

THE 31ST POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

Last year I (on-duty since 1998) wrote my usual report from yet another Seminar – it was our 30th anniversary (see *Folia Malacologica* 23(1): 51-86, 2015) and I complained, not for the first time either, about how difficult it was “to write a different seminar report each year”. Alas, I didn’t know then how lucky I was: I could attend the 30th Seminar and could give you the news first-hand. For reasons that

were entirely beyond my control I couldn’t attend the last one. Obviously, now I can tell you only what I heard from some of the participants (they told me things and gave me photos, thanks!). By the way, I’m proud of having mastered the art of writing reports from conferences I haven’t attended. Remember discussing books you’ve never read (mainly at secondary school)? It is a bit like that.



Fig. 1. Pretty nearly all the participants



Fig. 2. Banqueting. It must have been something official



Fig. 3. Banqueting. The person being hugged is the Main Organiser.

The 31st Seminar was held in September (22–25); we seem to have switched to autumn meetings for good. The place was Wieliczka (Fig. 1), a small town very close to Kraków. It is famous for its salt mine (but see below). A brand new dot on our Seminar map! The attendance was not all that great, but not very bad either: the number of registered participants was 47, the number of actual ones was 44, plus a few non-malacological accompanying persons: 3 non-malacological wives, and 3 (possibly malacological – future will show) children. The FTAs [= failed to appear] included BEATA JAKUBIK, ANDRZEJ PIECHOCKI, and myself, and we all of us had good excuses I think; there was also one neighbour from the Zhytomyr University, Ukraine, who failed to materialise, but now we regard this as more or less normal.

The organising institutions were the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences (Kraków), Wrocław University and the Association of Polish Malacologists; the organising committee included (listed in the same order as in the Abstract Book): EWA STWORZEWICZ (Kraków), MAGDALENA GAWLAK, MONIKA JASKULSKA, TOMASZ KAŁUSKI (all three from Poznań), ELŻBIETA KUŹNIK-KOWALSKA, TOMASZ K. MALTZ and MAŁGORZATA PROĆKÓW (all three from Wrocław). The Abstract Book was edited by TOMASZ K. MALTZ and TOMASZ KAŁUSKI and published by our publisher of the *Folia Malacologica*: Bogucki Wydawnictwo Naukowe. Our thanks go to the Organisers and the Editors. Great job! The Seminar was sponsored by the Association of Polish Malacologists, Carl Zeiss



Fig. 4. Banqueting. The new Honorary Member is indicated with arrow



Fig. 5 In the salt mine (St. Kinga's Chapel)



Fig. 6. Poster session

Ltd., Comef Ltd., Keyence International (Belgium) NV/SA and Keyence Microscope Europe.

At the 31st Seminar the handouts were the following: a dish (the size is such that you can serve cookies on it, or fruit) with a snail on it, a snail sticker, two postcards with a fossil snail (an amber inclusion), plus the usual stuff: pen, notebook, the Abstract Book, and the information about the salt mine and the local historic places.

Some of the participants, plus all the Organisers, arrived on Monday (21st). The Registration Desk worked since Tuesday morning. The snail on the welcoming poster was the same as on the postcards and the cover of the Abstract Book: an amber pupilloid. The Seminar proper started officially on Tuesday (22nd), at 15.00. I haven't heard much about the opening ceremony which means it must have been brief, and the sessions started at 15.30. The first session dealt with more general or universal topics. The other sessions were roughly divided into land and water. Such a division has good and bad sides. Among other things, it makes it possible for terrestrial people to skip aquatic sessions and vice versa. Is it good or bad? There are rumours (but from reliable

sources) of a terrestrial person who went to score *Cepaea* during the water sessions.

The banquet was on Wednesday, after the General Assembly of the Association (Figs 2–4). I haven't been there but I guess that it was during the banquet that we acquired our new Honorary Member – STANISŁAW MYZYK. For those who don't know (but I suspect almost everybody knows): STANISŁAW is one of our very few amateurs (accountant by trade), and a very good one. Some of you may remember his very good papers about life histories of various species of *Valvata* or *Vertigo* (see various issues of the *Folia*; see also Fig. 4).

On Thursday (24th) the Seminar Excursion went to the famous salt mine (Fig. 5). The mine is huge, and while visiting you face stairs with about 800 steps. It is also really deep, the St. Kinga Chapel which is a very important place, the mine's "heart", is 101 metres deep underground. The mine is one of the very few deep salt mines in Europe or even in the World. The only bad thing is that it is a bit too touristy. On Friday (25th) those who didn't have to leave early could visit the Museum of the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences (Kraków, so it wasn't very far).

Table 1. Number of papers/posters in consecutive years

No.	Discipline	2007–2010	2011	2012	2013	2014	2015	Total	Mean
1	Ecology & conservation	94	22	10	13	16	12	177	19.7
2	Applied malacology & parasitology	34	11	4	4	8	7	68	7.6
3	Life histories	32	8	7	5	2	5	59	6.6
5	Miscellaneous: general, behaviour, archaeology, collections, history, education, methodology	26	9	3	6	13	6	59	6.6
4	Biogeography & faunistics	20	11	9	8	1	1	50	5.6
6	Fossil molluscs	19	6	4	5	5	2	39	4.3
8	Structure (histology, cytology, shell) & variation	13	3	3	5	6	2	33	3.7
7	Systematics/phylogeny (including molecular)	19	2	2	6	1	2	32	3.6
9	Physiology	5	7	4	2	6	4	28	3.1
Total		262	79	46	54	58	41	577	64.1

The programme contained 25 oral presentations and 17 posters (Fig. 6). The snail:bivalve ratio was roughly 1.35 : 1 (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, 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 : 3 (1 : 3 in 2014, 0.4 : 1 in 2013, 0.6 : 1 in 2012, 0.4 : 1 in 2011, 0.9 : 1 in 2010), and the ratio of papers/posters presented by girls versus boys was 1.3 : 1 (1.3 : 1 in 2014, 1.6 : 1 in 2013, 1.3 : 1 in 2012, 1.2 : 1 in 2011, 1.9 : 1 in 2010).

Table 1 contains statistics of the 2007–2015 presentations and posters (many, as usual, assigned to more than one category). For technical reasons those of 2007–2010 have been lumped together. This year the leading category was ecology & conservation, and it had been so since 2007 (see also columns Total and Mean in the Table). The reasons for this situation are, I think, many and I can never decide which is the main one: real interest in preserving endangered species, possibility to get funding for conservation-related research, most basic ecological research having conservation implications, or using data from inventories (commissioned by local conservation authorities) as a basis for publication.

The numbers of papers within disciplines in consecutive years fluctuate rather than show a trend, but still, besides ecology & conservation, applied malacology & parasitology and life histories remain the most popular disciplines among the Polish malacologists. Most of the other general tendencies have not changed either; also the similarities and differences between the Polish malacology and that of the World have remained the same. If you are interested, see *Folia Malacologica* 23(1): 51–86, 2015 for some graphs illustrating the tendencies and comparisons.

The next Seminar will most probably be organised by the team from Łódź, but I don't know where exactly.

The photos in Figs 1–6 have been taken by ANNA SULIKOWSKA-DROZD and ROBERT A. D. CAMERON (I don't remember which are whose). The abstracts below include all the abstracts from the Abstract Book, most of them translated and some tweaked a bit by the author of this report.

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ABSTRACTS OF THE 31ST POLISH MALACOLOGICAL SEMINAR

HOLOCENE CALCAREOUS TUFAS IN THE VALLEY OF SKALSKI POTOK IN THE PIENINY MTS

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Calcareous tufas – characteristic Quaternary interglacial deposits – form as a result of calcium carbonate precipitation. Localities of such tufas are numerous in the Carpathians; they were formed in the Late Glacial and the Holocene. The described sites are located along the Skalski Potok, a left-bank tributary of the Grajcarek in the village Jaworki; it flows through a deep and partly forested and partly agricultural valley. The profiles stretch along a ca. 1,500 m section of the valley; 10 localities were examined. The 59 samples yielded more than 20,000 specimens representing 72 terrestrial and six freshwater snail

taxa. The malacological analysis followed the standard methods. The material included shade-loving, open-country, mesophile, hygrophile and freshwater species. Three faunal assemblages were distinguished: assemblage with shade-loving species, with open-country species and with *Bythinella austriaca*. They reflect the sedimentation conditions and, to some extent, the age. The first assemblage represents mixed forest habitats on limestone, in a warm climate of oceanic influence. The radiocarbon date (shells of *Helix pomatia*) is $6,500 \pm 270$ years BP, indicating the beginning of deposition in the Atlantic phase of the Holocene. The other two assemblages differ from the first one in the impoverishment of shade-loving species set and the presence of species which are typical of the historic period: *Bythinella austriaca* and *Cecilioides acicula*. The older tufas were formed during the Atlantic period, the younger ones during historic times, some of them showing effects of human influence.



