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THE 23RD POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

Our 23rd Seminar (Hey! It will be a quarter of a century soon!) took place on April 24th–27th in a very small village Serpelice (far from any big city, even Siedlce with its Podlasie Academy is far) and very close to the Belarussian border, on the very picturesque Bug River which separates us from the next-door neighbours. The organisers listed on the cover of the Abstract Book include the Institute of Biology, Podlasie Academy in Siedlce, The Association of Polish Malacologists, two landscape parks (Podlasie Bug River and Bug) and the Naturalists' Society "Stork". The actual people without whose effort there would have been no seminar included our colleagues from the Institute of Biology, Podlasie Academy: EWA JURKIEWICZ-KARNKOWSKA, BEATA JAKUBIK, KATARZYNA SARNOWSKA, KRZYSZTOF LEWANDOWSKI and RYSZARD KOWALSKI (some of you may remember that our previous Seminar, in 2006, was organised single-handedly by our colleague from Kielce). A round of applause for the Organisers! Another round of applause for the staff the Bug Landscape Park who organised the seminar excursion!

The village of Serpelice is very difficult to get to and equally difficult to leave: no railway station, few buses and you have to change from train to bus or from bus to bus at least once. There was a Seminar bus from Siedlce on the morning of the 24th but those who wanted to come the day before and were carless had to make do with local transport. Fortunately, malacologists are an obstinate folk: nobody lost heart on the way and all got there all right. The official opening of the seminar (speeches and so on) was brief (which was good), followed by two lectures, each about the wonders of one of the two landscape parks. We all stayed in a kind of holiday centre, formerly I suspect a communist recreation centre (we have many of those; apparently the communists liked recreation a lot), composed of several buildings with a few rooms in each, plus a separate building with a conference room. There are lots of things that can be said in favour of everybody staying in one place: informal discussions, various forms of socialising and even comparing our respective laptops and data contained therein. Some rooms (or maybe even all) had balconies on which to socialise, especially that the weather was very nice most of the time. This, and the proximity of the beautiful river could not be resisted. As a result many aquatic people missed the terrestrial sessions and as many terrestrial malacologists skipped the aquatic lectures. Some nice freshwater creatures could be collected in the river and its oxbows (see also some of the 2006 abstracts – Folia Malacologica 14: 85–97 and the 2007 abstracts below) but the area holds only few rather common land snails. During the Seminar excursion we were shown the two landscape parks, with some landscape, some history and the beautiful horses in the famous Janów Podlaski. We were also taken to the fossil site of *Viviparus diluvianus* in Ortel Królewski (again: see the two sets of abstracts) where we could collect as many specimens as we wished (see Phot. 2).

There were 40 oral presentations in the programme but five would-be-participants did not appear. Like during many of the previous seminars, most absentees were our wicked neighbours from across one border or another; they always submit their abstracts and then… nothing happens. Their abstracts were in the abstract book and are included here. The number of posters in the programme was 17 and again, three authors (and two posters) never arrived. The chairman of the poster session made each poster owner stand in front of their poster and explain to the audience what the poster was about, almost as if he doubted the quality of our graphics. The number of participants and the number of presentations were widely disparate for usual reasons: more than one author per presentation, more than one presentation per author, people without any presenta-

Phot. 1. Socialising...

Phot. 2. Malacologists collecting fossil *Viviparus* in Ortel Królewski. All the white blobs on the ground are shells

tions, presentations (included in the programme) without any people to them, people coming later or leaving earlier making it difficult to count. In all, there were more than sixty people present, including one guest from the Czech Republic who even chaired one of the sessions (and did it in Polish!). Many young people: master's or doctoral students, nice and bright kids who obviously still do not realise that malacology is not exactly a very profitable trade.

Like last year, to have a picture of the variety of presented topics, I have attempted assigning papers to disciplines and even compared the result with the previous seminar. Some presentations were difficult to assign to a discipline (some have been assigned to more than one in the table), and I had to apply more than one division into categories.

No.	Discipline	Number of papers/posters	
		2006	2007
1	Ecology	9	20
2	Life histories	9	7
3	Conservation	7	2
4	Fossil molluscs	5	6
5	Applied malacology	4	2
6	Parasitology	3	3
7	Faunistics	2	2
8	Methodology	2	3
9	Physiology	2	1
10	Structure (histology, cytology, shell)	2	0
11	Variation	0	2
12	Systematics	2	2
13	Molecular genetics	1	3
14	Others (general, behaviour, archaeology)	2	3

The only really significant difference between 2006 and 2007 is the much greater number of ecological papers and posters this year. The division in the table disregards whether the main character in the story was a snail or a bivalve or where it lived (land or water). The snail:bivalve ratio among the presentations was 1.67:1 (compared to 2.38:1 last year), and the land:water ratio was 0.54:1 (1.13:1 last year). No Chi square is required to see that aquatic malacology is more popular again, and the same is true of bivalve studies.

There were two official social events: the huge bonfire on the first evening, with grilled sausages and lots of beer, and the banquet on the second day. The banquet was very special – not only eating and drinking, but also awarding honorary memberships of the Association. We have two new honorary members now: Professor ANNA STAŃCZYKOWSKA-PIOTROWSKA who studied *Dreissena* even before most people realised that such a creature existed, and who is now the "*Dreissena* pope", and Professor ANDRZEJ SAMEK who is basically an engineer (Technical University in Cracow) but loves molluscs, and who unfortunately could not attend the Seminar. Apart from their malacological and educational merits, they are simply very nice people and we like them a lot. Congratulations!

