smallest degree of infection was recorded for *M. dilatatus* (1.8%) which is alien in Poland. Our preliminary results indicate a relatively small species diversity of digeneans in the Lymnaeidae and Planorbidae from the Konin Lake System. This may result from the availability of miracidia released from trematode eggs by ultimate hosts (mainly birds), and from a smaller survivorship of those development stages in higher temperatures.

VIVIPARUS AND DIGENEAN LARVAE IN A THERMALLY POLLUTED LAKE VERSUS A LAKE OF NATURAL THERMAL REGIME

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Temperature is one of the crucial factors which affect physicochemical and biological characteristics of lakes. Increase or decrease in water temperature beyond the limits of typical seasonal fluctuations is defined as thermal pollution. It directly affects biology of free-living organisms and indirectly influences their symbionts, including parasites. Gill-breathing snails are still only marginally studied from parasitological point of view which may be associated not only with their more difficult collecting, compared to pulmonates, but also with their smaller medical importance. The objective of the study was comparison of the host-parasite system in thermally different lakes, with viviparids and digeneans as examples. *Viviparus contectus* were caught from May to September 2015 in the thermally polluted Lake Licheńskie and in Lake Szymbarskie of natural thermal regime. Six digenean species were found in the 480 collected specimens of *V. contectus*. The digenean species richness was twice greater in Lake Szymbarskie than in the heated Lake Licheńskie. The degree of digenean infection in the snails was statistically significantly higher ($\chi^2=482.71$; $df=1$, $P=0.001$) in the lake of natural thermal regime (31.3%), compared to the thermally polluted lake (7.3%). Viviparids from Lake Licheńskie had larger shells and greater body mass (Mann-Whitney U-test, $P<0,001$) than those from Lake Szymbarskie. Females of *V. contectus* from the heated lake showed a higher fecundity (Mann-Whitney U-test, $P<0.001$) than those from Lake Szymbarskie. The observed differences in the host's biology may result from the earlier start and longer period of active life. The smaller degree of infection in the snails from Lake Licheńskie may result from the earlier, considering the higher temperature, exhaustion of energy reserves by snail-searching miracidia and from smaller survivorship of infected individuals. Experimental studies planned for the nearest future should make it possible to estimate the survivorship of infected and uninfected snails in different thermal conditions. The studies were financed from the Individual Grant WBiOŚ 2237-B/2015 to A. Cichy.

ACTIVE PROTECTION OF BIVALVES IN THE BIAŁA RIVER SYSTEM

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Freshwater bivalves are among the fastest taxa to go extinct; among the globally endangered molluscs unionids (Unionidae) are at the top of the list in terms of the number of endangered species. Bivalves are not only important components of aquatic ecosystems, due to their ecosystem services; some species meet the criteria of indicator species, banner species and umbrella species which makes them an excellent target group in conservation of water ecosystems. Such species as *Margaritifera margaritifera* and *Unio crassus* are targets of many European projects of active protection, with the total cost exceeding 60 million EUR. Investing such huge sums requires devising the best practice to guarantee the maximum success. Considering the complex unionid life cycle, the problem of devising the best strategy evoked a tempestuous discussion on the bases of their active protection. Should active protection be based mainly on introduction of captive-bred young or on stocking rivers with earlier infected fish? Which fish species are best for raising young bivalves? These problems were also encountered during the project "Przywrócenie drożności korytarza ekologicznego doliny rzeki Biała Tarnowska" [Restoring patency of the ecological corridor of the Biała Tarnowska River] (POIS-05.02.00-00-084/08), one of the main aims of which was to restore integrity of the bivalve population of the Biała system. Here we present the results of ex situ breeding, during which we experimentally studied the degree of infection of three potential fish hosts: nase (*Chondrostoma nasus*), barbel (*Barbus barbus*) and chub (*Squalius cephalus*), with glochidia of *U. crassus*. All the fish species became infected with glochidia, albeit with statistically significant differences in the degree of infection. The number of glochidia attached to particular fins depended on the fish species, kind of fin and the interaction between the two. The number of attached glochidia depended on the host's body length. Both the species and the size of fish should be carefully chosen when planning active protection of bivalves; the results may contribute to designing the best practice.



CAN A MUSSEL TREMBLE WITH FRIGHT?
EFFECT OF SELECTED BIOTIC FACTORS ON
SHELL OPENING AND CLOSING BY THE ZEBRA
MUSSEL *DREISSENA POLYMORPHA*

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The zebra mussel *Dreissena polymorpha* (Pallas, 1771) is ranked among the world's most invasive species. This freshwater sedentary bivalve is euryoecious which considerably contributes to its successful dispersal. Among the numerous studies on the species' biology, ecology and behaviour only few deal with shell opening and closing which may reflect the reaction to external conditions. We aimed at testing the effect of biotic environmental factors, i. e. kairomones of the roach *Rutilus rutilus* and alarm substance exuded by damaged individuals, on the shell movements of *D. polymorpha*. Both factors are associated with roach feeding on mussel beds and might induce stress reactions in the tested mussel (e.g. reducing the time spent open). Laboratory tests involved mussels caught in the Włocławski Reservoir and acclimated to artificial conditions for at least one week. One day before the experiment the mussels were fixed to microscopic slides and the movable shell valve was marked with a light coloured plastic mass, to facilitate measurements of the distance between the shell valves. Two-hour experiments with mussels exposed to the two factors were recorded with a high-quality camera and then analysed using a specialist software EthoVision®XT. The results can be summarised as follows: 1) there were no differences in shell closing or opening in the mussels exposed to roach smell; 2) the mussels reacted strongly to the alarm substance (reduced total time spent open, relatively long time spent at minimum opening - to 20% of amplitude of complete opening); 3) defensive reactions of *D. polymorpha* to the predator seem to be activated only by immediate danger (roach feeding) as signalled by the alarm substance.

AN ETERNAL SEA OR A PERIODIC PUDDLE?
THE HISTORY OF *PSEUDAMNICOLA*, *DAPHNIOLA*
AND *ECROBIA*

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Molecular genetics provides data on the genetic structure of (meta)populations shaped by their evolutionary history. Since that structure is shaped by an array of factors, it is usually difficult to draw univocal conclusions, but many hypotheses about the past can be sufficiently justified. Molecular clock is crucial, though it ticks with various speed and requires cautious interpretation. The islands of the Aegean Sea, spread over a large area and of a very different character, seem to be an excellent natural laboratory of evolution of isolated populations whose evolutionarily effective abundance is small, thus accelerating evolutionary processes. Our objects were freshwater and brackish snails of the superfamily Truncatelloidea. Considering that the freshwater ones inhabit only springs which are at least theoretically isolated, we deal with "islands on islands", which makes the picture potentially even more interesting. Though the present-day Mediterranean Sea dates back to the Mesozoic Tethys, it never existed as a spatially continuous water body. The uplifting of continental plates in the region of today's Gibraltar around six million years ago cut off the basin from the Atlantic, the sea dried out and changed into a desert, with bodies of water which was too fresh or too salty – it was the so called Messinian Salinity Crisis. The reopening of the strait at the end of the Miocene, the so called Pliocene flood (5.33 million years), restored the sea. The habitat fragmentation during the crisis was marked as differentiation between *Daphniola exigua* and *D. lousi*; *Bythinella turca* and *B. chia* (from Chios island) separated from the Greek *Bythinella* at that time. Later, the eastern part of the Mediterranean Sea was affected by volcanism, tectonic movements and consequent changes in sea level; the geomorphology underwent constant changes. Especially the consecutive glaciations caused periodic decrease in sea level by 130 metres or more, and where the Aegean Sea is now there was often dry land. The present positions of sea and land in the Aegean area date back to not more than 6–8 thousand years. One of the consequences of the unstable conditions is the species poverty of Truncatelloidea

on the islands; only a few species are found there. At the same time genetic studies unequivocally show that the history of between-island differentiation is very short. The estimates of divergence time between *Pseudamnicola* are only four million years, and for the clades from Euboea, Andros, Tinos and Naxos they do not exceed one million. This most probably reflects the recent connection between the islands. Passive transport, mainly by birds, can not be excluded, but it is noteworthy that Truncelloidea (except one, now nonexistent locality of *Pseudamnicola*) are absent from Cyprus, and the island was never connected to the mainland. *Daphniola* has a longer history, dating back to the Messinian Crisis, but this involved differentiation between continental species; here again we observe closeness between the taxa from Attica and the islands near Asia Minor. The history of the Black Sea was as tempestuous or even more so. Being part of the Tethys and later Paratethys, it formed the Ponto-Caspian reservoir and underwent fragmentation or lost and gained connection with the Mediterranean Sea, which became extremely freshened, and then flooded with sea water after the opening of the Bosphorus. *Ecrobia maritima*, a probably Pontic species, but reaching to the Aegean Sea, inhabits the Black Sea littoral. The estimate of divergence from *Ecrobia ventrosa*, which occurs from the Mediterranean Sea to the Baltic, is 3.30 ± 0.23 million years, corresponding to the late Piacenzian, when the Black Sea was connected to the Caspian Sea but not to the Mediterranean. Lake Primorie (Bulgaria), separated from the sea by a narrow bar, holds a population which is genetically much different from the other Black Sea populations, including those from the nearby Burgas. The estimated time of divergence between it and the remaining Black Sea *E. maritima* is 1.00 ± 0.11 million years. Certainly, no isolation could take place in this rather young reservoir which is a refugium for the population. The time of divergence corresponds to the Calabrian Salinity Crisis.

ANOMALIES IN RADULA STRUCTURE OF THREE SLUG SPECIES OF THE GENUS *ARION* (GASTROPODA: PULMONATA: ARIONIDAE)

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The radula is characteristic of all gastropod taxa and is part of their digestive tract. It is built of an elas-

tic membrane with teeth set on it in longitudinal and transverse rows. With time the teeth become worn and replaced by new ones which are produced as consecutive transverse rows. The radula is formed in the so called radular pocket in the hind part of pharynx. The pocket has three functionally different kinds of cells: membranoblasts, odontoblasts and basal plate cells. The membranoblasts incessantly produce the radular membrane, while the odontoblasts which form teeth primordia and the basal plate cells which are responsible for the connection between the teeth and the membrane, as well as maintaining regular distances between the teeth in the rows, become active at intervals. Disturbances, observed sometimes in the groups of cells which produce teeth and are responsible for their connection with the radula, may result in various anomalies in the radula structure. Such anomalies are always visible on whole length of the radula, in one or several longitudinal rows, since the disturbance is repeated throughout the individual's life. In the SEM studies on three members of the genus *Arion*: *A. lusitanicus*, *A. vulgaris* and *A. rufus*, we found an array of radula anomalies. They included malformations and defects of the teeth, as well as disturbance in the distance between the rows. Practically all the anomalies involved the outermost teeth rows. This may be associated with the fact that in pulmonates during the individual's life and growth consecutive teeth are added in the marginal parts of transverse rows.

IN VITRO DEVELOPMENT OF GLOCHIDIA OF THE THICK-SHELLED RIVER MUSSEL *UNIO CRASSUS*

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Our aim was devising an efficient protocol for in vitro production of glochidia of the endangered thick-shelled river mussel *Unio crassus*. Its glochidia attach to fish skin or gills where they lead parasitic life till metamorphosis. The conditions can be simulated in vitro, using standard techniques of tissue culture. The problem is when to interrupt the culture: it is unknown which stimuli or mechanisms in the wild cause release of the mature larva from the cyst. We assumed that the release of the larva, irrespective of its mechanisms, resulted in the larva's passing to life in pure water, and a similar mechanism should end the in vitro culture in a medium and CO₂ atmosphere. We tested the proper moment of interrupting the culture using the method of consecutive dilutions of the larvae-containing medium in



an environment imitating natural conditions (pure water). We observed metamorphosed young 24–27 days from establishing the culture, after beginning of dilution between days 13 and 17. In the cultures terminated too soon the young died since they were unable to develop further, in the cultures kept for too long the larvae were killed by infections.