SNAILS IN THE MIND: SYMBOLISM AND IMAGERY

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We eat snails, and in the past they have been used in various kinds of medical treatment, revived recently as the basis of beauty treatments. Shells are sometimes used in decorations, and there are a number of realistic depictions of snails in paintings, especially still lifes. These rarely carry any symbolic meaning; they are just beautiful objects. They have, however, been used symbolically, both in pictures and in writing. Here, I consider a few of these symbolic representations. The commonest modern forms usually refer to snails as a symbol of slowness, but occasionally to the carrying of one's house on one's back. In the past, however, snails signified many other things, reflected in painting, proverbs and literature. In the Middle Ages, snails might symbolise sloth (the standard Catholic symbolism) but also the Resurrection, purity, humility or cowardice! I illustrate some of these themes, especially that of cowardice, which has a long and disputed history. Snails (and slugs) also feature in the well-known Mediaeval tradition of depicting the absurd: "the world turned upside down", which persists into modern times. Most poetry mentioning snails refers, predictably, to their slowness, or to their carrying their own home. One rhyme, common to a number of countries, again uses the idea that it is cowardly to be frightened of snails. Another, a favourite nursery rhyme, brings back the notion of the absurd. Occasionally, a literary reference to snails is derogatory, but in modern times they seem to carry no moral burden. Some proverbs and divinations are more interesting, and may have very ancient origins. Find the name of your future lover; see whether he is true or false, rich or poor. A passage in Shakespeare's play "As You Like It" uses several of these themes, which crossed the Atlantic to persist in hillbilly country while dying out in Britain. The "horns" (the tentacles) could symbolise a cuckold, cattle or even Satan. The children's chants found all over Europe and even in China and Japan reveal an ancient tradition sometimes associated with spiral dances. Most of my examples come from western or southern Europe. Any thing from Poland other than the standard reference to slowness would be gratefully received.

PRELIMINARY STUDIES ON THE OCCURRENCE OF DIGENEAN TREMATODES IN MOLLUSCS FROM THE KONIN LAKES

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The system of Konin lakes includes interconnected lakes Gośławskie, Pątnowskie, Licheńskie, Wąsowsko-Mikorzyńskie and Ślesieńskie; their waters are used for cooling by the local power plant and are heated as a result. The objective of the study was to inventory the digenean species carried by native and alien molluscs and to estimate the degree of infection of the hosts. The molluscs were collected from May to August 2015 in lakes Gośławskie, Pątnowskie and Licheńskie. The 1,080 specimens (807 snails, 273 bivalves) represented 18 species: *Viviparus contectus* (124 specimens), *Lymnaea stagnalis* (138), *Radix* sp. (88), *Stagnicola palustris* (18), *Planorbium corneum* (90), *Physa acuta* (69), *Bithynia tentaculata* (84), *Menetus dilatatus* (57), *Anisus vortex* (37), *Gyraulus albus* (10), *Potamopyrgus antipodarum* (92), *Unio tumidus* (30), *U. pictorum* (1), *Sinanodonta woodiana* (54), *Dreissena polymorpha* (151), *Corbicula fluminea* (13), *Anodonta anatina* (21) and *Sphaerium rivicola* (3), and contained 27 digenean species (26 in snails, 1 in bivalves). The rate of infection (14.74% in snails, 3.3% in bivalves) varied according to the site and period. Despite the large number of mollusc species, compared to lakes of natural thermal regime, the digenean richness was relatively small.

ASPIDOGASTREANS (TREMATODA: ASPIDOGASTREA) IN NATIVE UNIONIDS

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Aspidogastreae are a subclass of parasitic flatworms with ca. 80 species; they reach maturity in bivalves, teleost fishes and freshwater turtles. Two species have been recorded in Poland to date: *Aspidogaster conchicola* von Baer, 1827 from the bivalve pericardial cavity and *A. limacoides* Diesing, 1835 from the fish intestine. Our aim was to check which of the unionids of Poland (*A. anatina*, *S. woodiana*, *U. tumidus*, *U. pictorum*) was the most frequent host of *A. conchicola*. The studies were carried out in 2014 and included 11 lakes of the Brodnickie, Iławskie, Dobrzyńskie and Gnieźnieńskie lakelands. Among the 1,047 unionid specimens (459 *A. anatina*, 133 *S. woodiana*, 23 *U. pictorum* and 432 *U. tumidus*) only *U. tumidus* carried the

parasites (extensity 0.7%). The small proportion of infected unionids indicates a necessity to increase the sample size for parasitological studies.

CAN ECOLOGICAL NICHE OF UNIONIDS BE DEFINED?

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Freshwater bivalves, and especially unionids, are among the most threatened organisms worldwide. Though they dominate in the biomass of freshwater ecosystems, most aspects of their life remain insufficiently known. Assuming that the ecological niche is an n-dimensional space with abiotic and biotic factors as dimensions, a question arises if at the present state of knowledge it is possible to define and model unionid niches. Earlier studies on *Anodonta anatina*, *A. cygnea*, *Pseudanodonta complanata*, *Unio pictorum* and *U. tumidus* revealed a pattern of their vertical and horizontal distribution, without significant differences among the species. The two-dimensional model of their fundamental niches considers only distance from the shore and the silt thickness, and is thus imprecise and insufficient from the point of view of modelling for conservation purposes. The studies showed also that the bivalves formed a guild, showed a scramble competition, character displacement, niche conservatism and behavioural optimisation. At present the crucial question is the direction of further studies on unionids and the range of factors that should be considered in the model of unionid ecological niches.

THE EFFECT OF CONSPECIFIC INDIVIDUALS ON THE LOCOMOTION OF THE ZEBRA MUSSEL *DREISSENA POLYMORPHA*

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The zebra mussel often forms large colonies, providing habitats for other species and enriching their food basis. Life in a colony has its advantages (e.g. protection against predators, reproduction) and disadvantages (intraspecific competition, high concentration of metabolic wastes). These factors may determine the mussel's behaviour which involves many compromises. In order to verify the hypothesis that too high densities should decrease the animal's preferences to conspecifics, we placed single individuals in aquaria in equal distance from groups of mussels,

and separated by a net. All the movements of the individuals were registered. The number of moving individuals decreased with increasing density of conspecifics, albeit the movements were not directional. The reaction may be positive, a response to stress, or it may be aimed at minimising the energy expenditure in the absence of ability to directional movement. It may also be aimed at maintaining the "safe distance" from dense groups of conspecifics.

IS SCLEROCHRONOLOGY A WASTE OF TIME?

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Age assessment based on growth rings, though fast and non-invasive, is often criticised as imprecise and not yielding comparable results. The objective of our experiment was to test whether sclerochronology could facilitate the assessment of age, growth rate and regularity of increment in *Sinanodonta woodiana*. We also attempted to verify the precision of age assessment based on growth rings and the possible differences in results obtained by different observers. The material was collected in 2013 in five sites. One half of the shell was cut, the other was left intact. Age assessment based on growth rings and on sclerochronology was done by two persons (a beginner and an experienced observer). The growth ring method did not make it possible to estimate the age precisely; the results were usually underestimated. The sclerochronology provided more precise results. There were differences in the values obtained by experienced and inexperienced observers. Age can be estimated based on growth rings, but the results should be checked against sclerochronology for each population.

THE EFFECT OF COPPER SULPHATE ON THE ALIMENTARY TRACT OF *ARION VULGARIS* MOQUIN-TANDON, 1855

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Arion vulgaris is an invasive species and a serious agricultural and horticultural pest; new methods of



its control are being sought. One of the possible substances to control the slug is copper sulphate. It acts as a repellent without increasing the slugs' mortality. Copper compounds are known to be cytotoxic, but studies on snails suggest that copper ions are not absorbed into the haemolymph and do not affect other tissues except the epithelial cells of the sole. We attempted to find out if copper supplied with food had an effect on the digestive tract cells of *A. vulgaris*. The slugs were fed with cabbage which had been submerged in 1% copper sulphate and in distilled water (control) for 10 seconds. After five days the slugs were killed and their tissues examined in TEM and SEM. Copper sulphate had an effect only on the hepatopancreas cells (their apical parts).

OVOVIVIPARITY IN FRESHWATER SNAILS – ADVANTAGES AND DISADVANTAGES

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One of the aspects of the diversity of life strategies among gastropods is their reproductive mode: oviparity, ovoviviparity or viviparity. Freshwaters present a habitat challenge to snails: changes in water level, temperature fluctuations, or seasonality, have enforced differences in the number and morphology of eggs, mode of their laying or fastening to the substratum. Most marine and freshwater snails are oviparous; they produce egg capsules which are affixed to the substratum, with one or more embryos developing in each capsule. Among the nine gastropod subclasses, ovoviviparity occurs only among Patellogastropoda, Caenogastropoda, Heterostropha and Opisthobranchia. Most ovoviviparous snails are marine. Ovoviviparous freshwater species found in Poland are *Potamopyrgus antipodarum*, *Valvata naticina* and all viviparids. The answer to the question of the rarity of this strategy among freshwater species rests in their evolutionary history. Freshwater species originate from marine ancestors and had to adapt to their new environment; one of such adaptations was ovoviviparity which ensured protection of the developing embryos but depended on the parent surviving during the reproductive period. The ovoviviparous species mentioned above are rather common and reach high densities in their habitats.