There are rumours that the next Seminar will be somewhere on the coast (Gdańsk?).

Our Abstract Book was in Polish, with a photo of the Bug River on the cover . Brief abstracts in English are presented below; in most cases translated surreptitiously behind the authors' back, by Yours Truly.

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ABSTRACTS OF THE 23RD POLISH MALACOLOGICAL SEMINAR, SERPELICE 2007

UNIONIDS (BIVALVIA: UNIONIDAE) OF THE DRAWA RIVER (WESTERN POMERANIAN LAKELAND)

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The sampling included 45 localities (50 sampling sites) along the Drawa River from its sources to the mouth (186 km), on its five tributaries and in some oxbows. The studies comprised the 40 km section within the Drawa National Park. Qualitative and quantitative samples contained 1,416 bivalve specimens representing six Polish unionid species; 985 live specimens were measured. The occurrence analysis was based on 213 specimens of *Unio crassus* Philipsson, 1788, 492 *U. tumidus* Philipsson, 1788, 140 *U. pictorum* Linnaeus, 1758, 10 *Anodonta cygnea* (Linnaeus, 1758), 120 *A. anatina* (Linnaeus, 1758) and 10 *Pseudanodonta complanata* (Rossmässler, 1835). In the upper section of the river unionids were represented by single individuals of *A. anatina*. Except transformed and polluted fragments of the Drawa, unionids were observed along the whole river. The dominant was *U. tumidus* found in most sites and reaching the highest densities (a few to 39 indiv./m^2). The highest density of *U. tumidus* (59 indiv./m^2) was found in a river bend with fertile detritus within the National Park below Drawnik. Common euryoecious *U. pictorum* and *A. anatina* were rare and not abundant, the former occurred in 1/4 sites, as a few individuals per square metre, the latter occurred singly in slow-flowing sections of the river. The stony-gravelly bottom of the Drawa and its fast flow in the gorge section favour the occurrence of *U. crassus* (EN, Red List). It was present in all 14 sites within the park, though it formed aggregations only locally. *P. complanata*, another red-listed species, preferred similar conditions; its single specimens were found mainly in the park section of the Drawa. The fast flowing Drawa provides few muddy places for *A. cygnea*; single individuals were found only in five sites in the river. Mean and maximum shell lengths of the studied unionids, except *U. pictorum,* were much smaller than those in the Pilica (for *U. tumidus* mean shell length in the Drawa 57.2 ± 14.7 cm, in the Pilica 70.5 ± 11.7 cm).

PERMISSIONS TO STUDY PROTECTED SPECIES AND AREAS – POLEMICS WITH THE MINISTER OF ENVIRONMENT

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Based on her own experience in 2006, when trying to obtain a permit to study unionid bivalves in the Drawa River (3 legally protected species plus the protected section of the river within the Drawa National Park), the author questions the principles, procedure and the fact of limiting the scientists's activities by clerks.

MALACOFAUNA OF THE LOESS PROFILE IN HALYCH, WESTERN UKRAINE

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Mollusc shells are known to occur in numerous loess localities in entire Europe, usually forming assemblages which are species-poor but include some characteristic species. The loess locality in Halych, on a high terrace of the Dnester River, includes a series up to 60 m thick, with several glacial cycles (loess) and interglacial phases (fossil soils). Nearly 50 samples containing c. 7,500 specimens of 39 species were analysed. The oldest fauna was found in the lowest part of the profile Halych IV – the assemblage with *Pupilla triplicata* characteristic of cold climate and open habitats of Arctic steppe type. The high proportion of *Pupilla muscorum loessica* Ložek indicates a high rate of sedimentation of aeolic dust**.** Another loess complex is associated with the Odra interglacial and contained in profiles Ha-IIA and Ha-IV. At that time the habitats in the region were very damp or even marshy, with a small shallow waterbody. The lower parts of the sequence in both profiles contain an assemblage with *Succinella oblonga* and a high number of higrophile species; its composition indicates a tundra developing in a very cold climate. In the higher part the profile the increased humidity is associated with appearance of the water body and an assemblage dominated by aquatic species. Marshy areas on the margins of the water body were inhabited by an assemblage with *Vertigo genesii*. Loesses of the last glaciation are mollusc-rich. The oldest assemblage with *Pupilla muscorum* and *Vallonia tenuilabris* was found in redeposited soil deposits in the floor of the loess series of the Vistula glaciation. Assemblages found above it are

dominated by open country species typical of cold climate (assemblages with *Pupilla muscorum* and *P. muscorum loessica*). They characterise a polar steppe type habitat. Appearance of an assemblage with a high proportion of shade-loving species is interesting. The assemblage is associated with upper Palaeolithic settlements and indicates appearance of human habitations.