PHYLOGENY AND SPECIATION OF CAVERNICOLOUS SNAILS OF THE FAMILY HYDROBIIDAE IN BULGARIA

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Troglobionts are natural models for many ecological and evolutionary studies; among other things they offer an insight into evolutionary processes and historic factors which affect biogeography, phylogeny and speciation. Despite numerous troglobiont-focused studies, many aspects of their biology, evolution or biogeography remain unknown, mainly because of the obvious problems posed by studies of cave-dwelling animals. At present two hypotheses attempt to explain the mechanism of speciation in cave animals. The 'climatic relict' hypothesis assumes an existence of a surface population whose individuals are capable of colonising caves. Following extinction of the surface individuals (e.g. because of climatic changes), several populations of troglobionts remain and evolve in allopatry. The 'adaptive shift' hypothesis assumes parapatric speciation model. Individuals from surface populations invade caves, with their different environment conditions. As a result, the evolution of cavernicolous species takes place under selection pressure different from that acting on the surface, thus producing troglobiont populations. In order to test the two hypotheses we analysed seven species of five genera of the family Hydrobiidae (Truncatelloidea), from 13 caves in Bulgaria. Their phylogeny was based on four genetic markers: mitochondrial fragment COI, and three fragments of nuclear genes: histone 3, 18S and 28S. All the markers univocally showed the existence of one, monophyletic lineage of cavernicolous snails, with six distinct clades corresponding to different genera. Our data lend support to the hypothesis of climatic relicts in the case of cavernicolous snails. Most probably the studied clades originated from a surface ancestor

which had colonised caves. Following extinction of the surface ancestor, the cave populations started evolving in allopatry. The lineage of cavernicolous snails arose some 7 – 6.75 million years ago, hence all the clades (6) of such snails came into existence at roughly the same time, as additionally confirmed by the ancestor's extinction as a result of the same event. The study was financed from the funds for statutory research no. K/ZDS/005401.

MOLLUSCS OF LAKE MIKOŁAJSKIE (MAZURIAN LAKELAND)

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The eutrophic Lake Mikołajskie, situated in the central part of the Land of Great Mazurian Lakes, has been subject to long-term, comprehensive hydrobiological studies. However, the rather numerous studies on its molluscs are either out-dated (1950s), or deal with selected taxa and/or ecological groups (e.g. Gastropoda, unionids, *Dreissena polymorpha*, plant-dwelling snails). Comprehensive studies on the lake's malacofauna were carried out in 2011–2015. The five-year survey yielded a total of 24 mollusc species: 12 snails and 12 bivalves. Besides live specimens, shells of another eight species were found. The most common and frequent snails were *Bithynia tentaculata*, *Valvata piscinalis* and, especially in 2014–2015, *Potamopyrgus antipodarum*, and among bivalves *Unio tumidus* and *Dreissena polymorpha*. *P. antipodarum*, an invasive species originating from New Zealand, was first found in Lake Mikołajskie in the 1970s/1980s; at present it occurs at the depth of 0.5–4.0 m, usually at densities of a few dozen to a few hundred individuals per 1 m² (max. 860). Another alien snail – *Lithoglyphus naticoides* – was found in the lake in 1997 in one site at the south-western shore and in subsequent years was recorded only there. The most recent survey (2014–2015) showed its occurrence also on the other side of the lake, at the north-eastern shore. *L. naticoides* was found at the depth of 1–4 m, with the maximum density of up to 250 indiv./m². Among unionids *Unio tumidus* dominated, while *U. pictorum* and *Anodonta anatina* were constant but not abundant. It is noteworthy that after a long absence (40 years) *A. cygnea* was found in Lake Mikołajskie; live individuals were observed in 2011 and 2015. The population of *D. polymorpha* has stabilised at a relatively low density – a few dozen mussels per square metre in its zone of occurrence (depth 0.5–5.0 m), and maximum of ca. 400 indiv./m². It is much smaller than the densities of several thousand recorded in the 1950s and 1970s. Members

of the family Sphaeriidae occurred in the lake at small densities: two species of the genus *Sphaerium* and five species of *Pisidium* were recorded, similarly as in the 1950s. Accumulations of shells in the lake's sublittoral were also analysed.

DIVERSITY OF FOREST MALACOCOENOSES AS AN EFFECT OF NATURAL AND ANTHROPOGENIC FACTORS: OAK-HORNBEAM FORESTS IN WIELKOPOLSKA

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Terrestrial gastropod communities were studied in Wielkopolska, in 14 Central European oak-hornbeam forests in 25 plots – 11 with planted Scots pine and 14 without. Most of the 42 recorded species were typical of forests, widespread and common in Poland. The occurrence of stenoeious species was limited to well-preserved forests. The diversity of the snail communities depended on the presence/absence of pine which affected the habitat conditions. In nearly all cases the snail communities in the plots with pine were poorer in species, and their abundance was smaller. The most significant factors for snails were soil fertility, herb layer coverage, proportion of soft-leaved trees, calcium content in the substratum and substratum pH.

CHANGES IN MALACOCOENOSES ALONG THE LOWLAND RIVER LIWIEC (E. POLAND)

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Liwiec is the largest left-bank tributary to the Bug River; it flows through two lowlands: Południowopodlaska and Środkowomazowiecka. Its upper section is completely canalised, the middle and lower sections have preserved a more natural character but they hold weirs and even a small dam. Only the mouth section of the Liwec is natural. The valley has preserved its natural character and is included in the network Natura 2000. The aim of the study was the analysis of changes in the composition, diversity, abundance and dominance structure of the mollusc communities along the Liwec, with special reference to natural (tributaries) and anthropogenic (discharge from sewage treatment plants, dam) disturbances

of the river's continuity. Molluscs were sampled in 38 sites: 9 in the upper, 8 in the middle and 21 in the lower section. Samples were taken in late spring (half of May – beginning of June) in 2013–2015 and in summer (July – half of September) in 2012–2015, at the banks and in the main current. Two-three samples of ca. 1 m² bottom were taken in each site. Forty two mollusc species were recorded: 27 in the upper section, 19 in the middle course and 34 in the lower course. Thirteen species were common to the three river sections, 17 were section-specific. The occurrence of *Unio crassus* in the lower section of Liwec is noteworthy. The composition of mollusc communities showed some changes along the river course. Fourteen species from the upper section were absent in the middle course, but another six were found there. The lower section held seven new species and six species from the upper section reappeared. Large differences in the number of species were observed between the sites: 26% showed small species richness (below 5 species). The mean number of species, values of the Shannon index (H') and $\exp(H')$ in the upper, middle and lower sections did not differ significantly, only the number of species differed distinctly (the greatest in the upper section). The mean abundance was the smallest in the middle section. The dominance structure differed considerably among the sites, but differences between the three river sections could also be observed. The proportion of bivalves in the community was high in the entire river (79%), and in each of the three sections (79.5%, 67.1% and 82.2%). In the upper section three species were common ($F > 50\%$) – *Sphaerium corneum*, *Pisidium subtruncatum* and *P. nitidum*. The middle and lower sections each held one species with frequency exceeding 50%: *B. tentaculata* and *S. corneum*, respectively. The relatively high total species diversity (γ) of molluscs in the Liwec resulted mainly from the large differences in species composition among the sites (β diversity). The effect of disturbances in the river continuity on the mollusc communities was rather small, but the differences between the sites above and below the disturbances were distinctly greater than those between consecutive sites within the river sections. They pertained to the number of species, abundance, dominance structure, and were more distinct in the case of anthropogenic as opposed to natural disturbances.



LONG-TERM CHANGES IN THE MALACOFAUNA OF AN EXPERIMENTAL POND LAKE WARNIAK (MAZURIAN LAKE LAND)

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Lake Warniak, a part of the system of Great Mazurian Lakes, is a shallow pond-type lake with more than 80% of its area consisting of littoral. The lake was subject to long-term experiments: changes in the composition and size of its fish stock (since 1967). The ichthyofaunal changes had a great effect on the physicochemical conditions in the lake and on the ecosystem's structure and functioning. We attempted to estimate the changes of the lake's malacofauna 17 years after the first studies (1998). We analysed the changes in species richness, abundance, dominance structure and frequency of individual species. Molluscs were sampled in summer (end of July 1998, beginning of August 2015) from 15 transects evenly distributed around the lake. In 2015 we took samples of water (4 sites) and bottom deposits (9 sites) for chemical analysis. Ammonium nitrogen and total nitrogen concentration, phosphates and total phosphorus concentration as well as concentration of calcium, magnesium, chlorides, alkalinity and chemical nitrogen demand in the water were determined. Temperature, pH and proper conductivity of the water were measured in the field. For the bottom deposits we determined the content of organic matter, and concentration of total nitrogen, total phosphorus, calcium and iron. In 1998, 23 mollusc species were found, and another 10 were identified based on empty shells. In 2015, 17 species were recorded, and another 13 were represented by empty shells. Eight species which were present in 1998 were not re-found in 2015, but two not previously recorded were discovered. Over a long period the proportion of rare species (i.e. present in one or two samples) in the total number of species increased considerably – from 17.4% in 1998 to 64.7% in 2015. The number of species represented by live individuals in particular sites decreased, but the mean values of 1998 and 2015 did not differ significantly. Live molluscs occurred at the depths exceeding 1 m in small numbers, except Unionidae in 1998 and *Pisidium nitidum* in 2015 (one site). In 1998 the species richness and mollusc abundance were more evenly distributed within the lake, while in 2015 higher values were recorded in the northern part. The similarity of species composition (J) of the malacocoenoses among the sites ranged from 0 to more than 0.5 in both studies. The mean values of Jaccard index in 1998 and 2015 were 0.238 and 0.194, respectively, and showed no statistically significant difference. The frequency of occurrence of

most species (except two) in 2015 was smaller than in 1998. Despite the decrease in frequency, *Anodonta cygnea* remained the most frequent species in the lake. The dominance structure changed distinctly. The observed changes in the malacocoenoses of Lake Warniak indicate a deterioration in the conditions for molluscs despite the smaller pressure from benthophagous fishes and the absence of significant changes in the physicochemical parameters of the water and bottom deposits. One of the important reasons may be the poverty of macroflora. The character of the bottom deposits (most often thick layer of dark mud, sand in shore shallows) is unfavourable. Despite the small mean value of the number of mollusc species per site in both 1998 and 2015, the total number of species in Lake Warniak is relatively high. This is a result of the large spatial variation in the composition of malacocoenoses.