SUSCEPTIBILITY OF VARIOUS VARIETIES OF BROAD BEAN (*VICIA FABA* L.) TO DAMAGE CAUSED BY SLUGS

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The broad bean (*Vicia faba* L., partim) is a valuable fodder plant; its most important pests include aphids (Aphididae), elephant beetles (Curculionidae) and, recently, also slugs (Arionidae, Agriolimacidae). In the absence of licensed chemical pesticides for its protection, alternative means of limiting the slug-caused damage are being sought. One possibility is the use of less susceptible varieties. Earlier studies dealt with other legumes but there were no data on the broad bean, though some observations indicated its considerable damage in slug-inhabited areas. We tried to assess the susceptibility of currently cultivated broad bean varieties to damage by selected slug species and to estimate the effect of tannin content on the degree of damage. Laboratory and field experiments used seeds and plants (stage of 3–4 and 5–6 leaves), exposed to feeding of *Arion vulgaris* Moquin-Tandon, 1885, *A. rufus* (Linnaeus, 1758) and *Deroceras reticulatum* (O. F. Müller, 1774). Five of the varieties contained small quantities of tannins in their seeds (0.032–0.035 mg/g dry mass), in the other four the content was high (0.398–0.499 mg/g dry mass). The results were subject to variance analysis and Fisher test at $\alpha = 0.05$. The degree of damage varied depending on the variety and the slug species; for some varieties the damage was radically different for seeds and plants. Each slug species showed different preferences to different varieties. The tannins seemed to have no significant effect on the feeding activity of the slugs. The preliminary assessment of susceptibility to damage by *A. vulgaris*, *A. rufus* and *D. reticulatum* will be further tested and the results will be used in practice.

THE EFFECT OF SELECTED AGONISTS AND ANTAGONISTS OF CHOLINERGIC RECEPTORS ON THE MOTOR ACTIVITY OF EPITHELIUM OF *ACHATINA FULICA*

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The motor activity of sole epithelium involves changes in its folding during the snail's movement. The forces causing movement are generated by the animal's muscles, while during the animal's motion the epithelium moves parts of the body covers in the form of moving sole waves. The experiments, aimed at estimating the effect of selected agonists and antagonists of cholinergic receptors of the sole epithelium, used 131 individuals of *Achatina fulica*, weight 10–36 g and shell height 42–70 mm, from the Department's culture. The snail movement was observed and registered using camera CCD DFK 41 AV02.AS (ImagingSource, Germany) and image analysis software IC Capture.AS 2.0. The snail velocity, sole length and width, sole length/width ratio, number and length of sole waves, length of intervals between waves, surface area ratio of sole waves to sole, frequency of waves, distance covered per one sole wave and folding value were registered in control conditions and following injections of the tested substances in doses of 10 and 0.1 (exceptionally 0.001) $\mu\text{g/g}$ body mass in the caudal part of dorsum, during 15–45 min and 45–75 min (with 30 min break). The tested substances were: epibatidine – non-specific agonist of cholinergic receptor N, hexamethonium – non-specific antagonist of cholinergic receptor N, pilocarpine – non-specific agonist of cholinergic receptor M, atropine – non-specific antagonist of cholinergic receptor M. Statistical significance was tested with Wilcoxon test ($p < 0.05$). The optimum doses were 0.1 $\mu\text{g/g}$ body mass for the agonists (epibatidine and pilocarpine) and 10 $\mu\text{g/g}$ for the antagonists (hexamethonium and atropine). The nicotine agonist – epibatidine – increased the snail velocity and some of the folding parameters, while the muscarine agonist – pilocarpine – decreased those parameters. The antagonists had no effect on the velocity. The nicotine antagonist – hexamethonium – decreased the area of sole waves, the muscarine antagonist – atropine – decreased the whole sole area. The tested substances had an effect on the regulation of the epithelium's motor activity which in turn affected the movement of *A. fulica*.

BEHAVIOUR OF *ARION VULGARIS* MOQUINTANDON, 1855 FROM SELECTED EUROPEAN POPULATIONS IN LABORATORY CONDITIONS

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The slug *Arion vulgaris* is among the most serious agricultural and horticultural pest slugs in Europe. In the 1950s it started its expansion from southern France into western Europe; on the turn of the 1980s and 1990s it was first recorded in Poland. Here we present preliminary results of observations of circadian activity of *A. vulgaris* from a few selected populations in Europe. The populations came from areas which were colonised at different times; this made it possible to compare the behaviour of the species at various stages of invasion. The observations were conducted in the laboratory at 15°C. Each container was lined with unwoven cloth pre-soaked in a mixture of water and gardening soil, with the surface divided into quarters. Shelter was placed in one of the quarters, food (two cabbage squares of 7 cm side) on another. One slug was placed in each container, and its behaviour was registered during 72 hours. The experiment was run in six replicates for each population. The video films were analysed with software EthoVision (Noldus); the time devoted to each kind of activity was statistically analysed separately for day and night. The study was financed by NCBiR within the project Pol-Nor/201888/77/2013.

THE EFFECT OF ABIOTIC FACTORS ON AGGREGATING OF THE ZEBRA MUSSEL *DREISSENA POLYMORPHA*

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Many bivalves, especially those which attach to the substratum with byssus, form colonies, thus limiting the effect of predation, excessive water movement or drying out. However, this mode of life results in increased intraspecific competition and accumulation of harmful metabolic wastes. We studied the effect of depth (1 or 5 m), substratum (loose – sand or hard – glass), light (0 or 100 lx), temperature (10–30°C, every 5°C) and water flow (0 or 9 cm s^{-1})



on aggregation forming by *Dreissena polymorpha* in the field (depth) and in the laboratory (remaining factors). The mussels most often formed aggregations at smaller depths, in medium temperatures (15–25°C) and in running water. Light had no significant effect on the degree of aggregation. To some extent the aggregating depended on the initial distance between the mussels, but such dependence was only found for distances of 15–30 mm. This may suggest that the mussels can move actively toward their conspecifics only within such distance. Druses (groups of individuals interconnected with byssus) were rarely formed. Druse-forming was almost only observed on sandy substratum which precluded attachment. Hard artificial substratum was distinctly preferred to conspecific shells. The mussels aggregated more often in the face of potential threat or in unfavourable conditions (shallow water or fast current, inadequate substratum), and when the negative effects of aggregating were less acute (medium temperatures and flowing water). The mussels attached to their conspecifics only as a last resort, in the absence of alternative hard substratum, which indicates avoidance of overdensity. Aggregation forming seems to be a compromise between the respective advantages and disadvantages of aggregated and solitary life and can be modified by environmental conditions.

DAMAGE TO POTATO TUBERS BY *ARION VULGARIS* MOQUIN-TANDON, 1885, *ARION RUFUS* (LINNAEUS, 1758) AND *DEROCERAS RETICULATUM* (O. F. MÜLLER, 1774)

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Slugs damage many cultivated plants; in recent years much slug damage has been observed in potato plantations. The most common species in such plantations are *Arion vulgaris*, *A. rufus* and *Deroceras reticulatum*; sometimes also other species of *Arion*, *Deroceras* or *Limax* are encountered, but they only cause small damage. Potato plants are attacked throughout the vegetation season; the slugs feed on all parts of the plant from the moment of planting to harvesting or storage. Damage to tubers causes the greatest losses. The slugs often attack tubers which have earlier been damaged by other pests; it is thought that intact tubers are not attacked by some slugs, e.g. *D. reticulatum*. Literature data indicate that some potato varieties, due to the presence of alkaloids, are less sensitive to slug feeding. We attempted to assess the

effect of mechanical damage to tubers on the feeding of *A. vulgaris*, *A. rufus* and *D. reticulatum* and to estimate the susceptibility of different varieties to slug feeding. In our laboratory experiments we used tubers of the varieties Vinieta, Ditta and Jelly, which were exposed to slugs of known body mass; feeding places and consumed mass of tubers were recorded during seven consecutive days. The results were subject to variance analysis and Fisher test at $\alpha=0.05$. The varieties differed in their susceptibility to slug feeding. All the slug species fed on artificially damaged and on intact tubers, but *D. reticulatum* preferred damaged tubers. With increasing mass of *A. vulgaris* and *A. rufus* the quantity of consumed food increased. The results will be used to devise a strategy for potato plant protection in slug-threatened areas.

LIFE CYCLE OF *LEPTAXIS ERUBESCENS* (LOWE, 1831) IN THE LABORATORY

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Leptaxis erubescens is a medium-sized (shell width 12–13 mm, height 10–11 mm) terrestrial snail. It is native to the Madeiran Archipelago: Madeira, Porto Santo and Desertas. In the Azores it is limited to anthropogenic sites and is thought to have been introduced from Madeira. We aimed at determining its life cycle parameters in laboratory conditions. The material (10 snails) was collected in July 2012 on Deserta Grande (32°31'11"N, 16°30'27"W). The snails were kept in Petri dishes and in plastic containers in a climate chamber of constant temperature (22°C day, 15°C night), humidity of 80% and 12 : 12 photoperiod. The snails were kept in pairs and groups of a few individuals, as well as singly since early juvenile stages. The three-year observations focussed on maturity, reproduction and growth. The species is oviparous, semelparous. Calcified, nearly spherical or oval eggs were deposited in one batch (22–110) in the soil by snails kept in groups. Juveniles, with shells of 1.3–2.1 whorls, hatched in 14–21 days; the hatching was asynchronous. No uniparental reproduction was observed. Morphological maturity (lip formation) was attained at 4.8 to 5.1 whorls (ca. 13 months). The snails reached sexual maturity (laying the first egg) when their shells were 5.0 to 5.2 whorls (ca. 26 months). The life span in laboratory conditions was at least 36 months.