SIZE STRUCTURE OF *DREISSENA* POPULATION OF THE COOLING RESERVOIR OF THE KHMELNITSKIY NUCLEAR POWER PLANT

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The research was carried out in 2005 and 2006 in the cooling reservoir of the Khmelnitskiy NPP (NW. Ukraine). Colonies of *Dreissena* are found in the entire reservoir. The main aim was the analysis of size structure of the population of *Dreissena polymorpha*. Six size classes, starting with 1–5 mm, with 5 mm intervals, were analysed. The population turned out to be rather unstable, with much variation in time and space. In June 2005 small individuals dominated in the benthos of the upper part of the reservoir, suggesting a recent settlement of the mussels, in contrast to the southern part, where older age classes (6–20 mm) were distributied at regular intervals. The analysis of size classes in the eastern part of the reservoir in 2006 revealed two periods of settling: early spring, which in April resulted in a dominance of mussels of 6–10 mm, and July – 11–15 mm. Another settling period at the end of summer was confirmed by the high proportion of the size class of 6–10 mm in October. On the dam small individuals predominated in April; in July in various sites older mussels dominated and an absolute dominance of the 6–10 mm class was observed in October. The distribution analysis made it possible to distinguish three basic types: one characterised by the dominance of individuals of the 1–5 mm class, whose proportion was over 25% – a "young", growing population. For the second type, most individuals were within the 6–10 mm or 11–15 mm class. The third type showed a co-dominance of two size classes which indicates a supply of young individuals at some stage. In none of the sites old individuals dominated. The insignificant proportion of individuals longer than 20 mm in all seasons and sites testifies to the mortality of these size classes. The interdependence between the structure (two basic classes: 6–10 mm and 16–20 mm) and depth was investigated. There was a decrease in the proportion of 16–20 mm mussels to the depth of 4 m, and then their proportion was nearly constant, of c. 10%. At the same time the proportion of 6–10 mm individuals increased, but then decreased at greater depths. Recruitment of young mussels at different depths had a different intensity, the 4 m level being the border zone. The maximum shell size was found to increase with depth. The maximum value of the Kv parameter was observed at the depth of 4 m.

CONCENTRATION OF SELECTED HEAVY METALS IN TISSUES AND SHELLS OF *LYMNAEA STAGNALIS* L. FROM THE BIEBRZA NATIONAL PARK

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The Biebrza National Park is among the least polluted areas in Poland. Heavy metal content in organisms living there may serve as a test of the alleged purity and provide information on the spread of anthropogenic pollution. Twenty two specimens of *L. stagnalis*, collected in July 2005 in an oxbow of the Biebrza near the village of Biały Grąd, were analysed for the content of cadmium, lead, copper and zinc in their shells, foot, hepatopancreas and viscera (rest of the tissues). Shell: cadmium 1.73–4.27 µg/g dry weight (mean 3.356±0.567 SE); lead 4.95–12.80 µg/g d.w. (mean 9.884±1.881 SE); copper 2.87- 5.76 µg/g d.w. (mean 4.953±0.637 SE); zinc 3.6–6.6 µg/g d.w. (mean 4.89±0.78 SE). Foot: cadmium 0–6.42 µg/g d.w. (mean 1.194±1.661 SE); lead 0–24.81 µg/g d.w. (mean 1.240±5.549 SE), copper 0–10.03 µg/g d.w. (mean 3.210±3.162 SE); zinc 74.9–150.1 µg/g d.w. (mean 108.04±20.86 SE). Hepatopancreas: cadmium, lead and copper ranged from 0 µg/g d.w. to 2.38 µg/g d.w. (mean 1.003±0.790 SE), 32.52 µg/g d.w. (mean 4.355±9.699 SE) and 20.41 µg/g d.w. (mean 6.600±4.685 SE), respectively; zinc 69.6–143.7 µg/g d.w. (mean 94.32±19.70 SE). Viscera: cadmium, lead and copper from 0 µg/g d.w. to 5.93 µg/g d.w. (mean 0.961±1.735 SE), 19.34 µg/g d.w. (mean 1.805±5.570 SE) and 12.61 µg/g d.w. (mean 5.005±3.938 SE), respectively; zinc 57.9–138.8 µg/g d.w. (mean 84.17±16.13 SE). The results are preliminary; materials from other areas for comparative analysis have been collected; they represent various species (*Lymnaea stagnalis* L., *Planorbarius corneus* L., *Viviparus viviparus* L.).

MARINE SNAILS OF THE MIDDLE MIOCENE OF KORYTNICA IN THE COLLECTION OF THE FACULTY OF BIOLOGY, ADAM MICKIEWICZ UNIVERSITY

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A collection of marine snails from the middle Miocene (Badenian) from Korytnica (Świętokrzyskie voivodeship, district Jędrzejów) is a part of the collections of the Faculty of Biology, Adam Mickiewicz University in Poznań. It includes 54 species of the families Aporrhaidae, Buccinidae, Calyptraeidae, Cancellariidae, Cassidae, Cerithiidae, Columbellidae, Conidae, Epitoniidae, Fasciolariidae, Melanellidae, Muricidae, Nassariidae, Naticidae, Olividae, Ranellidae, Ringiculidae, Rissoidae, Terebridae, Turbinidae, Turridae, Turritellidae and Vermetidae. The specimens are very well preserved, with glossy shells and delicate details of sculpture visible. Most are nearly complete shells; interior casts are few. Shells of *Natica tigrina* and *Ancilla glandiformis* have their colouration partly preserved. The collection makes it possible to conclude about ecological relations: mainly predation and using shells as a place of development. Many shells bear traces of boring by predators of the genera *Natica* and *Murex*. On some shells crab-made incisions are visible and burrows made by a cirripede *Trypetesa polonica*.