PHYLOGENETIC LINEAGES OF THE THICK-SHELLED RIVER MUSSEL *UNIO CRASSUS* (PHILIPSSON, 1788) IN CENTRAL-EASTERN EUROPE: ANALYSIS OF SECONDARY STRUCTURE OF SELECTED TRNA

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The ranges of occurrence and distribution patterns of the present-day animal and plant populations of Europe were mainly shaped by consecutive glacial and interglacial periods during the Pleistocene. Under the effect of climate changes and the glaciation of the northern and central parts of the continent, species retreated to the southern part of Europe, to the glacial refugia where the conditions favoured their survival. With the retreat of the glacier, the species began to re-colonise the European continent. The thick-shelled river mussel *Unio crassus* was one of the species which during the post-glacial period migrated from the refugia and re-colonised the continent. It is a freshwater bivalve which is an essential link in the food chain. As a filter-feeder, *U. crassus* plays an important role of bioindicator of water quality. The thick-shelled river mussel is now among the world's most endangered aquatic invertebrates; it is included in the IUCN list of Threatened Species with EN (endangered) category. Our aim was to determine the genetic structure and phylogeographic relationships among the populations of *U. crassus* from Central-Eastern Europe, to identify the refugial areas of the

species and the routes of its post-glacial migration. We analysed polymorphism of selected fragments of mitochondrial (*Fcox1* + *nd3-tRNA-nd2* and *Mcox1*) and nuclear DNA (11 loci of microsatellite DNA) in 33 populations. We also reconstructed the secondary structure of five molecules of tRNA and traced the distribution of the observed structural groups in the studied populations of *U. crassus*. The results indicate an hierarchical structure of the studied populations. They group in two main clusters: Pannonian-Eastern and Southern-Crimean; besides, sub-clusters were identified: southern, Crimean, Pannonian and Eastern, originating from separate refugia in the region of Lower Danube in the Balkan Peninsula, in the Crimean Peninsula, in the Pannonian Basin and in the Southern Bug valley. There is a positive correlation between the post-glacial migration routes of host fishes and those of *U. crassus*.

CHARACTERISTICS OF ADHESIVE LOCOMOTION OF *ACHATINA FULICA*

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Adhesive locomotion is characteristic of terrestrial gastropods. The movement is thought to be effected by a series of contraction waves passing along the sole surface which adheres to the substratum. The functional unit – contraction wave – involves muscles and nerve cells; it forms on one end of the sole and disappears on the other with muscle relaxation. The wave causes also simultaneous folding of the epithelium. Within the area of contraction wave, the epithelium is raised, moved forward with no contact with the substratum, and then lowered. When the wave reaches the foot anterior end, the animal will move forward by the distance which is equal to the epithelium fold. Due to the function of contraction and relaxation the sole is divided into mobile and stationary zones. The process is execution of the paradox of simultaneous adhesion and movement. The analysis of mucus which is present on the animal's sole during locomotion shows that the mucus viscosity within the mobile zones (sole waves) is smaller than that in the stationary zones (spaces between waves), which considerably increases the effectiveness of locomotion. The aim of the study was characteristics of the snail's adhesive locomotion. The material included 359 individuals of *Achatina fulica*, of body mass of 8–68 g and shell height of 35–80 mm, from the Laboratory's culture. The sole image was recorded during adhesive, spontaneous, rectilinear movement on a horizontal glass plate, us-

ing camera CCD DFK 41 AV02.AS (ImagingSource, Niemcy), with varifocal lens CCTV 5–50 mm F/1.8 (Pentax), and computer image analysis software IC Capture.AS 2.0 (AVI files). The following movement parameters were analysed: snail velocity, sole length and width, sole length/width ratio, number of sole waves, sole wave length (*lw*), length of space between waves, surface ratio of sole waves to total sole area, frequency of waves, distance covered per one sole wave (*shw*) and folding value (*shw/lw*). Pearson test ($p < 0.05$) was used to estimate correlation. Most of the analysed parameters showed numerous linear correlations of different strength. The snail velocity was strongly correlated ($r > 0.5$, $p < 0.001$) with the frequency of sole waves, distance covered per one sole wave and folding value. Besides, increase in foot length was effected mainly through elongation of the space between the waves ($r > 0.5$, $p < 0.001$), and the wave elongation was strongly correlated with the increase in the surface ratio of foot waves to total sole area ($r > 0.5$, $p < 0.001$).

PHENOTYPIC PLASTICITY OF *ARION VULGARIS* MOQUIN-TANDON, 1855 AND *A. RUFUS* (LINNAEUS, 1758) IN RELATION TO THEIR INVASION POTENTIAL

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Arion vulgaris, closely related to *A. rufus*, is a serious pest of cultivated crops and ornamental plants. Its invasion in Europe, from France to Norway, has been observed for 60 years. In many places it replaces native species of *Arion*. The factors which determine its success are still an open question. We attempted to estimate if the species' phenotypic plasticity, as expressed by changes in its behaviour, might facilitate invasion. We studied circadian activity at different temperatures in *A. vulgaris* and *A. rufus* from various populations in Europe. We chose populations from localities which were invaded by *A. vulgaris* at different time, in order to compare the behaviour of slugs at different stages of invasion. The observations were carried out in laboratory conditions, in climatic chambers, at 10, 15 and 20°C, and 12 : 12 lighting regime. One slug was placed in each translucent plastic container lined with geocover, with shelter and lettuce leaves (14 × 7 cm). Each container was equipped with an infrared camera. The slug's behaviour in each container was recorded during 72 hours. The films were analysed by summing the time devoted to various activities, for each hour separately, using software Noldus EthoVision. All the



experiments were done in six replicates. The study was financed by the National Centre for Research and Development within the project WARION – Pol-Nor/201888/77/2013.

MALACOCOENOSSES OF THE GORCE NATIONAL PARK

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The malacofauna of the Gorce National Park was studied in 2007–2009, from June till October each year. Samples were taken in 38 localities: snails were collected by eye and sieving litter. The sites were located in six plant communities: Carpathian beech forest (*Dentario glandulosae-Fagetum*), spruce-fir forest (*Abieti-Piceetum*), Carpathian alder forest (*Alnetum incanae*), rich mountain hay-growing meadow (*Gladiolo-Agrostietum*), mat grass sward (*Hieracio-Nardetum stricte*) and sedge fen (*Valeriano-Caricetum flavae*). Besides, springs and streams as well as a small overgrowing pond were searched. The total of ca. 3,500 specimens collected represented 61 species of terrestrial gastropods from 16 families, two species of freshwater snails (*Bythinella austriaca* and *Lymnaea peregra*) and a bivalve *Pisidium casertanum*. The richest malacocoenosis with 53 gastropod species was that of the beech forest. As many as 16 of them occurred only in that habitat. The ecological analysis showed a high proportion of forest-dwellers (65.5%), half of them (50.8%) being typical forest species, not found in other habitats. The best represented were Zonitidae (11 species) and Clausiliidae (10 species). The malacocoenoses of the other two forest habitats were much poorer, especially that of the coniferous forest, with only 15 gastropod species. All those species were also found in the beech forest, but in the alder and coniferous woods Clausiliidae and Zonitidae formed a much smaller proportion (3 species each), while Helicidae were more numerous (4 species). All three forest habitats had 15 species in common; most of them (9 species) were typical forest-dwellers: *Vitrea diaphana*, *Aegopinella pura*, *Bielzia coerulans*, *Cochlodina laminata*, *Macrogastra plicatula*, *M. ventricosa*, *Perforatella incarnata*, *Chilostoma faustinum*, *Arianta arbustorum* and *Isognomostoma isognomostoma*. Zoogeographically the malacofauna of forest habitats in the GNP showed prevalence of Carpathian species (10), with two Carpathian endemics: *Balea stabilis* and *Vestia gulo*. European species of wide distribution were somewhat fewer (9), followed by Holarctic species (8), European species of limited distribution (central-, southern- and eastern-European, 7) and Alpine-Carpathian species (6). The remaining

categories, such as Euro-Siberian, Boreal-montane and West-Palaearctic, were poorly represented. The poorest habitats were swards with mat grass which forms uniform carpets. They held 13 species, with predominance of more or less hygrophilous forms. The fauna of meadows and fens was somewhat richer (20 and 18 species, respectively), and the two malacocoenoses differed qualitatively. The best represented family in the meadows were helicids (4 species), while the fens held many Vertiginidae (6), among them *Vertigo angustior*. The most common gastropods in the GNP were *Carychium tridentatum*, *Columella edentula*, *Vitrina pellucida* and *Aegopinella pura*, which were found in all six habitats.

THE ZEBRA MUSSEL: FEEDING GROUND FOR BENTHOPHAGOUS GOBYS OR PROTECTION FOR THEIR PREY?

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Colonies of the invasive, Ponto-Caspian zebra mussel (*Dreissena polymorpha*) provide favourable habitats for many benthic invertebrates, considerably increasing their species richness and abundance. In such colonies, invertebrates find good protection from predators and, in the case of detritophages, an easily accessible and rich food source (mussel's pseudofaeces). However, the effect of the bivalves on the benthophagous fishes may range from positive to negative, depending on the increase in the prey density and limited prey access in a colony of complex structure. Determining the significance of the bivalves for individual species of benthophagous fishes requires detailed studies. It is suspected that Ponto-Caspian gobiids (racer goby – *Babka gymnotrachelus* and western tubenose goby – *Proterorhinus semilunaris*), since recently present in our fauna, may profit from the presence of zebra mussel and find easy feeding grounds in its colonies. To verify this hypothesis we designed laboratory experiments in order to determine at what increase in prey density (chironomid larvae, from 500 to 2,000 indiv./m²) in the mussel bed the fishes start to feed similarly

to or more effectively than on stony or sandy substrata which are available in the habitat (at a fixed density of 500 indiv./m²). We also traced the effect of changes in prey abundance in the mussel bed on the habitat preferences of the studied fish species. The mussel beds proved to be better feeding grounds at a prey abundance twice higher than that on mineral substrata (1,000 vs. 500 indiv./m²), irrespective of the predator's species and size. The tubenose goby always chose mussel-formed habitats irrespective of food availability while the racer goby changed its preferences, selecting mussel beds only at higher food abundance in the colonies. Besides, larger individuals of the racer goby were more associated with mussel beds than younger fish, and the tubenose goby foraged among the mussels more effectively than the racer goby. Literature data on the changes in the zoobenthos structure and abundance in the presence of zebra mussel indicate that the differences in abundance of chironomid larvae within the range used in our experiments are also observed in the wild. The zebra mussel most probably has a positive effect on the gobiids. It may be an important component of the invasional meltdown: increasing effectiveness of invasion by alien species with increasing number of invasive organisms already established in the area. The study was financed by grant NCN 2011/03/D/NZ8/03012

MOLLUSCS OF RESERVOIRS OF SELECTED CITY PARKS

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Earlier studies on molluscs of reservoirs located in city parks within Warsaw (lakes Powsinkowskie, Wilanowskie and Czerniakowskie) revealed a diverse malacofauna. The reservoirs are partly of natural origin (oxbows) and situated, at least partly, in a natural surroundings of cultivated fields and/or forests. The studies in 2014–2016 focused on the malacofauna of reservoirs located within city parks (Park Skaryszewski and Park Pole Mokotowskie). Lake Kamionkowskie, partly within Park Skaryszewski, is of natural origin (Vistula oxbow), but considerably transformed; the neighbouring four lakes within the Park, small and formed at the beginning of the 20th c., are artificial (fed by piped water, some have concreted bottom and are emptied in winter). Despite this the malacofauna proved species-rich, the most diverse

malacocoenoses being those of Lake Kamionkowskie and of the two most "artificial" (concreted and periodic) reservoirs within the Park. The reservoirs in Park Pole Mokotowskie originated in the 1970s and 1980s and are completely artificial (concreted bottom, fed with piped water, emptied in winter). Despite this, in the shallow reservoirs enriched with fallen tree leaves we found eight snail species and one bivalve - *Musculium lacustre*. In most of the sites molluscs were abundant or even dominant macroinvertebrates. Common species prevailed among the malacofauna (*Bithynia tentaculata*, *Valvata piscinalis*, *Radix balthica*), but also alien species were recorded (e.g. *Menetus dilatatus* in Lake Kamionkowskie, *Physella acuta* in the same lake and in the most transformed reservoir of Park Skaryszewski), as well as some rare and protected species (e.g. *Sphaerium rivicola* in Lake Kamionkowskie), or little known species such as *Bithynia troschelii* in two much transformed ponds of the Park. Park ponds may provide refugia for rare and endangered species, and offer habitats relatively quickly invaded by molluscs.