THE EFFECT OF DROUGHT ON THE REPRODUCTION OF *LACINIARIA PLICATA* IN LABORATORY CONDITIONS

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Laciniaria plicata, an Eastern- and Central-European species, is common in the lowlands and submontane areas of Poland. It is a woodland species, found also in parks, vegetated screes and ruins and in open rocky habitats. Like other studied baleines, it is long-lived (up to 7 years), iteroparous, with delayed maturity (reproduction at least 5–6 months after shell growth completion). It is oviparous. In laboratory conditions (constant temperature, high humidity, natural photoperiod) it lays partly calcified, spherical or slightly elongated eggs (1.4–2.13 × 1.35–1.96 mm), singly or in batches (2–14). Juveniles hatch after 11–19 days, in small batches synchronously, in large batches asynchronously (egg cannibalism has been observed). In the laboratory the snails reproduce throughout the year, with distinct peaks in spring and summer. In April 2013, 80 mature snails were brought from Bolków (Lower Silesia). After keeping them together for a week they were divided into four experimental groups which were subject to different drought regimes (G1 – constant high humidity without drought; G2 – two-week drought; G3 – four-week drought; G4 – eight-week drought). In each group in conditions of high humidity the snails were kept singly (individual marking) and observed during eight weeks, then the experiment was repeated, and the snails were subsequently observed in high humidity conditions during another eight weeks. Following the second drought five individuals were randomly selected from each group for histological examination of the gonad. The snails from groups G1 and G2 showed a similar reproductive activity as those observed in laboratory previously: they laid eggs singly or in small batches (2–7), even up to three times during eight weeks; spermatozoa, spermatids, numerous sperm packets, previtellogenic and advanced vitellogenic oocytes were visible in their gonads. The G3 snails produced larger batches (5–16 eggs), at most two in eight weeks, though also single eggs and small batches (2–3 eggs) were observed; their gonads contained greater numbers of vitellogenic oocytes. The gonads of G4 snails contained mainly mature vitellogenic oocytes but no spermatozoa were found. The G4 snails produced only one batch in eight weeks; the number of eggs per batch was high and ranged from 10 to 19.

BIRD SCHISTOSOMES IN POLAND – STATE OF KNOWLEDGE AND PERSPECTIVES

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The life cycle of bird schistosomes requires intermediate hosts – numerous species of freshwater snails, among others *Lymnaea stagnalis*, *Stagnicola palustris*, *Radix auricularia*, *R. balthica*, *Planorbarius corneus*, *Planorbis planorbis*, *Anisus vortex*, *Bithynia tentaculata*, or *Physa acuta*. Individual species of bird schistosomes are highly species-specific regarding their intermediate hosts, which is probably an outcome of the interaction between the snail's immune system and the parasite's molecules. The development within the intermediate host, from miracidium to cercaria, takes nearly two months, while attaining sexual maturity within the final host takes only a few days. The specificity toward final hosts is much smaller; the same parasite species is recorded in many bird families – Podicipedidae, Ardeidae, Ciconiidae and Anatidae. Invasive larvae released from snails actively seek their final hosts using chemoreception. Sometimes the similarity of some lipid components of bird and human body covers results in invasion of human skin ("swimmers' itch"). No cases of parasites developing in humans are known, but in monkeys and mice schistosomes may migrate to internal organs, including nervous system. The occurrence of bird schistosomes in Poland is poorly known. *Gigantobilharzia monocotyle*, *Dendrobilharzia pulverulanta*, *Bilharziella polonica* and *Trichobilharzia* sp. have been recorded in birds, while intermediate hosts have been found to carry *B. polonica* and *T. ocellata*. The last one is a species complex, with *T. szidati* identified in Poland with molecular methods. The high number of wetland and aquatic bird species and the common occurrence of intermediate host species favour spread and development of schistosomes in the Polish waters. Considering the health hazards it is necessary to monitor the spread and seasonal activity of the parasites in the populations of intermediate hosts. The planned studies will include morphological and molecular identification of bird schistosome cercariae; snail-schistosome interactions under changing environmental conditions will be traced. Cooperation with dermatologists, paediatricians and pharmacologists will make it possible to increase the society's awareness of schistosome invasion.



THE THICK-SHELLED MUSSEL *UNIO CRASSUS* IN THE SUWALSKI LANDSCAPE PARK

MAGDALENA MARZEC

Suwalski Park Krajobrazowy

Freshwater molluscs of the Suwalski Landscape Park (SLP) were studied in detail in 1985–1989 (KOŁODZIEJCZYK 1994). The inventory of the thick-shelled mussel, a legally protected species which requires active protection (Annex to the EU Habitats Directive, threatened with extinction: Polish Red List, EN category) was aimed at updating the distributional information on the species within the SLP. The studies were conducted from 22.07 to 06.08.2013, in the rivers within the SLP: Czarna Hańcza and Szeszupa with tributaries. Their fragments which potentially met the species' requirements were controlled. The thick-shelled mussel was found in three rivers: Szeszupa (4 localities) and its tributaries: Jacznówka (only empty shells) and Szurpiłówka. No live animals or shells were found in Czarna Hańcza within the boundaries of the SLP. The species was present in all the sites in which it had been recorded 25 years previously. Besides, it was found in two sites where it had not been recorded earlier. Shells and/or live animals of *Unio tumidus*, *U. pictorum*, *Anodonta anatina*, *A. cygnea*, *Pseudanodonta complanata* and *Dreissena polymorpha* were also found in the rivers of the SLP.

POTENTIAL ROLE OF HSP PROTEINS IN SNAILS OF THE GENUS *HELIX*

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The regulated decrease in metabolic rate makes it possible for terrestrial snails to survive adverse conditions such as cold, anoxia or dehydration. Since hypometabolism is an adaptive reaction, entering it and returning to normal activity stimulate defensive mechanisms which prevent tissue damage. This is due to intensification of antioxidation defence and to increased expression of stress proteins (heat shock proteins, HSP). Considering the well developed and seasonally regulated system of antioxidation defence in snails of the genus *Helix*, we decided to check if HSP expression depended on the species and if it was subject to endogenous control. We measured the level of HSP70 in the kidney, hepatopancreas and foot of *Helix pomatia* Linnaeus, 1758 and *H. aspersa* O. F. Müller, 1774 at the end of winter torpor and after resuming activity in spring. We used the western blot technique; HSP70 were detected using prima-

ry mouse monoclonal antibodies anti-HSP70 (Sigma H-5147) and secondary goat anti-mouse antibodies (Sigma A-2554). In both species the HSP70 level was the highest in the kidney and the smallest in the hepatopancreas. The HSP70 concentration was statistically significantly greater in all the organs examined in the Roman snail. Since the HSP70 concentration varies depending on species and according to torpor/activity, involvement of other groups of HSP in enhancing adaptive mechanisms associated with wintering and freezing tolerance in the snails can not be excluded.

RISKS ASSOCIATED WITH RIVER MAINTENANCE OUTSIDE PROTECTED AREAS – THE CASE OF *UNIO CRASSUS* IN A TRIBUTARY OF THE BIEBRZA RIVER, N.E. POLAND

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In recent years, in response to the possibility of obtaining funds for the so-called flood protection and river maintenance, works on deepening of riverbeds have intensified. In areas not included in any form of nature protection there are rarely doubts about the legitimacy of such treatment and its possible negative impact on the biota of the watercourses. In 2015, in the area adjacent to the Biebrza National Park, we carried out a malacological survey of three tributaries of the Biebrza River: the section of the Sidra River in which the deepening of the riverbed had been planned, and the Kosóдка and Brzozówka Rivers, which had been deepened in 2014. In the dug sections of the rivers, in most of the surveyed sites, we did not find any unionoids; only in the river Brzozówka few individuals of *Unio pictorum* and *Anodonta anatina* were present; we found one *Unio crassus* individual. In the undamaged section of the Sidra River, *U. crassus* was abundant; all other unionoids occurring in Poland were also present: *A. anatina*, *A. cygnea*, *Pseudanodonta complanata*, *U. tumidus* and *U. pictorum*. *U. crassus* occurred on sandy-gravel bottom in places with fast water flow, reaching the density of 0.5–7 indiv./m². The average shell length (\pm SD) was 60.8 \pm 9.5 mm, and the average weight of live animals (\pm SD) was 36.9 \pm 17.4 g (n = 182). The presence of large individuals (maximum shell length – 81 mm) and the presence of juveniles indicate a good condition of this population. In response to our report of



this survey submitted to the Regional Directorate for Environmental Protection, the planned deepening of the riverbed has been suspended, offering a chance to save these mussel populations. However, throughout the country, the pressure to carry out such works is very high and a lot of effort is needed to protect natural mussel habitats.