SPECIES COMPOSITION AND SHELL SIZE AMONG *UNIO* FROM ARCHAEOLOGICAL SITES

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The shells were obtained in 1988, 1989 and 2002 from shell dens located under grave-mounds of the Vielbarian culture (Roman period) in Nowy Łowicz nr. Drawsko Pomorskie (Pomerania), dated as period IV/V of bronze epoch (c. 3,000–2,650 years BP). Little damaged left shell valves were selected from each of the two sites: K22 and K23; a total of 2,166 shells were analysed. Three species were present: *Unio crassus, U. tumidus* and *U. pictorum*; no shells of *Anodonta* were found. K22 was dominated by *U. tumidus* (54%), K23 by *U. crassus* (56%); the difference was statistically significant ($p<0.001$). Shells of all three species were significantly larger (length, height, thickness, mass) in K23 than in K22. K22 assemblage contained few shells of aquatic snails and Sphaeriidae which suggests that the bivalves were not hand-collected; a dregde towed along the river bottom was used. K23 collection contained no shells other than *Unio*. The regular shape of the pit where the shells were found may suggest that it was destined to store large quantities of bivalves. The absence of traces of opening the shells and the presence of some valves connected by a ligament suggest that live bivalves were thrown into the pit. *U. crassus,* characterised by the thickest shells, dominated in K23, and was clearly bigger there than in K22. The facts may suggest that K23 shells were selected before storage while those from K22 represented refuse, not necessarily of the same age as K23. Shells from K23 were not kitchen garbage or storage of calcium used for pottery. They were stored for purpose, probably for production of ornaments, amulets or household tools. Analysis of species composition and biometrical characters of archaeological unionid shells may provide information about environmental conditions in the past.

PLANT EXTRACTS AND INFUSIONS AS MEANS OF LIMITING FEEDING OF *DEROCERAS LAEVE* MÜLL.

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Deroceras laeve Müll. when occurring in masses may become a serious pest of greenhouse cultivations; greenhouses provide a high humidity of air and substratum which favour its reproduction and feeding. It damages all parts of plants, often decreasing their decorative and commercial value. Commonly used molluscicides are not very effective in greenhouses and new methods of slug control are sought. The paper presents results of laboratory studies on deterrent properties of aquatic extracts and infusions from leaves of elder (*Sambucus nigra*), oak (*Quercus petraea*) and horse chestnut (*Aesculus hippocastanum*) in relation to *D. laeve*.

LIFE CYCLE OF *VESTIA GULO* (E.A. BIELZ, 1859) (PULMONATA: CLAUSILIIDAE)

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Laboratory and field studies made it possible to reconstruct the life cycle of *Vestia gulo*. The snail is oviparous, in the laboratory it produces batches of 6–15 eggs (mean 10.4). Adults collected in May, June and July have in their oviducts tightly packed eggs occupying 1–1.75 whorl of the viceral sac (8–21, most often 12–13 eggs). Egg-laying in the field takes place mainly

in July; batches were observed on pieces of timber under bark, in damp moss and at bases of stems. Juveniles of c. 2.5 whorl appear from the end of June till the end of August and are most numerous in July. The four studied populations in the Pieniny Mts and Gorce Mts were found to differ in their growth rate; it amounted to c. 4 whorls/season and resulted in a longer time necessary to complete growth in populations at high altitudes. In two populations from lower situated sites (c. 425 m a.s.l.: Krościenko, Pieniny) growth was the fastest; in the first season the juveniles produced c. 3.5 whorl, the maximum increment being 5 whorls. The growth was very slow from October to the end of April. At the beginning of May last year juveniles had a mean of 6.5 whorls, the maximum number being 8. In the second season the mean increment was 5.5 whorls, the maximum 8.5 whorls. A considerable proportion of juveniles finished their growth reaching c. 11 whorls and forming a lip in their second season. The fastest growing individuals completed their growth as early as May–June (aged c. 10 months). In that period the number of individuals producing the last whorl was the highest. The remaining snails finished their growth in the next season. In their first season juveniles from the population at 650 m a.s.l. (Rzeki, Gorce) gained on average 2 whorls. At the beginning of May last year juveniles had c. 5 whorls, the maximum was 7 whorls. In the second season the mean increment was 3 whorls, the maximum 7 whorls. Only the fastest growing snails completed their growth in their second season. The growth period was even longer in the population from 1,150 m a.s.l. (Kudłoń, Gorce). In their first season the juveniles reached a maximum of 5 whorls, and completed their growth in the third year of life. In the laboratory the snails started laying eggs in the third season of life, c. one year after lip completion. Anatomical examination confirmed the delay in the development of the reproductive system compared to shell completion. Adults kept in laboratory (hibernation in low temperature) could live for at least 5 years reproducting in consecutive seasons. Individuals of *V. gulo* kept singly from early juvenile stages were capable of uniparental reproduction, and their eggs did not differ in size from those produced by snails kept in pairs, but showed a low hatching success (22%).