PROSPECTS AND PROBLEMS IN RADIOCARBON DATING OF MOLLUSCAN SHELLS

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Radiocarbon dating is based on the assumption that the proportion of the carbon isotopes ¹⁴C and ¹²C at the time of the organism's death is similar to that in the surrounding atmosphere. Unfortunately, calcium, which is necessary for the formation of molluscan shells, is often taken up (in the form of CaCO₃) from food and water, where calcium carbonate often contains fossil carbon. Therefore, shells often exhibit "older" radiocarbon dates. Our laboratory is trying to compare the activity of carbon 14 in calcium carbonate as well as in shell proteins and in soft bodies of recent molluscs living under different ecological conditions and taking calcium from different sources (karst limestone, ruins of castles, citrate calcium, carbonates dissolved in water). The hypothesis assumes that the effect of fossil calcium uptake on the "radiocarbon age" will be strongest in the case of inorganic (CaCO₃) component of the shell and less distinct in the case of soft tissues.

ASSESSMENT OF SUSCEPTIBILITY OF PEA
(*PISUM SATIVUM* L.) VARIETIES TO DAMAGE
BY *ARION VULGARIS* AND *ARION RUFUS*
(GASTROPODA: ARIONIDAE)

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Arionids (Gastropoda: Arionidae) are pests in pea crops. They damage germinating seeds, seedlings and pods. The greatest crop damage results from slugs feeding on pods. However, slug-caused damage in early development stages of the plants is also significant. The slugs damage germs in the seeds and germinating plants, leading to great losses in pea crops of some varieties. Non-chemical methods are gaining importance within the integrated plant protection against pest slugs. Using varieties which are tolerant and less susceptible to slug feeding is especially important. Most studies dealing with the problem were done on rapeseed, potato, lupin and clover. Some varieties or forms of the plants were found to be less susceptible to slug damage, but there is no information on pea varieties. This was the reason why we undertook this study. The experiments were conducted in controlled conditions in which seeds and seedlings of 11 pea varieties were exposed to feeding of *Arion vulgaris* and *A. rufus*. We assessed the rate and size of damage, and the susceptibility of the varieties. The results showed that for both slug species the most susceptible were seeds and plants of variety Muza. In the case of *A. vulgaris* also plants of variety Mentor showed a high susceptibility to damage, and in the case of *A. rufus* – variety Medal. Those varieties should not be cultivated in areas inhabited by *A. vulgaris* and *A. rufus*.

COMPARISON OF DAMAGE TO WHITE
CLOVER (*TRIFOLIUM REPENS* L.) BY *ARION*
VULGARIS MOQUIN-TANDON, 1885, *ARION*
RUFUS (LINNAEUS, 1758) AND *DEROCERAS*
RETICULATUM (O. F. MÜLLER, 1774)

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White clover (*Trifolium repens* L.) is a valuable fodder, medicinal and honey plant. It is sown as second crop and used to establish and renew permanent green crops, especially pastures. Because of its high protein content it is very attractive to many pests, including gastropods. At present there are no regis-

tered means of protection of clover from pest slugs. Other ways of limiting pest damage are being sought, especially non-chemical methods. One of them involves using varieties which are tolerant or less susceptible to damage. Information on the subject is very scanty and this was the reason why we undertook these studies. The experiments were carried out in controlled conditions using seven varieties of white clover, exposed to feeding of *Arion vulgaris*, *A. rufus* and *Deroceras reticulatum*. We aimed at assessing the effect of biochemical properties of the varieties on their susceptibility to damage by those slug species. The plants were analysed for the content of cyanogenic glycosides. The rate and size of damage were estimated in no choice tests. The results were subject to variance analysis; Fisher test was used at significance level = 0.05. The size of damage depended on the plant variety and slug species. The least damaged were plants of variety Riesling with a high content of cyanogenic glycosides. This indicates that secondary plant metabolites may significantly limit slug feeding and consequent plant damage. Varieties with high content of such substances may be naturally protected against herbivore feeding. They can be cultivated in areas threatened by slugs and other pests instead of susceptible varieties such as Romena, Tasman or Sonja.

MOLECULAR PHYLOGEOGRAPHIC ANALYSIS
OF *DISCUS PERSPECTIVUS* (MEGERLE VON
MUEHLFELD, 1818)

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Discus perspectivus, a terrestrial snail of the family Endodontidae, is a Carpathian-Dinaric-East Alpine species of disjunct distribution; its range surrounds the Pannonian Basin with an irregular ring. It inhabits nearly the whole of Carpathians (with Transilvanian Alps and Transilvania), through Serbia and Montenegro reaching south Dalmatia, then the Dinaric Mts, and along the Adriatic coast to the Eastern Alps. In the west it reaches south-western Bavaria, the environs of Munich and Nürnberg,

in the north the Bohemian Highlands, Lower Silesia, Kraków-Częstochowa Jura and the northern Carpathians. In Poland it occurs in the Bieszczady where it reaches 1,000 m a.s.l. and in their foothills, as well as in Roztocze, Beskid Niski, Sądecki, Wyspowy and Żywiecki, and in the Pieniny (up to 700 m a.s.l.). Besides, it occurs in the Sudetes and in the Kraków-Częstochowa Jura, from where it is also known as subfossil. As fossil *D. perspectivus* is known since the Middle Pleistocene (Cromerian Interglacial) and regarded as an index species of interglacial periods, especially the Eemian. In warmer periods of the Pleistocene it was more widespread, especially toward north-west. The northern border of its range crosses Poland; the opinions on the origin of its insular localities vary and are not supported by any studies. It seems that the extant populations from different parts of the country may have different origin. In order to test this hypothesis we sequenced a fragment of COI gene from 102 individuals from populations in Poland, Czech Republic, Austria and Serbia. Thirty haplotypes of mtDNA were found among the 74 sequences. Preliminary results indicate that the present-day distribution of *D. perspectivus* in Poland may be a result of: 1) colonisation from other areas within the present distribution range but never glaciated (southern and eastern Carpathians); 2) colonisation from one of the so called "small refugia", in this case from the Kraków-Częstochowa Jura; 3) colonisation from different sources. The project was co-financed by the KNOW for 2014-2018 for the Wrocław Centre of Biotechnology.

WHAT CAN LIFE HISTORY TELL US ABOUT THE POPULATION STRUCTURE AND DYNAMICS OF THE ENDANGERED *VERTIGO MOULINSIANA* (DUPUY, 1849)

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The rare terrestrial snail *Vertigo moulinsiana* has few and scattered localities in all of its range. Its life history has been studied in detail. The studies on the population dynamics revealed an annual pattern which is typical of many invertebrates: during the vegetation period the population reaches a high abundance and spreads while outside the vegetation season the snails are difficult to find. Such population dynamics is explained by the life history features, based on different susceptibility of each development stage to various external factors. The hypothesis was

verified using mathematical simulations and field data. The results confirm the abundance fluctuations both within the season and from year to year, which are characteristic of the species. It follows from our model that the mortality of eggs and juveniles is the most important for the population's survival. The number of eggs produced in the next season depends on that parameter. Our model, based on life history features, shows also the importance of studying fecundity.

WHAT DO KIDS' BOOKS TELL US ABOUT MOLLUSCS? ANALYSIS OF MALACOLOGICAL THEMES IN CHILDRENS' LITERATURE

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I tried to analyse malacological themes in the available Polish language children's literature in view of the question if and in what way such themes may provide knowledge of molluscs for the youngest reader. I analysed 39 book titles which I found using key-words: snail, mollusc, clam, shell, pearl, octopus in auction services and common search engines. The analysed titles can be provisionally divided according to different criteria, for example, readers' age, significance of illustrations, form of the book, didactic and educational purposes. It should be emphasised that the educational-didactic aspect is the most important in children's literature, hence the presented contents are subordinate to moral rather than empirical values. Popular scientific books addressed to children and teenagers (4 titles) are a separate category. The most frequent malacological motive is the snail and its shell. In book illustrations the authors usually do not pay attention to the shell shape and chirality; snail shells are often diagrammatic, though there are also illustrations depicting shell sculpture (e.g. B. Sudół "Wyprawa ślimaka do grodu Kraka" [The snail's expedition to Kraków]). Snails are usually presented as slow, nice, friendly and sociable animals, the exception being "Pocałunek ślimaka" [The snail's kiss] by Fabrizi Poluzzi. Two of the analysed publications draw attention to the existence of snails and slugs, though the explanation of the difference remains at the moral (symbolic) level, ignoring the empirical explanation. In one analysed case the snail character is used to justify an ideological message ("Kim jest ślimak Sam?" [Who is snail Sam?]). In two titles the word "snail" pertains not to malacological themes, but to the implant of cochlea [in Polish literally "snail"] (A. Chmielewska, "Ślimak" [Snail i.e. cochlea]), and to the sexual behaviour of an adult toward a child (F. Poluzzi "Pocałunek ślimaka" [The snail's kiss]). Both these publications are the so



called “therapeutic stories”. In three books octopus appears and represents positive features of character; squid features in a fantasy book for teenagers. Shell features in children’s literature as a mysterious, unusual and attractive object. Surprising is the absence of any reference to bivalves which I suspect is the effect of the absence of anthropomorphic features (no eyes, mouth, head or arms); bivalves appear marginally in the book “Osiem ramion ósmiornicy” [Eight arms of the octopus]. Among the popular scientific books for children and teenagers there are some with many factual errors. Children’s and teenagers’ literature may provide an attractive starting point for discussing the surrounding reality with children, but in itself is of small cognitive value regarding the mollusc world.

HISTOLOGY, ULTRASTRUCTURE AND FUNCTION OF ALLOSPERMIDUCT IN BALEINE CLAUSILIIDS OF DIFFERENT REPRODUCTIVE STRATEGIES (GASTROPODA: PULMONATA: CLAUSILIIDAE)

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Most pulmonates have semidiaulic reproductive systems in which the spermoviduct is composed of two partly open ducts: vas deferens partly surrounded by prostate, and oviduct. Having separated below the prostate, these ducts become independent. In some species the reproductive system is semitraulic: in the gonoduct there is an additional canal – allospermiduct. In such snails the spermoviduct is composed of three partly open canals: spermoviduct (=autospermiduct), allospermiduct and oviduct, and after separation of the free vas deferens the allospermiduct with the oviduct canal form the free oviduct. Such a reproductive system is typical of all the studied clausiliids. Since the allospermiduct is part of spermoviduct and free oviduct, our anatomical, histological and ultrastructural examination included both those organs. We attempted to check if there were differences in the structure of oviduct and allospermiduct related to different reproductive strategies: oviparity, egg retention and ovoviviparity (sensu Tompa)/lecitotrophic oviparity (sensu Blackburn). The selection of the two organs was also dictated by the fact that in egg retainers the eggs are retained in the lower part of spermoviduct and in the free oviduct. We used three baleine spe-

cies of known life histories and different reproductive strategies: *Laciniaria plicata* (oviparous), *Vestia gulo* (egg retainer) and *Alinda biplicata* (viviparous). Anatomical examination showed that the length ratio of free oviduct to spermoviduct differed between oviparous snails vs. egg retainers/viviparous snails. Histological and ultrastructural studies showed no differences in the spermoviduct structure. The duct is composed of three partly connected canals. Each is built of a layer of epithelial cells, while allospermiduct and oviduct additionally have subepithelial secretory cells. Significant differences were observed in the morphological structure and ultrastructure of allospermiduct being part of free oviduct in species of different reproductive strategies. The differences pertained to secretions of the subepithelial secretory cells which are probably crucial to egg retention/viviparity. The studies were financed by project NN 303 796740.