DANGEROUS RELATIONS: *PSEUDANODONTA COMPLANATA* AND *DREISSENA POLYMORPHA*

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In Lake Sieciono, Drawa Lake District, an abundant population of *Pseudanodonta complanata* was found during scuba diving in August 2015. The mussels inhabited a sandy bottom at the depths of 2 to 6 m and in places of occurrence they reached densities of approximately 1 indiv./3 m². They were the only unionid species present; only two empty shells of *Anodonta anatina* were also found. The population of *P. complanata* consisted of mature and young individuals, indicating that renewal processes were taking place. However, all the individuals found were heavily infested with *Dreissena polymorpha*. Their total mass often exceeded that of *P. complanata*, with the effect that individuals removed from the bottom and placed on it again were unable to dig themselves back in for at least five days; mussels from which *D. polymorpha* were removed returned to their natural position within a few hours. The shells of *P. complanata* after removing *D. polymorpha* were deformed, and the animals were unable to fully close their shells. Clearly, feeding and reproduction in *P. complanata* were negatively affected. Shells of *P. complanata* were much more numerous than live individuals. *D. polymorpha* is increasingly often regarded as a possible tool for improving water quality in reservoirs and encouraging its abundance in the invaded regions is regarded as plausible. The present finding underlines the danger this invasive species brings to the native freshwater mussels.

MONACHA CLAUSTRALIS (ROSSMÄSSLER, 1834) AND *MONACHA CARTUSIANA* (O. F. MÜLLER, 1774) IN POLAND

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The list of invasive species recorded in Poland includes two members of the genus *Monacha* Fitzinger, 1833. Besides *M. cartusiana* (O. F. Müller, 1774) which was introduced in the environs of Wrocław and detected in the early 1970s, since the beginning of the 21st c. there have been increasingly more numerous records of another species, recently identified as *M. claustralis* (Rossmässler, 1834). The species, of similar shell morphology, can be identified based on their genitalia (among others, in *M. claustralis* distinctly longer distal part of vagina without a caecum which is present in *M. cartusiana*) and sequences of mitochondrial genes – subunit 1 of cytochrome oxidase *COI*, and ribosomal DNA, *16SrDNA*). Our aim was to study the distribution of the two species in Poland based on the molecular characters. Eleven new sequences of the *COI* fragment and nine of *16SrDNA* were found. Their comparison with the sequences in the GenBank made it possible to assign six sequences of each *COI* and *16SrDNA* to *M. claustralis*, five sequences of *COI* and three of *16SrDNA* to *M. cartusiana*. With the sequences from the GenBank they form two distinct clusters in the Neighbour-Joining dendrograms. The distance coefficients determined with Kimura's method (K2P) indicate species distinctness of *M. claustralis* and *M. cartusiana*, and a third species of *Monacha*, used as out-group, i.e. *M. cantiana* (Montagu, 1803). We recorded *M. claustralis* in a few regions of Poland: nine localities in the Świętokrzyskie Voivodeship, five in Wielkopolskie, one in Kujawsko-Pomorskie and three in Pomorskie. *M. cartusiana* has fewer localities, though it was probably introduced earlier. Besides the two localities in Wrocław, we found it in two sites in Kielce (in Wietrznia and in Grzybowa street). In these two sites the two species co-occur; the same was observed earlier in Prague (Czech Republic). We hope that further studies on the populations from Poland and other countries will make it possible to reconstruct the migration routes of the two species into Poland.



IDENTIFICATION AND CHARACTERISTICS OF
AQUAPORIN-CODING SEQUENCES IN *ARION*
VULGARIS MOQUIN-TANDON, 1855 AND
PLANORBARIUS CORNEUS (LINNAEUS, 1758)

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Aquaporins (AQP), that is proteins which build aquapores in biological membranes, were identified in all the organisms examined for their presence. Despite differences in their amino-acid sequences, they have a nearly identical spatial structure composed of six trans-membrane domains and five connecting loops. Structural components which are characteristic of AQP and line the pore are two conservative NPA motives and a four-amino-acid selectivity filter (FS). According to the transported substances aquaporins can be divided into the so called classic aquaporins which mainly transport water, and aquaglyceroporins which, besides water, transport also larger molecules such as glycerol. Apart from some unicellular organisms, each of the examined species has a set of several kinds of aquaporins. The genes which code for them show a tissue-specific expression. The greatest numbers of aquaporins are expressed in organs or tissues which very actively transport water, such as epithelia or kidney. Despite their common occurrence in molluscs, the knowledge of mollusc aquaporins is scanty. In our earlier studies we identified and characterised aquaporins of two pulmonate species: freshwater *Lymnaea stagnalis* (L.) and terrestrial *Helix pomatia* L. The present results supplement those studies with data on another two species: terrestrial slug *Arion vulgaris* Moquin-Tandon and freshwater *Planorbarius corneus* (L.). We identified eight sequences coding for full-length aquaporins in *A. vulgaris* and nine in *P. corneus*. Bioinformatic analysis (among others, ascertaining NPA and FS motives) combined with phylogenetic analysis allowed a preliminary assignment of seven of them to classic aquaporins (4 in *A. vulgaris* and 3 in *P. corneus*) and ten to aquaglyceroporins (4 in *A. vulgaris* and 6 in *P. corneus*). The studies were financed from NCN grant no. DEC-2011/01/B/NZ4/00630.

INVENTORIES AND EXPERTISES – A PAINFUL
TOPIC

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Within the last few years, like many of us, I was involved in several inventories and expertises: inventory of species from Annex II of the EU Habitats Directive commissioned by the Management of State Forests (MSF: four forest districts), a similar inventory in the Kraków-Wieluń Jura commissioned by a Canadian prospecting company, expertise for the General Management of State Roads and Motorways (GMSRM), and several inventories commissioned by various landscape parks. Besides, I reviewed two expertises, one for GMSRM, another for the Tatra National Park. The expertises and inventories focussed on species of the genus *Vertigo*. My experiences, though not very rich, suggest the following. 1. Inventories/expertises are very often entrusted to incompetent people (in the cases of snail species from Annex II known to me - entomologists); these people are employed on a distinct request or at least with approval of the employer. In several cases the effect was misidentification (mistaking a common species for a protected one is harmless, but the reverse?). The situation is similar when it comes to inviting “experts” to radio and TV (educational!) programmes. 2. Information which is supposed to facilitate the inventory is often incomplete and the instructions are not clear. 3. The attitude of local authorities (forest districts) is hostile, since finding Annex II species according to the EU regulations requires protection of the sites which is often in conflict with the current or planned land use. 4. Deadlines and timing of inventory contracts often preclude a reliable study of species distribution and possible threats; as a result inventories are done in a hurry, based solely on literature information. 5. A side effect is often an attempt to use the data obtained during a hurried and superficial inventory as a basis for publications. Being aware of the lack of a legal basis for counteracting such unreliable practices, I can see a possibility of such counteracting within the Association of Polish Malacologists activities. 1. Preparing a list of competent experts for individual species/malacocoenoses. 2. Sending the list to pertinent institutions (potential employers), such as national and landscape parks, National Fund for Environment Protection, GMSRM, MSF, Regional Fund for Environment Protection etc, or to local conservation authorities. 3. Creating a countrywide database of Annex II species (or all rare and endangered species of Poland), which would be regularly updated. 4. Creating a uniform set of recommendations regarding monitoring and protection of localities. 5. Creating a list of information required

from the employer prior to the expertise. All such information should be placed on the Association's website.

POLYMORPHISM OF *CEPAEA NEMORALIS* (L., 1758) IN WARSAW

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Cepaea nemoralis is an excellent model species. It is common and abundant, often found in anthropogenic habitats; its shell is polymorphic with respect to colour and pattern. The aim of the study was to check if and how specific conditions of a large city agglomeration (habitat fragmentation and reduced predation) affected the colouration of *C. nemoralis*. The studied populations came from 14 city sites and four village sites with roadside vegetation. The city sites were located in different districts; in each of them at least two sites were located close to each other but isolated. Some of the sites were located in large parks, some in small green areas. The first 100 individuals in each site were scored for colour and banding. Morph diversity within the sites was assessed using the Shannon index. Within the city the snails occurred mostly in dense shrubbery where it is difficult to trim grass and rake litter. Their habitats were small and insular not only in built up areas but also in large parks. The populations from large parks differed from those from small green areas in their colour and banding. The diversity within both kinds of populations was similar. There was no dependence between the colouration and the distance between the sites. The city populations differed from the village ones in their colour but there were no differences in banding. Within-site diversity was greater in the village than in the city. It appears that in city conditions the founder effect has a greater influence on the colouration compared to the village populations, but selection in favour of some morphs is still active in the city.