EFFECT OF PARENT BODY SIZE ON THE QUALITY OF PROGENY IN *HELIX POMATIA* L.

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In 2004–2005 development of juveniles derived from 60 parents of *Helix pomatia* L. was analysed from incubation till the end of the second year of life; special attention was paid to a possible size (shell height, width and diameter) correlation between the parent and the progeny. Only size of early juveniles was correlated with that of their parents; size of juveniles several monhs old was no longer correlated with the parent size. A significant factor affecting the juvenile shell size may be maternal effect. Batches of larger parents contained larger eggs. Because the father's size was unknown it was impossible to estimate the total heritability of body size. The observations suggest that the external conditions have a strong effect on the development of young snails. Additionally, factors that render culture of Roman snail dificult were analysed: cannibalism resulting in 50% losses in the first few days after hatching, climatic and food conditions, parasites and moulds. According to current regulations it is allowed to collect Roman snail of more than 30 mm. If size is not heritable, removal of larger individuals from populations will have no effect (phenotypic selection) on the size of future generations. The problem requires more detailed studies.

EFFECT OF ENVIRONMENTAL FACTORS ON THE STRUCTURE OF MALACOCOENOSES OF ASTATIC MIDFIELD POOLS

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Species composition and quantitative structure of malacocoenoses of 30 small midfield pools in western Wielkopolska were studied in 2002 and 2003. All the pools underwent considerable fluctuations of water level, most dried up for 1–8 months per year, the maximum surface area ranged from 135 to 2,500 m^2, the depth from 0.3 to 1.5 m. Samples were taken in all microhabitats observed, five samples of 0.1 m^2 each per microhabitat (total 0.5 m^2) in the spring and autumn 2002 and spring 2003. On each occasion physico-chemical properties of water and bottom deposits were determined; morphometric character of the water bodies and their catchment area were described. Eleven aquatic pulmonate species and two bivalve species were recorded (114,437 specimens). The malacocoenoses varied significantly both qualitatively (2–9 species) and quantitatively (30 to over 10,000 indiv./m^2). The most common species were *Anisus leucostomus* (100% pools, 89% microhabitats) and *Segmentina nitida* (97% pools, 95% microhabitats). *Aplexa hypnorum*, regarded as typical for drying-out waterbodies, proved to be surprisingly rare (7 pools, 15% microhabitats). The effect of ecological factors was analysed with CCA and RDA canonical analyses. The most significant factors were the permanence of the pool and the microhabitat, the remaining signifi-

cant factors being organic matter content in the bottom deposits, oxygen content and orthophosphates in the water, water pH. Four types of malacocoenoses were recognised: 1. *S. nitida* + *A. leucostomus* – characteristic of ephemereal pools of slightly acid pH and small content of organic matter in bottom deposits; 2. *Stagnicola corvus* + *Planorbis planorbis* – periodically drying pools, considerably overgrown with macrophytes, moderate water pH and high orthophosphate content; 3. *Planorbarius corneus* + *Radix balthica* – more permanent waterbodies than those of the preceding malacocoenosis, of higher water pH and smaller orthophosphate content; 4. *Armiger crista* + *Lymnaea stagnalis* – characteristic of the most permanent pools, of alkaline pH, oxygen-rich and orthophosphate-poor, high content of organic matter in bottom deposits.

ON EMPLOYING "VOLUNTEERS" IN MALACOLOGICAL STUDIES AND THE EFFECT OF PERSONAL CHARACTERS OF THE RESEARCHER ON THE RESULTS

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Semiquantitative methods (e.g. collecting during a given time) are often biased and should be used only as supplementary to quantitative methods. The drawbacks are frequent omitting of small species, and also individual characters of researchers, e.g. experience of psychophysical traits. On the other hand, employing many collectors may increase the efficiency of collecting or the chance of finding rare species. Our aim was to check if and to what extent employing many people, not necessarily experienced, is sensible and which individual characters of collectors affect the results significantly. The study took place in June 2004, in a malacologically well known manor park in Obrzycko, with participation of III year biology students. Five plots (each 200 m^2) of similar habitat conditions were selected. Five groups of students, each of five people plus supervisor-malacologist, were employed; each group, supervisor included, searched for molluscs in one plot for 30 minutes (total of 2.5 hr or 22.5 person-hour). Then all the participants filled in enquiry sheets in order to assess their physical (sex, eyesight) and psychophysical traits (tiredness, enthusiasm etc.) and experience in malacology. The total collection included 457 specimens of 15 species (50% species recorded from the park). Seven species earlier detected with quantitative methods (Oekland) were not found. Ten species found by the students had not been recorded from similar habitats in earlier quantitative studies. Differences between the students' and supervisor's results consisted mainly in the number of snails that are difficult to find (e.g. *Clausilia bidentata*). On the other hand, the students were somewhat better at finding big snails (e.g. *Helix pomatia, Cepaea nemoralis*). The differences were statistically significant (RDA, p=0.002; F=4.96), but accounted for only 11% variation among the results of individual persons. Among the physical characters considered only sex affected the results: girls found more small and rare species (RDA, p=0.028; F=2.13). Sex and significant psychophysical factors (number of sleep hours, enthusiasm) accounted for 27.3% observed variation. Employing a larger group of volunteers supervised by an experienced person increases the efficiency of collecting, whereas individual differences between the volunteers account for only a small percentage of the observed variation.