TRICHOBIKHARZIA SP. IN RELATION TO OTHER DIGENEAN INVASIONS IN LYMNAEIDAE

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Bird schistosomes are parasitic flatworms of the family Schistosomatidae, with life cycle requiring two hosts. Birds are their ultimate hosts and aquatic pulmonates their intermediate hosts. Penetration of cercariae into an untypical host – human – does not result in completion of life cycle, but the further fate of the invasive larvae is unknown. The rash appearing on the skin of infected person may be accompanied by other symptoms: nausea, diarrhoea, swollen lymphatic nodes, insomnia, fever, even anaphylactic shock or breathing difficulties. It is noteworthy that in experimental conditions the parasite overcomes the mammal skin barrier and reaches internal organs. We tried to assess the degree of infection of Lymnaeidae with *Trichobilharzia* sp. in relation to the other digenean invasions, in selected water bodies during a period of intense recreation. We determined the prevalence and invasion intensity measured as the number of cercariae released by the snails in controlled thermal conditions (19°C). Snails were sampled in July and August 2015 in Lakes Głuszyńskie, Modzerowskie (Kujawsko-Pomorskie Voivodeship), Skulskie (Wielkopolskie Voivodeship) and Szymbarskie (Warmia-Mazury Voivodeship). The material included 286 specimens of *Lymnaea stagnalis* and 264 *Radix balthica*. Bird schistosomes were found in *L. stagnalis* from four and in *R. balthica* from two lakes. Digeneans were found in 55.6%

of *L. stagnalis* and in 23.1% of *R. balthica*. Hosts of *Trichobilharzia* sp. constituted 10.1% in the whole set of infected *L. stagnalis* and 3.3% among the infected *R. balthica*. The proportion of snails infected by other digeneans ranged from 1.3 to 33.3 %. In experimental conditions snails of the genus *Radix* released on average 1,657 (± 54) cercariae of bird schistosomes per day, 990 (± 110) larvae of *Diplostomum pseudospathaceum* and 503 (± 35) *Tyleodelphys clavata*. The differences were statistically significant (one-way ANOVA: $F_{2,6}=62.12$, $p<0.001$). Snails infected with *Trichobilharzia* sp. release thousands of invasive cercariae during their lifetime, hence even at a small prevalence there is a threat of swimmers' itch. The common occurrence of snails which release bird schistosome cercariae and the presence of aquatic birds, as well as the increasingly frequent incidence of swimmers' itch are strong enough arguments in favour of monitoring of invasion of these parasites in snails in bathing places.

TERRESTRIAL GASTROPODS OF THE SUWAŁKI LANDSCAPE PARK

MAGDALENA MARZEC

Suwałski Park Krajobrazowy, Malesowizna–Turtul, Jeleniewo

Terrestrial snails of the Suwałki Landscape Park (Podlaskie Voivodeship, Suwałki county) were inventoried in 2013 and 2014. Previously in that region only the environs of Lake Hańcza were studied in detail, and there was anecdotic information on gastropods of the environs of Lake Jaczno. Twenty eight localities in the SLP were studied, including 15 forests and 13 open habitats. A total of 56 species of terrestrial gastropods were recorded. The up-dated list of terrestrial gastropods of the SLP includes 61 species: *Acicula polita*, *Carychium minimum*, *C. tridentatum*, *Succinea oblonga*, *S. putris*, *Oxyloma sarsii*, *Cochlicopa lubrica*, *C. lubricella*, *C. nitens*, *Columella edentula*, *Truncatellina cylindrica*, *Vertigo alpestris*, *V. antiver-tigo*, *V. moulinsiana*, *V. pusilla*, *V. pygmaea*, *V. substriata*, *V. angustior*, *Pupilla muscorum*, *P. pratensis*, *Vallonia costata*, *V. excentrica*, *V. pulchella*, *Acanthinula aculeata*, *Ena obscura*, *Punctum pygmaeum*, *Discus rudatus*, *D. rotundatus*, *Arion subfuscus*, *A. circumscriptus*, *Vitrea pellucida*, *Vitrea contracta*, *V. crystallina*, *Aegopinella minor*, *Ae. pura*, *Nesovitrea hammonis*, *N. petronella*, *Zonitoides nitidus*, *Limax cinereoniger*, *Malacolimax tenellus*, *Deroceras laeve*, *Euconulus alderi*, *E. fulvus*, *Cochlodina laminata*, *C. orthostoma*, *Macrogastra latestriata*, *M. plicatula*, *M. ventricosa*, *Clausilia cruciata*, *C. dubia*, *Laciniaria plicata*, *Bulgarica cana*, *Bradybaena fruticum*, *Helicella obvia*, *Perforatella bidentata*, *P. rubiginosa*, *Euomphalia strigella*, *Arianta arbustorum*, *Cepea hortensis*, *C. nemoralis*, *Helix pomatia*.

WŁADYSŁAW EMANUEL LUBOMIRSKI (1824–1882) AND HIS MALACOLOGICAL COLLECTION

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Władysław Emanuel Lubomirski was born in 1824 in Stanisławów, in Mohylev province (now Belarus). Son of Eugeniusz and Maria née Czacka, he was orphaned early (his mother died when he was three, his father seven years later) and his older brother Stefan Lubomirski became his guardian. Władysław E. Lubomirski was educated in Wawrzyniec Czekanowski's private school in Krzemieniec. He owed his interest in nature to this teacher and amateur entomologist. He continued his education in secondary schools in Kiev and Carskie Sioło (now Pushkin) near St. Petersburg. Having left the school, he worked as a civil servant for a short time, but he soon returned to Stanisławów to manage the property. During his stay in Stanisławów he collected plants and made a herbarium of local flora which he later supplemented with plants from various parts of the world. He established a botanic garden and a library of mainly botanical works. He looked after the clerks and peasants from his property: he organised a hospital, pharmacy and people's schools. In 1858–1863 he was marshal of nobility of the Orsza county. During the January Insurrection he was voivodeship commissar for which he was sentenced to a few years exile in the Russian interior. After his return from exile in 1867 he lived permanently in Warsaw. It was there that Lubomirski established contact with the zoologists grouped round the Zoological Cabinet (among other scientists Władysław Taczanowski, Antoni Waga, Antoni Walecki) and the patrons of natural sciences Aleksander and Konstanty Branicki. Next to the Branicki brothers he became one of the patrons of the Cabinet. Władysław E. Lubomirski financed collection purchases and scientific expeditions (among others, Benedykt Dybowski's studies in Siberia). With his brother Jan Tadeusz Lubomirski he financed the first journal of the Zoological Cabinet – *Wiadomości z Nauk Przyrodzonych* [Natural History News]. In his spare time Lubomirski acclimated plants in a small garden in Warsaw; the plants were sent by Benedykt Dybowski from Asia, and by Konstanty Jelski and Jan Sztolcman from South America. Besides, he started collecting mollusc shells from all over the world, mainly buying them from specialised commercial companies, and financing exploratory activities of

Polish naturalists. Within 15 years he established the first scientific collection of shells in Poland, with ca. 8,000 species. Together with Antoni Ślósarski, Lubomirski arranged and identified the malacological collection of the Zoological Cabinet. At the end of his life he started studying South American snails sent by K. Jelski and J. Sztolcman. He produced two papers: *Note sur une nouvelle espèce de Guesteria Crosse* (Paris, 1879) and *Notice sur quelques Cogouilles du Pérou* (London, 1879). He also prepared a third publication, based on the shells collected in Peru by J. Sztolcman, but failed to finish it because of illness and untimely death. He was member of the *Société Zoologique de France*. Władysław Emanuel Lubomirski died on February 24th 1882 in Warsaw. His grave is in the Powązki Cemetery. Some animal species were dedicated to him, among others *Helix (Fruticicola) lubomirski* Ślósarski, 1881 (Mollusca), *Mycetophila lubomirskii* Dziedziński, 1884 (Arthropoda), *Hyale lubomirski* Wrzeźniowski, 1879 (Arthropoda), *Marpissa lubomirskii* Taczanowski, 1879 (Arthropoda), *Pipreola lubomirskii* Taczanowski, 1879 (Chordata), *Nenia lubomirskii* Poliński, 1922 (Mollusca). After Lubomirski's death, his malacological collection was given to the Polish State Museum of Natural History in Warsaw (now Museum and Institute of Zoology, Polish Academy of Sciences). In his report on the Museum's activities in 1919–1921, Antoni Wagner (director of the Warsaw Museum in 1921–1928) wrote: „*Donations. Stefan prince Lubomirski (Kruszyna): huge malacological collection of the late Władysław Lubomirski, with ca. 8,000, for the most part very rare mollusc species from all over the world, more than 40,000 specimens, in 5 mahogany cabinets with 130 drawers*”. Władysław Emanuel Lubomirski's collection has been preserved till today and is available at the Museum and Institute of Zoology, Polish Academy of Sciences.

NEW LOCALITIES OF *CEPAEA VINDOBONENSIS* (FÉRUSSAC, 1821) IN POLAND

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New localities of *Cepaea vindobonensis* were found in Poland in 2010–2015. The species was recorded in the Szczercowska Basin (for the first time in the mesoregion) in 2010, in Burzenin, on a scarp at the road Burzenin-Szynkielów, in a place of former limestone mining. The site is protected within the Natural-Landscape Complex "Góry Wapienne", part of the Landscape Park of Warta and Widawka. Three years later, in 2013, *C. vindobonensis* was observed

also in the nature reserve "Winnica" in Wielka Wieś near Burzenin. In the same year the species was found in the Wieluń Upland, from where only two localities had been previously known, described by Berger in 1958 and 1961. The observations were conducted in Działoszyn, in a place overgrown with young *Robinia*, near Cement Works Warta. Other localities, south of the Wieluń Upland, were found in 2011 in Wierzchowie, on limestone outcrops in the Kluczwody Valley and in Prądnik Korzkiewski, on a scrub-covered scarp along the road in the Valley of Prądnik in the Olkusz Upland. The species is common in the mesoregion. More localities were discovered in the Vistula valley. In 2012 *C. vindobonensis* was recorded in the Małopolski Gorge of Vistula, in Dobrze near Kazimierz on the Vistula, on a scrub-covered scarp. In the mesoregion the species was repeatedly recorded in the Vistula valley, on the section Zawichost-Puławy. The survey included also the Warsaw Basin, where in 2013 *C. vindobonensis* was found in Czerwińsk on the Vistula, on the river scarp, and in a similar habitat on a vegetated scarp in Wyszogród. Besides, in 2015 localities were found in Zakroczym between road S7 and the Warsaw-Modlin airport and in Izabelin-Dziekanówek on the Vistula floodplain.