MULTI-METHOD APPROACH TO IDENTIFICATION OF SPECIES OF *TROCHULUS* (GASTROPODA: HYGROMIIDAE)

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Snails of the genus *Trochulus* have always caused debates about classification, number of species and diagnostic characters. The wide morphological variation and the great number of forms resulted in some authors describing numerous species (e.g. LOCARD 1895–1896 mentioned 55 species from France alone while GERMAIN 1929 distinguished only a few). The problems become even more acute when allopatric taxa and uniparental reproduction are considered. Some species of *Trochulus* are fairly easy to distinguish conchologically (e.g. *T. biconicus*, *T. lubomirskii*, *T. villosulus*, *T. villosus*), while others pose problems even using the structure of genitalia. Recent papers using morphological and/or genetic information revealed complicated relationships between taxa; the question of the status of forms resembling *T. hispidus* (Linnaeus, 1758), including *T. sericeus* (Draparnaud, 1801), *T. plebeius* (Draparnaud, 1805) and *T. coelomphala* (Locard, 1888), remains open. In the case of taxa which have no morphological diagnostic characters, or are extremely variable, it is important to use a combination of morphological and anatomical characters, molecular markers and ecological preferences. Such an approach was used in the case of the endemic *T. graminicola* and other very similar sympatric species, including *T. striolatus* and the *T. hispidus* complex. Comparison of shell and genital characters made possible: (1) conchological identification of *T. striolatus* and *T. sericeus* and (2) anatomical and ecological identification of *T. graminicola*. Phylogenetic analysis of COI gene failed to demonstrate full monophyly of five species of *Trochulus*. In most cases monophyletic conspecific clades were formed by sequences from the same region or country. All the examined *T. striolatus* formed one clade, including also one sequence assigned to *T. plebeius/sericeus*. The sequences of *T. graminicola* (except one) were also grouped together in the tree. Specimens of *T. hispidus* and *T. sericeus* tended to cluster together which confirmed their appurtenance to one complex. *T. coelomphala* formed two pure monophyletic clades separated from each other. The clustering of the sequences assigned to morphologically different species may indicate very



complicated evolutionary relationships associated with gene flow between species. Due to the frequent lack of morphological differentiation, complicated taxonomy and indications of on-going speciation, the genus *Trochulus* seems to be an ideal model for studying evolutionary and ecological processes which lead to genetic diversification and reproductive isolation. Geographical isolation, selection and genetic drift may cause geographic divergence of populations and, consequently, speciation. Based on genetic and morphological data it is possible to estimate differences and similarities among the taxa and to test various species concepts treating the genus as a model.

MINERAL SHELL COMPONENTS IN *CEPAEA NEMORALIS* (L.): DIFFERENCES BETWEEN COLOUR MORPHS AND RELATIONS WITH STRUCTURAL SHELL CHARACTERS

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Evolution and maintaining of shell colour polymorphism in populations of *Cepaea nemoralis* are classical problems of evolutionary ecology. Predation pressure and climatic selection are mentioned among the most important driving forces of the diversity. To date no explanation was proposed for mechanisms of differential selection by predators toward morphs of *C. nemoralis*. The colour morphs are known to differ in their shell resistance to cracking. The mineral composition of the shell may affect its structural characters and the predator's preferences. We attempted: (1) determining the content of calcium and 14 other elements in shells of *C. nemoralis*; (2) checking differences in their content between the morphs and (3) finding possible dependences between the content of particular elements and the shell's structural characters (thickness and resistance to cracking). The morphs differed significantly in the content of Al, Ca, Fe, Mg, Mn, P and Sr in their shells. There was a statistically significant negative correlation between the cracking resistance and the content of Mg, Mn, P, S and Zn. A significant positive correlation between the resistance and Ca content was demonstrated only for yellow mid-banded shells. The differences in the content of elements between the studied morphs may result from different food and microhabitat preferences and/or metabolism of

the elements (homeostasis and excretion). Shells of different morphs may differ in their palatability and attractiveness to predators.

ON MALACOLOGY – STARRING: SNAIL

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Natural sciences focus on studying the world and human societies which change fast but are tangible, measurable and describable. They aim at generalisations, discovering universal laws, objective description of reality and learning about phenomena. Teaching about natural sciences has incorporated humanities components into thinking about nature. Education is a much contextualised process. Its context comes not only from pure science, which is by definition objective and comparable worldwide, but also from cultural and social aspects. What is the purpose of biological education in modern society? JAAKKOLA & SLAUGHTER (2002) maintain that it is understanding life. PENNICK (1995) speaks about combining theory, practice and education in agreement with the idea of natural sciences. WISEHART & MANDELL (2008) maintain that teaching biology combines two products: concrete information (facts) and skill of scientific argumentation. A third aspect should be mentioned here: developing pro-environmental attitudes (IOZZI 1989). As observed by KAISER & FUHRER (2003), environmental knowledge is one of the main determinants of ecological awareness. POOLEY & O'CONNOR (2000) argue that, besides knowledge, also feelings and convictions about the environment and its components affect people's attitudes. In view of the above it can be assumed that the knowledge and convictions affect the behaviour and serve as predictors of pro-environmental attitudes. Snails play an important part in terrestrial and aquatic ecosystems. Such species as the Roman snail are known to practically everybody in the country. Nevertheless, snails are often regarded as revolting or slimy (BIXLER & FLOYD 1999, LINDEMANN-MATTHIES 2002). We prepared a teaching programme aimed at making the audience interested in snails as organisms which react to stimuli and are easy to observe. The classes were tested on a group of 115 pupils from eight secondary schools of the Wielkopolskie and Lubuskie voivodeships. All the participants had participated in malacology classes, but none had had contact with live snails during the classes or observed the animals for teaching purposes.



CEPHALOPODS – UNKNOWN WORLD OF OCEANIC DEPTHS

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Oceans and seas covering more than 71% of the Earth's surface are still very little known from the natural history point of view. Edward Forbes's theory that life could not exist below 550 m was refuted only in the second half of the 19th c. Despite the adverse conditions of temperature, pressure and lack of light, oceanic depths hold a surprising variety of living forms. The most surprising are cephalopods: they inhabit both depths and shallows, move on the bottom, swim or drift and show a great variety of adaptations. The famous expeditions contributed greatly to the knowledge of cephalopods: those of "Galathea" (1840s), "Challenger" (1870s), "Albatross" (1880s–1890s) or "Valdivia" (1890s). Giant cephalopods stopped being a legend: the Danish naturalist Japetus Steenstrup came to a conclusion that the famous Kraken was a giant squid and described it in 1857 as *Architeuthis dux*. The studies of the depths progressed: in 1930 William Beebe and Otis Barton reached the depth of 923 m, and in 1960 Jacques Piccard and Don Walsh descended to 10,899 m. The mid 20th c. witnessed development of submarine vessels with crew, but they were still difficult to operate and dangerous. Underwater robots turned out to be more useful. They developed in two directions: initially Remotely Operated Vehicles were widely used. With advancing technology Autonomous Underwater Vehicles were introduced. The new devices made it possible to observe and record the fauna of the depths. The deep sea cephalopods show an array of specific adaptations. Their body is jelly-like (often with high ammonia content), ensuring zero buoyancy which facilitates balance and movement. Their eyes are huge and well developed (the largest eye is 40 cm in diameter). Bioluminescence is common; the emitted light is usually blue-green, wave length 470–490 nm, penetrating sea water most efficiently. In some octopus the suckers have lost their prehensile function and emit light. Squids have additional chitinous hooks on their arms, besides the chitinous rings on their suckers. Though deep sea organisms are usually rather small, many cephalopods reach huge size. Besides the squids *Architeuthis dux*, 12–15 m long, and probably even larger *Mesonychoteuthis hamiltoni*, there are also giant species of octopus, for example *Haliphron atlanticus* with its length of 4 m. Some large squids of unusual appearance were seen for the first time: *Magnapinna* sp., with long thin arms about 7 m long, or *Asperoteuthis* sp. Some are only known from films. Studies on deep sea fauna are complicated; intact individuals are obtained only

very rarely and practically impossible to keep in the laboratory. Despite this the underwater studies have already changed the opinions about the deep sea cephalopod fauna.

LONG-TERM CHANGES IN SNAIL COMMUNITIES OF SELECTED ANTHROPOGENIC WATER BODIES OF THE SILESIA UPLAND. I. SUBSIDENCE RESERVOIRS

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Because of their origin, subsidence reservoirs are the most common anthropogenic water bodies in the Silesian Upland. They are fed by atmospheric precipitation, surface runoff and ground waters. Their localisation is accidental and affects their quality. Many of them are just reservoirs of industrial or communal waste, or saline mining waters. Their occurrence shows spatial and temporal variation depending on the intensity of subsidence. Also meteorological conditions are important for the feeding of such reservoirs. The aim of our study was to estimate the long-term changes in the structure of their snail communities. We compared the results of studies of the late 1980s with those of the 2008–2014 research; both used comparable methods. The new research revealed 21 snail species, 14 of them rare and not abundant (in total 13.9% of the collection); in the earlier studies 19 species were recorded, 12 of them rare and not abundant (8.4% of the collection). The increase in the number of alien species is noteworthy. The proportion of the 17 species in common for the two study periods changed, but the general tendencies remained unaltered. The communities are characterised by abundant occurrence of few species, while the others are infrequent and represented by few individuals. At present the frequent and abundant species are *Radix balthica*, *Planorbarius corneus* and *Gyraulus crista*, formerly they were *Lymnaea stagnalis* and *R. balthica*. Single sites yielded new species for this kind of habitat: *Ferissia fragilis*, *Hippeutis complanatus*, *Radix auricularia* and *Bithynia tentaculata*. *Anisus leucostoma* and *A. vorticulus* were not recorded. The snail density increased compared to the earlier study (103 and 416 indiv./m², respectively). Because of their origin, life span and use, subsidence reservoirs are interesting from the hydrobiological point of view. The decreasing activity of coal mines in the next decades may limit creation of new habitats of this kind and cause disappearance of many of them.