QUANTITATIVE DEVELOPMENT OF TREMATODES IN A COMMUNITY OF BENTHIC MOLLUSCS

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Populations of dominant species of benthic snails: *Viviparus viviparus* L., *Lymnaea stagnalis* L., *Radix auricularia* L., *Planorbarius corneus* L. in the littoral biocenosis of lake Babje Lake (Dnipro River, Kiev) were investigated in the spring-autumn period (2006). All molluscs or a part of a sample were dissected using common parasitological techniques. Larvae and partenites were counted in the Bogorov chamber. Using parameters of infection and snail population density, the biomass and average quantity of trematode partenites and larvae per unit substratum (1 m^2 bottom) were calculated. The biomass of trematodes was determined with volumetric method. In the spring the population density of *V. viviparus* was 31 specimens/m^2, the total prevalence of infection – 19%. Two species of trematodes: *Leucochloridiomorpha constantiae* Muller and *Cercaria bolschewensis* Cotowa were found. The prevalence of infection (PI) for *L. constantia* was 10%, the average intensity of infection (AII) – 1.3 cercariae/mollusc, the average number (AQ) – 4 cercariae/m^2, biomass (B) – 11 mg/m^2; for *C. bolschewensis*: PI – 6%, AII – 17 cercariae/mollusc, 787 rediae/mollusc, AQ – 17 cercariae/m^2, 2,362±118 rediae/m^2, B – 0.5 and 0.8 mg/m^2 respectively. The other snails: *L. stagnalis* (density – 6 specimens/m^2), *R. auricularia* (3 specimens/m^2) and *P. corneus* (9 specimens/m^2) were not infected. In the summer the density of *V. viviparus* was 20 specimens/m^2, the total prevalence of infection – 20%. Four species of trematodes: *L. constantiae, C. bolschewensis*, *Cercaria pugnax* La Valette and trematode rediae of the family Echinostomatidae

were found. The infection parameters were: *L. constantiae*: PI – 10%, AII – 1 cercariae/mollusc, AQ – 2 cercariae/m^2, B – 7 mg/m^2; *C. bolschewensis*: PI – 5%, AII – 218 cercariae/mollusc, 854 rediae/mollusk, AQ – 218±11 cercariae/m^2, 854±43 rediae/m^2, B – 6 and 221 mg/m^2, respectively; *C. pugnax*: PI – 5%, AII – 7,264 cercariae/mollusc, 17,829 sporocyst/mollusk, AQ – 7,264±363 cercariae/m^2, 17,829±891 sporocyst/m^2, B – 9 and 27 mg/m^2, respectively; rediae of Echinostomatidae sp.: PI – 10%, AII – 814 rediae/mollusc, AQ – 1,629±81 rediae/m^2, B – 423 mg/m^2. Examining *L. stagnalis* (density 11 specimens/m^2) revealed a single case of infection with cercariae of *Opisthioglyphe ranae* (Froelich): average intensity of infection 15,208 cercariae/mollusc. In the autumn the density of *V. viviparus* was 7 specimens/m^2, and the total prevalence of infection – 86%. Two trematode species: *C. bolschewensis* and *C. pugnax* were found. *C. bolschewensis*: PI – 50%, AII – 73 cercariae/mollusc, 132 rediae/mollusc, AQ – 219±11 cercariae/m^2, 529±26 rediae/m^2, B – 6 and 137 mg/m^2 respectively; *C. pugnax*: PI – 14%, AII – 583 sporocyst/mollusc, AQ – 583±29 sporocyst/m^2, B – 0.9 mg/m^2. The density of *P. corneus* was 12 specimens/m^2, the total prevalence of infection – 17%. Cercariae of *Opisthioglyphe* sp. (PI – 16%, average intensity of infection – 674 cercariae/mollusc) were found. *L. stagnalis* (density 6 specimens/m^2) and *R. auricularia* (density 12 specimens/m^2) were not infected. The total mean number of the three species of trematodes (larvae and partenites) was maximum in the summer and reached 2,703±135 specimens/m^2, with the total biomass 665 mg/m^2. The trematode per hosr organism may amount to 1–11% host's body mass.

DIET AND LIFE STRATEGY OF *VIVIPARUS VIVIPARUS*

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The number of embryos incubated by *Viviparus viviparus* was found to depend on the female body size. *V. viviparus* is iteroparous and lives in a climate with well-defined seasons. Variation in its body size may result from different initial size, different growth rate or different duration of growth period. *V. viviparus* starts its growth with the same body size, thus the size variation may result from different food niches of males and females. We examined the contents of alimentary tracts of snails from four aquatic habitats: dam reservoir, estuary sections of rivers, river and oxbows. The proportion of detritus in their alimentary tracts varied from over 70% to c. 90%; algae constituted a smaller proportion (up to 15%). Inorganic matter (e.g. sand grains) in the alimentary tracts of snails from the dam reservoir and oxbows constituted a smaller proportion, compared to the snails from other habitats. The algae included benthic, periphytic and planktonic species (the last group indicating filtration). In the dam reservoir most food consisted of the genus *Scenedesmus*, with fewer diatoms, dinoflagellates and chrysophytes. Snails from the river estuaries had more diatoms (up to 48%), less green algae (25%) and rather much sand, compared to the reservoir snails. The diet of the snails from the Narew was similar to that of the estuarine snails. The alimentary tracts of snails from the Bug oxbows contained mostly green algae of the genus *Monoraphidium* and diatomes (*Stephanodiscus, Cyclotella, Nitzschia*). The proportion of blue-green algae, chrysophytes and dinoflagellates was small. The diet was similar in both sexes in all the populations. The degree of filling of the alimentary tracts varied: snails with empty guts were few in the river and estuaries; their proportion in the reservoir and oxbow was up to 20%. Feeding was the most intense in the summer, less so in the spring and autumn; only the oxbow snails fed the most intensely in the autumn. Sex had no effect on the feeding intensity (the same degree of filling of alimentary tract in both sexes) but different size classes differed in this respect: the smallest snails fed the most intensely.