GENETIC STRUCTURE OF THE ENDANGERED THICK-SHELLED RIVER MUSSEL *UNIO CRASSUS* (PHILIPSSON, 1788) IN THE RIVERS OF POLAND

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The spatial structure of genetic variation in many species, including European freshwater bivalves, is shaped by both their evolutionary history and by contemporary demographic phenomena. Most species are genetically structured within their distribution ranges. The object of our studies was the endangered and strictly legally protected freshwater bivalve, the thick-shelled river mussel *Unio crassus* (Philipsson 1788). We estimated variation and genetic differentiation of populations of *U. crassus* in the rivers of Poland; we studied the species' genetic structure and factors affecting it; we tested the usefulness of M type mtDNA genome (fragment *Mcox1*) in phylogeographic analyses; we identified conservation units of *U. crassus* in Poland. Spatial genetic structure of *U. crassus* was determined using two categories of molecular markers: nuclear DNA – 13 loci

of microsatellite DNA (msatDNA) and maternally inherited mitochondrial DNA (mtDNA of F type) – *Fcox1* and *ND3-ND2*. Besides, using heteroplasma of mtDNA in somatic tissues, we tested the usefulness of paternally inherited marker *Mcox1* (mtDNA of M type) in reconstructing phylogeography of the species. The spatial genetic structure of *U. crassus* in the rivers of Poland was essentially compatible at the level of independent categories of genetic markers. The studied populations were divided in two distinct clades (probably derived from different glacial refugia): northern (populations from lowland rivers) and southern (populations from mountain rivers). A contact zone of the two evolutionary lineages was found in central Poland. The analysis of the genetic structure at the level of microsatellite DNA loci revealed subclades in the southern clade: one from the Danube system and another from the Vistula system, as a result of their isolation and recent changes of genetic structure. All the studied populations of *U. crassus* are to various extent isolated, and their genetic variation is currently shaped according to the model of isolation by distance. Both the patterns of genetic variation and the results of neutrality tests are characteristic of spatial and demographic expansion and lend support to the hypothesis of post-glacial colonisation of Poland by two different evolutionary lineages of *U. crassus*. Groups of populations representing those lineages merit the status of main conservation units, i.e. Evolutionarily Significant Units; ESU). Populations with their own evolutionary history are especially valuable from the point of view of conservation.

SNAILS AS BIOINDICATORS OF ENVIRONMENTAL POLLUTION: EFFECT OF MAGNETIC FIELD

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Electromagnetic field (EMF), as a natural environmental factor, affects circadian and annual rhythms of many organisms. Environmental pollution with electric factors has a deleterious effect on their functioning. Electromagnetic field disturbs chemical reactions in cells and, through increasing synthesis of free radicals, may cause oxidation stress. Electromagnetic field prolongs the lifetime of free radicals in cells and changes the activity of some antioxidant enzymes. Its effect depends on the frequency of the signal, amplitude and wave length. Since there is still no sufficient knowledge on the effect of

electromagnetic field on human organism and on the functioning of its various systems, model organisms for studying the problem are sought. Since snails are successfully used as bioindicators of environment pollution, we attempted analysis of the effect of electromagnetic field on their antioxidant defence. In our experiments we used the Roman snail (*Helix pomatia*) from two natural localities: 1) site regarded as ecologically pure, far from power lines, and 2) site directly under a power line. Each group (n=20) was divided in two subgroups: i) control, ii) individuals exposed to electromagnetic field in laboratory conditions. For this purpose we used a solenoid of inner diameter of 19 cm and length of 21 cm, which generated sinusoid field of dominant magnetic component. The EMF frequency was $f=50$ Hz and the magnetic induction was $B=7$ mT. An exposure-imitating set, but without EMF, was used for the control group. Following the exposure, kidney and hepatopancreas from each specimen were examined for the activity of selected antioxidant enzymes: catalase (CAT), selenium-dependent glutathione peroxidase (Se-GPX) and glutathione transferase (GST), as well as the content of reduced glutathione (GSH). Concentrations of malonic aldehyde (MDA) and carbonyl groups of proteins (CP) were determined as indicators of damage to membrane lipids and proteins. The activity of antioxidant enzymes in the snails from the site far from electromagnetic field sources was much higher than in the snails from the site under the power line. Besides, the control subgroup from the ecologically pure site showed a higher concentration of oxidation stress markers than the control subgroup from under the power line. Exposure of snails from the pure site to EMF caused no changes in the activity of CAT, or Se-GPX, but resulted in a decrease in the activity of GST in the kidney. In both subgroups, control and EMF-exposed, the GSH concentration was higher in the hepatopancreas than in the kidney. EMF-exposure did not increase the damage to the membrane lipids (MDA) or proteins (CP). Snails from under the power line, exposed to EMF in the laboratory, showed no changes in the CAT activity. However, an increase in the activity of Se-GPX in the kidney and a decrease in the GST in the hepatopancreas was observed. The EMF exposure caused no changes in the GSH concentration or increase in damage assessed on the basis of the MDA and CP concentration. The results do not make it possible to ascertain if low frequency EMF has a negative effect on living organisms, and further experiments are planned. However, considering the statistically significant differences in the activity of the studied enzymes between the control groups from different habitats, it can be supposed that the group of snails from the “ecologically pure” site was influenced by other factors which changed their antioxidant status.

THE EFFECT OF THE REGION'S GEOLOGICAL HISTORY ON THE GENETIC STRUCTURE AND MORPHOLOGICAL VARIATION IN POPULATIONS OF *BYTHINELLA* FROM THE BALKANS AND THE AEGEAN SEA BASIN

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Because of the analogies with the fauna of isolated islands, the spring-dwelling fauna presents an interesting object for studies on various aspects of evolutionary biology. The example here is the genus *Bythinella*, very small, freshwater, dioecious proso-branches which inhabit central and southern Europe and Asia Minor. Their typical habitats are springs and subterranean waters. We aimed at expanding the knowledge of the distribution of the genus in the Balkans (Bulgaria and continental Greece) and in the Aegean Sea basin including Anatolia. We took samples from 34 new localities and analysed morphological (shell shape, structure of male and female reproductive organs) and genetic characters (variation of two genetic markers, mitochondrial COI and nuclear ITS-1). The results were combined with the existing data on the taxon from the studied areas. The genetic studies made it possible to distinguish five main clades of *Bythinella* in Bulgaria and seven in Greece and the Aegean Basin. The phylogeographic patterns were then analysed in the light of contemporary knowledge of the geological and climatological history of the area. The following conclusions were drawn. The differentiation of *Bythinella* in the present-day Bulgaria is probably a result of the Pleistocene glaciations, Messinian Crisis and the temporary existence of the Dacian Basin. The distinctness of the populations from south-western Anatolia from the remaining spring snails of the Aegean Basin is an effect of ecological isolation caused by refilling of the Mediterranean Sea after the Messinian Crisis, ca. 5.3 million years ago. Generally, the degree of genetic differentiation between the mainland populations and those from islands was similar, suggesting that both land and sea water constitute similar barriers to gene flow between the spring snail populations. An interesting result of the studies is the discovery of an evolutionary hotspot of *Bythinella* in central Greece. Financed by DS-3253/ZAZ.

IDENTIFICATION OF A NEW GROUP OF AQUAPORINS (MALACOAQUAPORINS) EXCLUSIVE TO MOLLUSCS

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Aquaporins are proteins which build aquapores in biological membranes. They belong to the MIP (Membrane Intrinsic Proteins) protein family. They can be divided in two groups: classic aquaporins (AQP), which transport mainly water according to the concentration gradient, and aquaglyceroporins (AQGP), which additionally transport other small electrically neutral molecules such as glycerol. MIP have been identified in both eukaryotic and prokaryotic organisms. The presence of several different MIP proteins in a single organism is characteristic. They differ in the kind of transported substance, velocity of transport and in the tissue- or organ-specific site of expression of their encoding genes. All the MIP proteins have a common basic structure: six trans-membrane domains and five loops connecting them. The structural elements characteristic of AQP which determine the selectivity of transport are two conservative NPA motives lining the pore, and a four-amino-acid selectivity filter (FS). The best studied MIP proteins are those found in mammals; among invertebrates insects are the best studied. Mollusc aquaporins are among the least known MIP proteins. The results of phylogenetic analysis of aquaporins from different animal species make it possible to subdivide the MIP family into four subfamilies: AQP1-like, AQP3-like, AQP8-like and AQP12-like (from the names of mammalian aquaporins). Most of the analysed MIP sequences can be placed in one of the four subfamilies. However, there are some exceptions to the rule. Such an exception is an additional subfamily composed of some MIP proteins found in molluscs. The group includes aquaporins identified in *Crassostrea gigas* (Thunberg, 1793) (two proteins), *Lottia gigantea* (Sowerby I, 1834) (one protein), *Helix pomatia* Linnaeus, 1758 (one protein) and *Planorbis* *corneus* (Linnaeus, 1758) (one protein). These MIP sequences were called malacoaquaporins (Maqp) because of being mollusc-specific. Bioinformatic analysis of the amino-acid sequences of Maqp proteins made it possible to ascertain their NPA motives and FS structure. The diversity of the FS amino-acid structure identified among the Maqp is noteworthy: TVGR – *C. gigas*, AIGR – *C. gigas*, SIAR – *L. gigantea*, CIAR – *H. pomatia* and AVSR – *P. corneus*. Besides, we experimentally proved the functionality of the Maqp found in *H. pomatia* and *P. corneus* as water-transport-



ing channels and excluded the possibility of glycerol transport. Study financed from grant NCN no. DEC-2011/01/B/NZ4/00630.

PHENOTYPIC PLASTICITY AND ABSENCE OF REPRODUCTIVE BARRIERS BETWEEN TWO MORPHOLOGICAL FORMS OF *TROCHULUS HISPIDUS* (GASTROPODA: HYGROMIIDAE)

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Many snails of the genus *Trochulus* display an extremely wide morphological variation and their taxonomic status is unclear. This pertains especially to two forms of different shell shape, often regarded as distinct species: *T. hispidus* and *T. plebeius*. The latter is sometimes regarded as a synonym of *T. sericeus*. In order to determine to what extent the two sympatric forms were reproductively isolated we attempted crossing them in laboratory. To test the expected model of phenotypic plasticity in laboratory, we compared the shell morphology in the offspring of two generations with their “wild” parents. The two forms were not separated by reproductive barriers. Fecundity, mean batch size and viability of F₁ generation in all kinds of crosses did not differ statistically significantly, however the pairs differed in the number of produced eggs and the control pairs produced more eggs than the experimental ones. Likewise, reproductive compatibility, similar fecundity and hatching success between the hybrids in F₂ generation were similar as in the parental crosses. Phylogenetic analyses showed significant clustering of sequences from various forms and confirmed the lack of reproductive isolation between them. In laboratory, morphological shell characters showed a great plasticity. The average shape of the *hispidus* form underwent a considerable change: over one generation the flat shell with wide umbilicus changed into a more spherical or even elevated shell, resembling that of *sericeus/plebeius*. The results indicate that the studied forms are not distinct species and their gene pools are not separate. We suggest that phenotypic plasticity may have played a significant part in the evolution of shell polymorphism. The forms have probably evolved independently as part of separate phylogenetic lineages under the effect of local environmental factors.