ALIEN SNAIL SPECIES IN ANTHROPOGENIC WATER BODIES OF DIFFERENT ORIGIN AND USE

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Molluscs were sampled in 31 anthropogenic water bodies in the Silesian Upland, outside forested areas: 7 fish ponds, 14 subsidence reservoirs, 5 sand pits and 5 gravel pits. The aim was to specify which types of anthropogenic water bodies, of different substratum and use, might create conditions for the occurrence of alien species. The greatest snail diversity was found in the subsidence reservoirs (19 species). The three alien species recorded occurred only in subsidence reservoirs; only *Physella acuta* was present in the fish ponds; it was also the only species present in all kinds of water bodies, in some with high constancy (F=100% – gravel pits). The gravel pits showed the greatest mean density of alien species which was caused by the presence of *Potamopyrgus antipodarum*. Gravel pits are characterised by small electric conductivity, chloride content and fertility compared to the other types of anthropogenic water bodies, which do not always provide adequate conditions for native species but, due to the limited competition, facilitate occurrence of alien species. Besides, young reservoirs provide various unoccupied niches which facilitates introduction and establishing populations of alien species. Our studies indicate that the number of introduced species in anthropogenic water bodies increases with the increasingly urban character of the area.

MONITORING OF THE THICK-SHELLED MUSSEL *UNIO CRASSUS* PHILIPSSON, 1788 IN RIVERS OF THE WESTERN BIESZCZADY MTS

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The thick-shelled mussel is strictly legally protected in Poland; it is included in the EU Habitats Directive (Annexes II and IV) and in the Red List of Animals (EN category). In the lowlands it is rare, found in pure, small and medium-sized rivers with sandy-gravelly bottom; it is also found in rapid submontane streams and rivers. In 2015, while preparing protection plan for the area Natura 2000 Bieszczady PLC180001, we searched for the mussel

in the following rivers of the Western Bieszczady: San, Wołosaty, Czarna, Wetlinka, Solinka, Hoczewka and Osława. They are typical rivers of Carpathian flysh, with shallow, wide beds of rocky bottom. The inventory included visual search in river sections 1 km long and quantitative estimates along transects across the river bed. *U. crassus* was recorded in the upper San (section Łokieć – Rajske), Osława and the mouth section of the stream Wołosaty. The mussels occurred mainly near the banks, in places in aggregations – the greatest recorded density was 201 indiv./m², the mean density – 36.7 indiv./m². Only single individuals were found in the middle part of the river bed. The mussels were completely buried in the bottom deposits, with only siphonal orifices protruding, which made it easier to locate them. Except one individual of *Anodonta anatina* no other unionids were found in the rivers. Biometrical analysis of more than 550 individuals of *U. crassus* made it possible to determine the size structure of the population: the mean shell length ± SD was 48.0 ± 11.7 mm (range 12.1–70.6 mm); the mean height ± SD = 25.3 ± 5.7 mm (6.6–39.6 mm), the mean thickness ± SD = 16.6 ± 4.6 mm (2.5–28.0 mm) the mean mass ± SD = 17.0 ± 10.4 g (0.2–53.2 g). The mean age was estimated as 4–5 years (range 1–10). The presence of the thick-shelled mussel in the San basin near Przemyśl was observed already in the 19th c. by KOTULA (1882). The species was also mentioned from the Biosphere Reserve of the Eastern Carpathians (ZAJĄC 2004). The results suggest that the population of *U. crassus* from the Western Bieszczady is probably the largest in the country, and the San River above the Solina Reservoir deserves special protection as an important refuge of the species.

TESTING METHODS OF COLLECTING VERTIGINIDS – AREA NATURA 2000: MEADOW IN BĘCZKOWICE

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The area Natura 2000 Łąka w Bęczkowicach [Meadow in Bęczkowice] PLH100004 is a complex of damp meadows and wetlands on the Luciaża River in the Pilica basin. In 2014 *Vertigo moulinsiana* (Dupuy, 1849) and *V. angustior* Jeffreys, 1830 were found there. They are legally protected, included in the EU Habitats Directive (Annex II) and the Red List of Animals of Poland. Further malacological studies were then planned, including comparison of collecting methods of vertiginids recommended in the literature. Samples were taken every 10–20 m

along a transect 220 m long running across the valley. The first method involved collecting vegetation and substratum from an area of 400 cm² within a metal frame (quadrate method), drying the material, sieving it and sorting under stereomicroscope in the laboratory (see "Monitoring gatunków zwierząt. Przewodnik metodyczny" 2012). The second method consisted in shaking snails off tall vegetation over a plastic tray and counting them in the field (see STEBBINGS & KILLEEN 1998). Using the quadrate method 29 mollusc species were recorded (terrestrial and freshwater gastropods, bivalves). The set included the two protected vertiginids and another three endangered, red-listed species: *Anisus vorticulus*, *Gyraulus riparius* and *Pisidium obtusale*. The assemblage was dominated by *V. moulinsiana*, *Valvata cristata* and *Carychium minimum*. The mollusc density in the spring was 2,569 indiv./m²; in the autumn – 4,425 indiv./m². The samples from vegetation yielded five species: *V. moulinsiana* (dominance 87%), *V. angustior*, *V. antivertigo*, *Succinea* sp. and *Zonitoides nitidus*. As could be expected, the method is useful for qualitative studies on the vegetation-climbing species, and thus makes it possible to detect *V. moulinsiana* quickly and easily. However the abundance of the species in the vegetation-shaking samples and in the quadrate samples was not correlated.

MALACOFAUNA IN CAVE DEPOSITS OF THE UDORKA VALLEY (KRAKÓW-CZĘSTOCHOWA UPLAND)

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The studies were carried out in three localities of cave deposits in the Udorka Valley, in the central part of the Kraków-Częstochowa Upland, ca. 80 km SE of Częstochowa: Rock Shelter in Udórz II, Rock Shelter in Udorka Valley I and Cave Perspektywiczna (profiles Udórz IVb, Udórz IVc, Udórz V). The malacological analysis involved 149 samples from layers of humus dust, humus loam, sometimes dusty, and loam with rubble; the deposits were mainly accumulated in the Middle and Late Holocene. The samples from the lowest level in Cave Perspektywiczna may represent the Vistulian Glaciation (OIS 2 and 3), but a part of the deposit was re-deposited. The malacological material was rather poor. The total of 751 specimens represented 36 snail species. Snails of shaded habitats were the best represented (24 species, 428 specimens) with the dominants *Helicigona*

faustina and *Balea biplicata*. A rather high frequency of *Helix pomatia* is noteworthy; it was practically absent from the neighbouring sites explored earlier. Mesophile snails included 7 species (155 specimens), *Laciniaria plicata* and *Helicigona lapicida* being the most abundant. Open-country species formed an accessory element – 4 species, 17 specimens. Besides, the assemblage included one hygrophile – *Carychium minimum* represented by 3 specimens. The composition of the malacofauna indicates its development in damp shaded forest habitats, while the absence of glacial relics and cold-loving forms suggests favourable thermal conditions. The richest assemblages were those of Udórz IVb and V in Cave Perspektywiczna; they constitute a good starting point for further research in the Udorka Valley. The field work was financed from NCN grant no. 2011/01/N/HS3/01299. Malacological studies were financed by the Faculty of Geology, Warsaw University, project DSM 108 006.

LOAD OF PARASITIC LARVAE OF *UNIO CRASSUS* IN FISHES IN NATURAL CONDITIONS

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The load of glochidia of *Unio crassus*, an endangered species, in fishes was studied. Electrofishing was conducted in three plots, on four occasions during the spring and summer of 2015 in the river Warkocz in the Świętokrzyskie Mts. Out of the total of 666 individuals caught, 128 were infected with glochidia (19%). The fish species composition was dominated by the minnow *Phoxinus phoxinus*; the minnow carried the greatest number of glochidia. The remaining species carried negligible numbers of glochidia. 57% of the infected fishes carried one glochidium each. The maximum number of glochidia carried by one individual was 19 (1% of fishes). The number of glochidia was the highest in June. The number of larvae was correlated with the fish size, while the proportion of infected individuals in a species did not depend on the species' abundance. This indicates a random character of infection; the great proportion of minnow among the infected fishes results from its abundance in the habitat.



THE PRODUCTION STRUCTURE OF POPULATIONS OF *VIVIPARUS CONTECTUS* IN RIVERS UNDER DIFFERENT ANTHROPOPRESSURE

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The study of production characteristics of freshwater molluscs is important for evaluation of bio-coenosis production and in investigation of energy balance of species and ecosystems as a whole. The purpose of the work was to determine the production indices of *Viviparus conlectus* (Mill.) in rivers under different anthropopressure. The material was collected in the summer of 2014 in the Zhytomyr region, in waters of different degree of anthropogenic influence: 1. a largely natural river section – Svydoluzhka river (Rudenka village); 2. a river section under small anthropogenic influence – Svydoluzhka river (Studenytysya village); 3. a river under heavy anthropogenic influence – Teteriv river (Korostyshiv town). The greatest annual production in terms of total weight of snails was recorded in the most natural river section – 245.90 g/m²; it was slightly smaller in the medium-affected river section – 118.98 g/m², and the smallest in the highly affected river – 99.76 g/m². The same was true of production in terms of shell weight. The P/B-coefficient decreased with increasing degree of anthropopressure and ranged from 0.76 to 0.90. The total annual production of *V. conlectus* depended on the age structure. In colonies under high anthropopressure the main contribution to the total annual production was made by older snails (4–5 years), in the natural river section and in the one under small anthropopressure a considerable contribution was made by young individuals (aged <1 to 2 year).