DIVERSITY OF AQUATIC MALACOCOENOSES OF THE FLOODPLAIN OF THE LOWER BUG RIVER

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The objective of the study was to characterise the species richness and diversity (Shannon-Weaver, H') of the malacofauna, frequency of particular species and structure of malacocoenoses of selected water bodies on the left bank floodplain of the lower Bug river. We also attempted an assessment of usefulness of molluscs for characteristics (grouping) of the studied habitats. Samples were taken in 2004–2006, mainly from May to September, in 58 water bodies in five fragments of the left bank part of the Bug valley, between 50. and 152. km river course. Fifty two species were recorded: 36 snails (1 based on empty shells) and 16 bivalves. The number of species in individual water bodies ranged from 0 to 25 (2–30 including species recorded based on empty shells). The number of specimens varied from 0 to over 300 in a sample (area of 0.5–1 m^2). Malacocoenoses of most habitats showed a considerable diversity (H' c. 2–3). The value of Shannon-Weaver index (H') in the five studied fragments was within 3.4–4.1, and for the whole area it was 4.5. The most common species (F=50%) were *Planorbarius corneus* (L.), *Lymnaea*

stagnalis (L.) and *Bithynia tentaculata* (L.), and considering molluscs found as empty shells, also *Anisus vortex* (L.), *Viviparus contectus* (Millet) and *Radix labiata* (Rossmässler). These species constituted a large proportion of the malacocoenoses, but the dominance structure varied between the groups of water bodies and habitats. Multidimensional analyses (principal component analysis PCCA and cluster analysis; Statistica 7.0) of the data on the occurrence and abundance in the habitats presented on a 7-degree scale made it possible to distinguish five subgroups of water bodies which formed two main groups: 1) temporary water bodies or shallow and much drying water bodies, 2) larger, deeper water bodies, often representing younger stages of succession and hydrologically more connected with the river.

PLANT PROTECTION FROM GASTROPODS – PAST, PRESENT AND FUTURE

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The first mentions of gastropod damage to plants date from the 10th c. The prayer of martyr Trypho who prayed that "snails and other pests do not damage plants but go to the wild mountains instead" dates from that period. Another mention comes from 1777, when reverend Gilbert White mentiones great damage to young wheat by slugs. Attempts to control these pests started at the beginning of the 19th c. In 1821 William Cobbett gave information on how to limit plant damage by slugs in field crops. He recommended using cabbage as bait in wheat crops. On the turn of the 19th/20th c. various commonly accessible substances started being used for plant protection against gastropods: lime, salt, soot, ash, carbolic acid, sawdust, tabacco, Bordeaux solution, sulphur hydroxide, copper sulphate, iron sulphate, potassium aluminosulphate and others. At the end of the 19th c. Tyron proposed molluscicides in the form of granulated baits. The first granulates contained Paris green (copper acetoarsenate) and other derivatives of copper and arsenium as active substances. The beginning of the 20th c. brought a development of use of more complex chemicals. The first important step in limiting gastropod-caused damage was the 1934 accidental discovery of molluscicidal properties of metaldehyde. The pertinent information appeared in the British gardening press in 1936 and four years later metaldehyde became the most often used active substance in gastropod control in garden crops. Parallelly, studies were conducted on the possible application of other active substances used as insecticides, herbicides or fungicides, for gastropod control. In 1954 studies started on the use of various active substances in control of *Centaureus aspersus* in the plantations of the Californian citrus tree. In 1964 a new substance was described which later was called methiocarb and became the second main active substance of molluscicides. Attempts were also made at using derivatives of various metals for control of terrestrial gastropods, and the studies are still continued. Much hope for discovering new active substances is attached to plant-derived chemicals. The hitherto studies indicate that some of them may be useful as control agents. Because of the unsatisfactory effectiveness and environmental effects of the commonly used granulated molluscicides, other methods of applying active substances are being sought. One of them is impregnating seeds with special polymers. Studies on this method have been conducted since 1984 in Great Britain and The Netherlands, and in recent years also at the Institute of Plant Protection in Poznań. It is believed that the future of methods of pest gastropod control will depend on discovery of new active substances of low toxicity and on devising new methods of their aplication. Improving agrotechnical methods of protecting plants against pests will also be important.