THE MUSK RAT *ONDATA ZIBETHICUS* DISCOVERS THE CHINESE CLAM *SINANODONTA WOODIANA* IN THE VISTULA IN WARSAW

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The musk rat *Ondatra zibethicus* is strictly associated with aquatic and semi-aquatic habitats. Its diet is composed of aquatic and terrestrial plants, bivalves, frogs and crayfish. Evidence of its feeding is provided by numerous bivalve shells, with the valves still connected by the ligament, on lake and river shores. On the 29th of June 2016, among numerous shells of *Unio tumidus*, predated and left by the musk rat on the left bank of the Vistula near the General Stefan Grot Rowecki bridge in Warsaw (52°17'07"N 20°59'42"E), we found two valves of the Chinese clam *Sinanodonta woodiana*. Further search for the species was conducted in July and August 2016 on both sides of the river within the boundaries of Warsaw. Besides, samples were taken from the bottom of the Vistula and its oxbows (to the depth of ca. 40 cm), with a metal sieve 20 cm in diameter. Shells of *S. woodiana* were found on both banks of the studied river section. Several complete shells and 12 valves were collected on the banks and three live individuals were found on the river bottom. *S. woodiana* is an invasive species which is native to Eastern Asia. It was introduced into Poland from Hungary, with fish fry, in the middle 1980s and since then inhabited the system of heated lakes and canals in Konin. About a dozen further records were made, among others in Wielkopolska. The species was not previously recorded in central Poland, especially the Vistula. The earlier records of *S. woodiana* in Poland were thought to be associated with fish transports, but its presence in the mid Vistula may indicate its natural spread along rivers. It is advisable to continue studying its spread in the Vistula system. In our experience observation of musk rat feeding grounds is a valuable addition to the typical methods of bivalve sampling.



THE OCCURRENCE AND ABUNDANCE OF *CEPAEA NEMORALIS* (L.) IN THE COUNTRYSIDE: SIGNIFICANCE ON SPATIAL SCALE, HUMAN INTERFERENCE AND PREDATION PRESSURE

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Cepaea nemoralis (L.) is among the world's best studied organisms. However, the knowledge of the environmental factors which shape its occurrence and abundance on the scale of landscape, habitat and microhabitat, is incomplete. The species seems to be an ideal model organism for studying landscape ecology, anthropopressure and predator-prey relations. Till now there are no studies integrating the factors which act at various spatial scales and have different character (biotic/abiotic) in order to explain the occurrence and abundance of land snails. Moreover, despite the considerable advancement of the knowledge of metapopulation functioning, human influence and its interactions with predation pressure have only rarely been taken into account. Our aim was to test: 1) relations between the presence and abundance of the snail and environmental variables of different spatial scale (landscape, habitat, microhabitat), 2) assumption that human activity can modify relations between *C. nemoralis* and its predators (thrushes *Turdus* spp. and small mammals), 3) relation between predator abundance, predation pressure and pressure of environmental factors associated with landscape and habitat structure. At the landscape level the occurrence of the snail's colonies was positively correlated with the proportion of wasteland and length of roads within the radius of 100 m. The abundance of thrushes was a positive predictor of the presence of colonies of *C. nemoralis*, but only in places with strong anthropopressure, and a negative predictor in places with small human interference. The colony's abundance was positively correlated with the size of habitat patch, road length within 100 m and bird predation pressure, and negatively correlated with the proportion of forest within 100 m. At the habitat level the snail's presence and abundance were negatively correlated with the presence of dry vegetation and the distance to the nearest tree or shrub, and positively with the height of herbaceous vegetation. The thrush predation pressure was negatively correlated with the proportion of

built up areas and forest in the landscape, while the small mammal pressure was positively dependent on the abundance of the colony of *C. nemoralis* and on human interference. The distribution and abundance of the snail's colonies in a fragmented countryside are shaped by different environmental factors associated with the structure of landscape, habitat and microhabitat. There are also dependences between the presence and abundance of *C. nemoralis*, abundance of its predators and predation pressure. Humans have a positive effect on the snail's presence and abundance through creating favourable habitats and through limiting the bird predation. At the microhabitat level the snails depend on the type of substratum and shelter. The studies were financed by the grant NCN no. 2011/01/N/NZ8/02015.

PONTOBELGRANDIELLA: A RECENT IMMIGRANT OR AN EMIGRANT FROM SUBTERRANEAN WATERS?

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A fragment of mitochondrial DNA: cytochrome oxidase, subunit I (COI), was sequenced in all the nominal species of *Belgrandiella* Wagner, 1927 and *Pontobelgrandiella* Radoman, 1973, described from Bulgaria. The snails came from 16 localities. Both the morphology and the sequences of COI and nuclear 18S excluded the occurrence of *Belgrandiella* in Bulgaria. All the studied populations belong to *Pontobelgrandiella*. Eleven COI haplotypes were identified among the 60 examined sequences (haplotype differentiation $Hd = 0.870$). The variation within the Bulgarian population was small, the nucleotide differentiation was 0.0078 with 14 variable positions. Except one locality with two haplotypes, each held a single haplotype, and hence no polymorphism was detected. The haplotypes formed four clades with small differences (p -distance = 0.7–1.5%). Clade I, represented by eight populations in the Balkan mountains, showed the greatest diversity of sequences (five haplotypes, $p = 0.6$ –1.2%, i.e. 3–6 point mutations). Clade II, represented by a single haplotype, was identified in two populations separated by a considerable distance. Clade III, with three haplotypes, and clade IV, with two haplotypes, were close to each other. The PCA for seven shell characters showed that, at a considerable variation with overlapping ranges, the molecularly distinct clades differed in their shell morphometrics. The lack of polymorphism may reflect founder effect, bottleneck during consecutive local extinctions and/or drastic reduction in population abundance, but it may also result from strong selection. The genetic distances

p between the clades (0.7–1.5%) may point to divergence time from 0.38–0.43 to 0.81–0.92 million years. Hence the divergence may have taken place in the Pleistocene, or more precisely in the Calabrian and Middle Pleistocene. This suggests a recent adaptation to cavernicolous life and stygobiontic habitats in *Pontobelgrandiella*. During the Calabrian and Middle Pleistocene *Pontobelgrandiella* started living in subterranean waters which may have been associated with the Pleistocene climate fluctuations. It is noteworthy that though *Pontobelgrandiella* belongs to a distinct clade, till now recorded only from subterranean waters of Bulgaria, as opposed to the other clades it is also often found on the surface, in springs, though it is unknown if it is its natural habitat or if it is occasionally washed out. In the former case strong selection on the surface may have caused the small genetic differentiation of the populations.

SINANODONTA WOODIANA AND NATIVE UNIONIDS IN THE LOWER Odra RIVER

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Till now *Sinanodonta woodiana*, spreading all over Europe, in Poland was found mainly in stagnant waters: fish ponds but, in contrast to other European countries, there were no records from rivers. In 2015 we controlled the lower section of the Odra and the Warta mouth, and found the Chinese clam for the first time. The fact was due to the long drought which led to a record decrease in water level in most inland waters. In four localities we found 18 live clams of shell length of 38–118 mm. *S. woodiana* reached small densities, from 0.5 to 2.6 indiv./m², and co-occurred with the native unionids, the dominants being *Anodonta anatina*, *Unio tumidus*, *U. pictorum* and *Pseudanodonta complanata*. The proportion of *S. woodiana* in the community ranged from 1.85 to 6.1%, and the biomass from 3.64 to 26.15%. The results show that the Chinese clam has inhabited the Odra for many years, without reaching great density or biomass. Perhaps the habitat conditions are still more favourable for the native unionids. The co-occurrence of the species is also due to the varied char-

acter of the bottom which provides adequate habitats to species of different requirements. The studies show also that the Chinese clam is spreading efficiently, colonising waters of various types in entire Poland, which in the future may lead to appearance of its numerous populations.

MOLLUSCS FROM THE DEPOSITS OF PERSPEKTYWICZNA CAVE, KRAKÓW-CZĘSTOCHOWA UPLAND

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Perspektywiczna Cave (50°26'33.5"N, 19°46'1.5"E) is located in the environs of the village Poręba Dzierżna, in the valley of Udorka stream, central part of the Kraków-Częstochowa Upland, ca. 80 km SE of Częstochowa. Malacological studies were done in profile Udórz V (sampled in 2013–2014), near the cave's entrance. The profile included: humus dusty soil with rubble, accumulated in the late Holocene (layers 1, 2); dusty loams with rubble, representing Early/Middle Holocene (3, 4); loesses (5, 6), dusty loam with rubble (7, 8) and rock rubble with intercalations of dusty loam or loess (9), preliminarily assigned to the Pleistocene (MIS 2). Till now 4.5 m of deposits were uncovered. We present the results for 52 samples representing all nine layers. The samples contained 1,237 specimens of 57 taxa: 46 species of terrestrial snails and one bivalve. The single shell of *Pisidium casertanum*, the accompanying fish scale and the sedimentation features of layer 9 may indicate periodic flooding of the cave by the Udorka. The lowest part of the profile held increased frequencies of *Succinella oblonga*, often found near water and in periodically flooded meadows. Layers 9 and 8 were dominated by *Discus ruderratus* and *Vallonia pulchella* with accompanying glacial relict *Vallonia tenuilabris*. The fauna is typical of taiga communities with numerous open places. In the higher part of the profile shade-loving species dominated, with a high proportion of the hygrophile *Vitrea crystallina* in layers 6 and 4, and with a distinct layer rich in *Discus rotundatus*, *D. perspectivus* and *Aegopinella pura* (layer 4), probably indicating the Holocene climatic optimum – Atlantic phase. Because of the paucity of shells in the examined samples from the upper part of the profile the reconstruction of environmental changes in the Late Holocene is difficult and requires examination of



more extensive material. The study was financed by the NCN grant no. 2014/15/D/HS3/01302.

WHO DOES THE ZEBRA MUSSEL LIKE MORE?

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The zebra mussel (*Dreissena polymorpha*) is among the best studied invasive species; its introduction caused disturbances in many freshwater ecosystems. The mussel populations may have a direct or indirect effect on the ecosystems: their ecology, biochemistry, biodiversity or economy. An important aspect is the disappearance of the native Unionoida. The appearance of the zebra mussel has a negative effect on the native populations, as a result of treating them as substratum, thus deteriorating their filtration conditions, decreasing their mobility, preventing them from digging down and damaging their shells. Our aim was to determine if there was any difference in accessibility of the native vs. invasive unionid to *D. polymorpha*. In 2014 we selected populations of *Sinanodonta woodiana* and *Anodonta anatina* co-occurring with *D. polymorpha* in Lake Gołławskie. The unionids occurred on sandy bottom and their shells were the main substratum to which the zebra mussel attached. The bivalves were collected by a scuba diver; the unionids were measured and their photographs were used to analyse the shell surface available to the zebra mussel and the surface actually occupied by it. The zebra mussels were also counted. There were statistically significant differences in the surface available to the zebra mussel between the native and the alien unionid. *A. anatina* was more overgrown with the zebra mussel than the Chinese clam and had a larger shell surface available to the zebra mussel. In the same habitat only 25.5% (17.6–39.2) of shells of *S. woodiana* protruded from the bottom deposit, thus being available to the zebra mussel, while the mean corresponding surface in *A. anatina* was 45.38% (24.6–64.4). The data indicate that, though the shells of *S. woodiana* are used as a substratum by the zebra mussel, due to deep digging in the substratum they are better protected from the negative effect; the zebra mussel is better adapted to the native species, in this case *A. anatina*.

AN ALIEN AMONG OUR OWN – IS IT POSSIBLE?