DREISSENA ROSTRIFORMIS BUGENSIS IN THE GULF OF SZCZECIN – THE FIRST RECORD IN THE WATERS OF POLAND

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In 2014 the invasive mussel *Dreissena rostriformis bugensis* (Andrusov, 1897) was found in the Gulf of Szczecin. It is the first record for Poland and in the whole Baltic Basin. It is another stage of the fast ex-

pansion of the species in Europe which has been observed since the beginning of the 19th c. Examining of the specimens collected in 2014 and re-examination of archive benthos samples showed that *D. rostriformis bugensis* appeared in the gulf at least three years earlier but remained undetected. Analysis of DNA sequences of two mitochondrial genes confirmed the genetic distinctness of the species from *D. polymorpha*. Based on the current observations it can be said that at present *D. rostriformis bugensis* is common and abundant in the Gulf of Szczecin where it has formed a robust, reproducing population and it co-occurs with the common *D. polymorpha*. The proportion of the two species based on the 2014 samples was 6:4, with dominance of *D. polymorpha* (abundance of the order of 6,000 and 4,000 indiv./m², respectively) while the preliminary results of 2015 indicate an increase of the proportion of *D. rostriformis bugensis*, which has locally exceeded 50%. The length measurements of the specimens collected in 2014 show that the population of *D. rostriformis bugensis* is composed of individuals 1.56 mm to 31.76 mm long, with small individuals of less than 7 mm constituting 52.5% of the population. We plan to monitor the invasion of the gulf by the invasive mussel with special reference to its interactions with *D. polymorpha*.

DEPENDENCE OF IMMUNE RESPONSE OF *ARION VULGARIS* (MOQUIN-TANDON, 1855) ON THE DIET AND TEMPERATURE

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Snail immunology is little known, but recently has evoked increasing interest. Mollusc immune system includes several components; among them phenoloxidase – a multifunctional enzyme associated with melanisation – plays an important part. The activity of phenoloxidase is often used as a physiological indicator of functioning of the individual in given conditions. Immune response of animals is influenced by many factors; temperature and diet composition play a significant part. Juveniles of *Arion vulgaris* were kept at optimum temperature of 15°C and suboptimum temperatures of 10°C and 20°C. The slugs were fed one of five kinds of diet of different protein : sug-

ar proportions: 10% : 50%, 20% : 40%, 30% : 30%, 40% : 20%, 50% : 10%. Each diet was supplemented with cellulose (31.9%), olive oil (8%) and vitamins (0.1%). Haemolymph was sampled after a month of keeping the slugs in the above conditions. Only temperature had an effect on the phenoloxidase activity: it increased in both suboptimum temperature regimes. The increased activity at 10°C and 20°C indicates that suboptimum ambient temperature may affect the immune response of *A. vulgaris*. No statistically significant effect of the diet on the immune response was observed.

REPRODUCTIVE BIOLOGY OF *UNIO CRASSUS* IN THE CARPATHIANS

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Freshwater bivalves expend most of their assimilated energy on reproduction; they produce huge numbers of larvae. Though the basic facts of reproduction are known, its ecological determinants remain to a large extent unexplained which renders the bivalve protection difficult. In 2013–2015 we studied the reproduction of the thick-shelled mussel *Unio crassus*, by regular sampling of several tens of individuals from three rivers: Zborowianka and Biała Dunajcowa (Ciężkowice Foothills) and San (Bieszczady Mts). Gonad puncture was performed on each animal to determine sex and the state of gametes, and thus the reproduction phenology. The advancement of development of glochidia was estimated based on marsupium puncture. Throughout the year, also in winter, the gonads of *U. crassus* contain oocytes and spermatocytes, thus sex determination is always certain. The reproduction starts early, immediately after spring floods, and the glochidia release reaches its peak in May. The reproduction ends very late: the last glochidia are observed even at the end of July. There are small phenological differences between the various rivers. During the whole year the ovaries contain oocytes at all development stages, but mature eggs are present only during the reproductive period. It is difficult to assess the development stage of glochidia in the field, but the early (cleavage), and the final (open, “biting” glochidia) stages are easily identified. The development most often takes ca. two weeks and never exceeds three weeks. The reproduction is repeated in short cycles of variable duration and number. With progressing season the degree of filling of marsupia decreases. Each cycle ends with release of larvae.

WHAT CAN BE INFERRED FROM SHELL MORPHOLOGY OF *UNIO CRASSUS*?

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Large unionids are regarded as crucial components of freshwater ecosystems. Despite this there are still many gaps in the knowledge of their taxonomy, ecology as well as threats and protection status. Shell morphology provides the most easily available information. Shells are rather durable but their characters vary widely. We examined environmental factors which might be responsible for shell variation in the endangered thick-shelled mussel *Unio crassus*. The studies were carried out in Carpathian rivers San and Biała Tarnowska with its tributary Zborowianka/Bieśninka. Mussels from the two rivers of different habitat conditions – bottom rocky or covered by fine-grained deposits – differed significantly in their shell size and shape, growth rate and asymptotic size estimated from von Bertalanffy’s curve. Analysis of large samples of *U. crassus* revealed sexual dimorphism expressed as size difference, but the size could not be used to determine sex of single individuals. In one of the rivers, San, we found that the shells were significantly more curved in places closer to the middle of the river bed, with relatively fast current, compared to those from places near the banks, with weaker flow. The results reflect the wide spectrum of phenotypic reactions of the species: the variation is visible on a small spatial scale of a few tens of square metres. It may also affect the systematics and ecology of the bivalves. Some shell characters, such as shell length index or von Bertalanffy’s curve based on annual increments, may provide much information about the individual’s habitat.

THE EFFECT OF KAIROMONES OF THE ROACH *RUTILUS RUTILUS* ON THE MOVEMENTS OF THE ZEBRA MUSSEL *DREISSENA POLYMORPHA*

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The zebra mussel *Dreissena polymorpha* is an invasive species, and it is important to study its behaviour. Chemical signals are regarded as the most ancestral way of communication among aquatic organisms. We studied the effect of predator kairomones on the movements of the zebra mussel. Kairomones are signal compounds; they evoke reactions which are profitable for the recipient which is not conspecific with the emitter. In the case of the zebra mussel the



source of kairomone is the roach *Rutilus rutilus*, which is its natural predator. The bivalve shell movement is a visible symptom of the animal's activity. Shell closing and opening were registered with camera during two-hour observation. Prior to the observations brightly coloured plastic mass was glued to each shell. The three experimental variants were: control – well oxygenated water of 18°C; variant 2 – water with kairomones of fish fed with neutral food (chironomid larvae); variant 3 – water with kairomones of mussel-fed fish. The films were analysed with software EthoVision®XT and the results with Visual Basic for Excel. The total time of opening of shell valves in the control was 84 to 90% of the observation time. The mussels from the neutral food variant behaved similarly as the control ones. Compared to these variants, in the variant with mussel-fed fish the mussels spent relatively more time half open (up to 20% of total time), and were completely open less often. In that variant the mussel movements had a significantly larger amplitude (range of degrees of opening). We observed a very wide individual variation in the control group. At present we can conclude that the roach kairomones do not affect the mussel by themselves but need to be combined with alarm substances emitted by damaged bivalves. The studies require continuation.

PRELIMINARY STUDIES ON INHIBITION OF BEHAVIOURAL FEVER IN *PLANORBARIUS CORNEUS*

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Symptoms of behavioural fever have been observed in various vertebrate and invertebrate taxa. Migration of ectothermic animals into microhabitats of increased temperature increases their body tem-

perature and, when it results from infection or experimental injection of pyrogens, it is classified as a behavioural defensive reaction. Literature provides numerous examples of similarities between endothermic and ectothermic fever: thermo-behavioural reactions of ectotherms after administration of exogenous pyrogens or prostaglandins (PGE1). The effects were in some cases successfully inhibited by administering antipyretics which are common in mammals. The ectothermic species which were found to display symptoms of behavioural fever are more numerous than those whose thermo-behaviour can be unequivocally qualified as fever reaction. The mere fact of increase in preferred temperature in response to contact with exogenous pyrogens does not amount to behavioural fever. Only the therapeutic effect of such reaction, for example after microbial infection, or inhibition of reaction to pyrogens by anti-fever substances indicates an association between the fever symptoms and the process. We attempted to check if behavioural fever symptoms in *Planorbarius corneus* testified to the fever abilities of the snails. The research tasks were: (i) testing survivorship of snails after injection of bacteria at two temperatures, and (ii) registering thermo-behavioural reaction of snails after injection of pyrogen combined with antipyretic. The preliminary results indicate that the strain of bacteria used is probably not pathogenic for the snails. The survivorship of infected snails did not differ from that of the control ones. The temperature was the factor that significantly differentiated the experimental groups. The experiments with thermal gradient showed that the course of thermo-behavioural reaction may depend on the order in which the substances are injected. The results do not provide an unambiguous answer to the question if the selection of increased ambient temperature by the snails which were treated with exogenous pyrogens can be classified as behavioural fever, but provide a starting point for studies on the mechanisms of snail thermo-behaviour.