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Since the beginning of the 1980s, the Asian Chinese clam (*Sinanodonta woodiana*) has been spreading in the whole of Europe including Poland. About 30 localities are known within the country, and their number is increasing. Till now only few examples of co-occurrence of the native unionids with the Chinese clam have been observed, and little is known about its effect on the native bivalves. Some publications indicate replacement of the native species by the invader, but such cases have not been studied in detail. The usual explanations include faster growth and higher reproduction rate of *S. woodiana*, glochidia competing for the same fish species, or increased resistance to adverse environmental conditions, especially to higher water temperature. Finding a few localities where *S. woodiana* co-occurred with the native unionids encouraged us to try to check how long-lasting they were. The examples presented here are varied in terms of thermal and habitat conditions, the co-occurring species and their densities. They include bivalve populations from two ponds of natural thermal regime, Lake Gołławskie, a discharge canal of the Konin power plant, and the Odra river. In the naturalised and now unused fish pond on the boundary of the Słowiński National Park, *S. woodiana* (43%) dominates, with co-occurring *A. cygnea* (39%) and *A. anatina* (18%). In the discharge canal of the Konin power plant four unionids co-occur with the Chinese clam (71.3%): *Anodonta anatina* (18.7), *Unio tumidus* (7.2), *U. pictorum* (2.6) and *A. cygnea* (0.2). In the Odra the maximum proportion of *S. woodiana* was 6.1%, while in the pond near Nowy Lipsk (Podlasie voivodeship) its percentage was even smaller – to 5%. Replacing of the native unionids by *S. woodiana* seems possible but not obligatory. Regular studies including population monitoring and experiments are needed to verify our observations.

NEW LOCALITY OF *CORBICULA FLUMINEA* IN THE VISTULA IN WARSAWMICHAŁ WINCZEK^{1,2}, JERZY ROMANOWSKI¹¹Wydział Biologii i Nauk o Środowisku, Uniwersytet Kardynała Stefana Wyszyńskiego, Warszawa²Koło Biologów Terenowych Uniwersytetu Kardynała Stefana Wyszyńskiego, Warszawa

Shells of two specimens of *Corbicula fluminea* were found on the 29th July of 2016 on the left bank of the Vistula near the bridge of general Stefan Grot Rowecki in Warsaw (52°17'07"N, 20°59'42"E). Further search was conducted in July and August of 2016 on both banks of the Vistula and in two oxbows within Warsaw. Besides, samples were taken from the river bottom and oxbows (to the depth of 40 cm), using metal sieve of 20 cm diameter. Shells of *C. fluminea* were found on both banks of the studied Vistula section. A total of 19 complete shells and 76 valves were collected. Live bivalves were found on the river bottom (2 individuals) and in an oxbow on the boundary of Młociński Forest (6 individuals). *C. fluminea* is an invasive species which is native to Asia. In Europe it was first recorded in Portugal and France. In Poland it was found in heated waters of the Lower Odra canal near Nowy Czarnów and Gryfino (West Pomerania) in October 2003. Further studies documented the species' expansion on the whole of mid and lower Odra and in the upper Vistula in the environs of Kraków. In central Poland the species had not been previously recorded. The earlier considerations on the course of invasion of *C. fluminea* in Poland focused on anthropogenic factors, such as introduction with fish fry or by anglers. The records of the species in the upper Vistula since ca. 2008, and now also in the Warsaw section of the Vistula, indicate a possibility of successful spread of the species along the watercourses of Poland.

GENETIC VARIATION OF *ARION VULGARIS* MOQUIN-TANDON, 1855 IN EUROPEKAMILA ZAJĄC¹, DOROTA LACHOWSKA-CIERLIK², ANNA FILIPIAK³, BJØRN A. HATTELAND^{4,5}, BARBARA FELDMEYER⁶, MARKUS PFENNINGER⁶¹Zespół Ekologii Fizjologicznej i Ewolucyjnej Bezkręgowców, Instytut Nauk o Środowisku, Uniwersytet Jagielloński, Kraków²Zakład Entomologii, Instytut Zoologii, Uniwersytet Jagielloński, Kraków³Instytut Ochrony Roślin – Państwowy Instytut Badawczy, Poznań⁴Department of Biology, University of Bergen, Bergen, Norway⁵Bioforsk – Norwegian Institute for Agricultural and Environmental Research, Lofthus, Norway⁶Biodiversity und Climate Research Centre by Senckenberg Naturforschende Gesellschaft, Goethe-Universität, Frankfurt, Germany

Arion vulgaris Moquin-Tandon, 1855, for many years called *A. lusitanicus* (Mabille, 1868), is among the hundred most invasive species in Europe. We aimed at studying the genetic variation in *A. vulgaris* among and within European populations and at identifying the possible pattern of haplotype distribution. Besides, we attempted to check if there were cryptic species within *A. vulgaris*, based on the mean genetic distances between the haplotypes of *cox1*. In the molecular analyses we used specimens from 28 populations from European countries: Norway (11), Poland (9), Denmark (3), Germany (3) and France (2). In order to confirm the taxonomic identification of the slugs we used anatomical characters. Analyses of sequence of the mitochondrial gene *cox1* showed the presence of 19 haplotypes, which differed in 1 to 10 changes in single nucleotides in their DNA (SNP) sequence; 20 polymorphic sites were identified. The mean genetic distance between the haplotypes was 1.19% (range 0.2–2.4%), while the mean genetic distance between species of the genus *Arion* (based on GenBank sequences) was 17.67%. The data confirm that there are no cryptic species within *A. vulgaris*, the examined specimens are conspecific and belong to a widely distributed species. Besides, there is a segregation pattern of haplotypes, further confirming the conspecificity.



CHARACTERISTICS OF *AEROMONAS HYDROPHILA* ISOLATED FROM DISEASED EUROPEAN BROWN SNAIL *CORNU ASPERSUM*

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Some snail diseases are reported to be caused by a group of closely related aeromonads. Here we used biochemical and MALDI-TOF tools for further characterisation of a strain of *A. hydrophila* isolated from diseased *Cornu aspersum*. During the epizootic disease of *C. aspersum*, *A. hydrophila* HA1 were obtained from diseased snails (in contrast to non-affected snails) from a private farm in the environs of Lublin (Poland). The bacteria were G (-), motile rods which produced smooth rounded colonies, 2–3 mm in diameter, and green with a black centre in Aeromonas Agar Base media (AAB, Ryan). According to the biochemical characteristics (Api 20E Test, BioMerieux, France), the percentage of identification (%id) of the isolated strain HA1 to *A. hydrophila* was as high as 99.9%, with a T-index of 0.67. The %id is an estimate of how closely the profile corresponds to the taxon relative to all other taxa in the database. The T-index estimates how closely the profile corresponds to the most typical set of reactions for each taxon: excellent (%id ≥ 99.0, T ≥ 0.075), very good (%id ≥ 99.0, T ≥ 0.5), good (%id ≥ 90, T ≥ 0.25), and acceptable (%id ≥ 80.0, T ≥ 0). The assignment of the bacteria to the species level within the genus *Aeromonas* was based on biochemical tests and MALDI-TOF-MS. For spectra and comparison with the Bruker Daltonik database the strain HA1 yielded identification of *A. hydrophila* three times, with mean scores of 2.046 ± 0.002 (for whole bacterial cells analysis, W-HA1) and 2.124 ± 0.003 (for bacterial cell lysates, L-HA1). Upon comparison, the W-HA1 *m/z* signature closely resembled *A. hydrophila* CECT 839 and *A. bestiarum* CECT 4227 spectra rather than *A. salmonicida* NCIMB 834 and *A. veronii* bv. *sobria* CECT 4246 spectra. The L-HA1 *m/z* signature closely resembled *A. hydrophila* CECT 839 and *A. salmonicida* NCIMB 834. The susceptibility of *C. aspersum* to *A. hydrophila* HA1 was tested by immersion challenge. *A. hydrophila* HA1 reproducibly

infected snails and caused morbidity and mortality. To our knowledge, this is the first report on the isolation and accurate identification of *A. hydrophila* associated with the snail disease in a Polish farm. This study should facilitate devising suitable strategies for fast identification and control of the pathogen.

THE EFFECT OF SPRAYING WITH 0.25% SOLUTION OF LAMBDA-CYHALOTHRINS (COMMERCIAL PREPARATION KARATE ZEON 050 CS) ON THE CONDITION OF *CORNU ASPERSUM*

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In Poland, *Cornu aspersum* Müller is farmed in an open system. Juveniles are transferred to protected fields with food plants (e.g. agrimony). Larvae of *Plutella xylostella* and *Pieris rapae* are among the most common agrimony pests. Insect control in such cultivations is difficult because of the presence of snails which are sensitive to many insecticides. Preparations of pyrethroid group are among commonly used insecticides. We attempted to test the effect of the spray on selected biochemical parameters of the snail haemolymph. The material included 60 *C. aspersum*. They were kept in a plastic container with garden soil. About 2 kg of agrimony were placed in the container, with larvae of *P. xylostella*. On the first day of the experiment haemolymph was sampled from 15 snails and the level of AST and ALT was determined using the apparatus for biochemical blood tests BS 30. Then the snails and the plants in the container were sprayed with 0.25% of Karate Zeon 050 CS. The animals were then observed for 14 days. Three consecutive haemolymph tests were done, using 15 snails in each test, on the 1st, 7th and 14th day of the experiment. The snails' behaviour, appetite and activity were also observed. The determination of the aminotransferases level on the 1st, 7th and 14th day showed no great differences compared to the results prior to the experiment. Noteworthy was the slight increase in the level of AST and ALT on the first day after spraying (10 and 7.8% respectively, in relation to the results prior to the experiment). The AST : ALT ratio increased, though it seemed to decrease with time. The animals showed no changes in their activity or feeding intensity. No deaths were recorded. The results indicate that the solution of lambda-cyhalothrins does not significantly affect the activity of aminotransferases, whose value may in-



crease in cases of poisoning. The spraying did not affect the animals' appetite or activity, and eliminated the insect larvae.

THE ROLE OF FRESHWATER SNAILS IN TRANSMISSION OF PARASITOSEs

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Parasitic diseases (parasitoses), spread by snails, belong to the metazoonoses category. Because of their role in trophic webs, freshwater snails are important links in transmission of many groups of parasites, especially digenean trematodes (Digenea). The complex relations in the snail-digenean system are an effect of nearly 200 million years of co-evolution. Various snail species play the role of both first and second intermediate hosts to digeneans, and in special cases they are sites of development of adult parasites. Hosts in which mobile, active cercariae arise, and also hosts of metacercariae whose passive transmission is through the digestive tract, are important from the medical and veterinary point

of view. Among the digeneans transmitted by freshwater snails are some which cause human diseases, such as schistosomiasis and/or „swimmers' itch”, fasciolosis, dicrocoeliosis, opisthorchosis, fasciolopso-sis, echinostomosis, paragonimosis or alariosis. Most of these parasitoses pose problems to medicine and veterinary sciences since they belong to the category of zoonoses. Besides the above-mentioned, the interest of farmers focuses on fish parasites transmitted by snails and causing, for example, diplostomosis or postodiplostomosis, or parasites of birds, especially domestic ducks and geese, which cause trichobilharziosis, echinostomosis, echinopariphosis, psilotremosis, notocotylosis and others. Because of the constantly increasing range of occurrence of the mentioned parasitoses, resulting both from global climate changes and from human activities, attempts at eliminating the malacological link in the transmission are made increasingly often, using molluscicides or mechanical removal of molluscs from water bodies. Since the small effectiveness of such measures may encourage actions which disturb freshwater ecosystems, it is necessary to devise methods which on the one hand limit the danger of digenean invasion in humans and animals, and on the other do not cause serious perturbations in the environment.