GASTROPODS OF THE CATCHMENT AREA OF THE KONINA STREAM IN THE GORCE NATIONAL PARK

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The Gorce National Park is little known and very interesting with respect to its malacofauna. The Gorce Mts are located in the central part of the Western Beskidy Mts. Five main montain ridges are arranged radially from the highest summit – Turbacz (1,310 m as.l.); they are dissected by deep stream valleys. One of them, the Konina stream valley, was studied in 2003–2005. The stream is located in the northern part of the Park, its sources are near the peak of Mostownica (1,251 m a.s.l.). Terrestrial snails were collected during two seasons, every 7–14 days. A few to about a dozen litter samples were taken in selected plots; the sampling was supplemented with visual search. Thirty snail species representing nine families were recorded; most of them not recorded from the GNP area earlier. Many of them are red-listed in Poland as vulnerable or rare. The former category includes *Semilimax kotulai* and *Trichia bielzi*, the second *Acicula parcelineata, Macrogastra tumida*, *Vestia turgida*, *V. gulo*, *Eucobresia nivalis*, *Semilimax semilimax* and *Oxychilus glaber*. Studies aimed at determining the composition of malacocoenoses of various habitats in the GPN will continue during the next few years.

BEHAVIOUR OF THE ZEBRA MUSSEL (*DREISSENA POLYMORPHA* PALL.) IN THE PRESENCE OF CONSPECIFIC INDIVIDUALS

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The zebra mussel often reaches high densities; the mussels attached to other mussels or to hard substrate form compact aggregations. This life style makes the zebra mussel behaviour likely to change under the effect of the presence of conspecifics. According to many authors settling postveligers of the zebra mussel react to the presence of adults on the substratum, though the kind of reaction seems to depend on other factors (e.g. density). In my earlier studies the density of postveligers on substrata with live adults, empty shells or stones did not differ from that on control substratum (empty plastic plates), but the distribution varied: settled individuals were the most numerous near live adults and shells. The presence of conspecifics affects also attachment to the substratum; bivalves in groups attach earlier and their attachment is stronger compared to solitary individuals. The differences did not depend on direct physical contact between individuals which suggests a role played by chemical substances released to the water. Some organisms change their behaviour in the presence of injured conspecifics which may indicate a potential danger. Limited locomotion as a response to such a stimulus has been observed in the zebra mussel. The experiments were aimed at studying other possible reactions: attachment strength, geotaxy and aggregating. In the presence of injured individuals the attachment strength did not change, the same was true of vertical migrations. The degree of aggregation in the presence of injured individuals was smaller than in the control group. This pertained only to large mussels (>10 mm) examined after 1 day of exposure. In the remaining variants (6-day exposure of small mussels) the differences were insignificant. This may result from the limited mobility of large mussels under the effect of injured conspecifics, but the exact explanation of the phenomenon requires further studies. The results suggest that in the studies on mussel physiology and ethology the presence of conspecifics may affect the reactions of the test animals.

MALACOFAUNA OF THE LITTORAL OF THE JORKA RIVER LAKES (MAZURIAN LAKELAND) – LONG TERM CHANGES

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The occurence of benthic molluscs in the littoral of selected lakes of the Jorka river (Majcz Wielki, Inulec, Głębokie, Jorzec) was studied in August 2006. Samples were taken in 10 sites in each lake, from the depth of 1–2 m. All molluscs were identified and counted; for *Dreissena polymorpha* the size structure was also determined. The results were compared with the data for the last 30 years. The malacofauna proved to be very poor; only 220 specimens were collected; of these 212 were *D. polymorpha*. Single specimens of *Theodoxus fluviatilis*, *Viviparus viviparus*, *Bithynia tentaculata*, *Unio pictorum*, *U. tumidus*, *Anodonta anatina* and *A. complanata* were also found. The most numerous mollusc species (4) were found in lake Jorzec, the fewest (2 in each) in lakes Majcz Wielki and Głębokie. Neither live snails nor empty shells of *Lithoglyphus naticoides*, recorded earlier (1970s) from lakes Majcz Wielki and Jorzec, were found. Another invasive species, *Potamopyrgus antipodarum*, frequent in the 1990s in lakes Inulec and Głębokie, does not ocur there any more; only its empty shells were found in bottom deposits of lakes Inulec, Głębokie and Jorzec. *D. polymorpha* as present in lakes Majcz Wielki, Inulec and Głębokie; in each it formed over 90% malacofauna, and its frequency was 30–50%. It was not found in lake Jorzec, where it had been observed at low densities in the 1970s. The abundance of *D. polymorpha* was the highest in lake Inulec (c. 500 indiv./m^2), much lower (100–200 indiv./m^2) in the other lakes. The size structure of zebra mussel varied between the lakes. Becuse of the differences in sampling methods between the study periods it is difficult to compare some results, especially for snails. It seems however that a qualitative and quantitative impoverishment has taken place. It may result from environmental changes within the last 30 years. Till 1980s lake Głębokie was used for trout farming which resulted in a strong eutrophication of that lake and the lower situated Jorzec. Information on the occurrence of *Lithoglyphus naticoides* seems to result from misidentification. The presence of empty shells of *Potamopyrgus antipodarum* indicates that its 1990s invasion was unsuccessful.

ROMAN SNAIL (*HELIX POMATIA* L.) IN THE NORTHERN PART OF MAZOVIAN VOIVODESHIP

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In the summer of 2006 we carried out field studies aimed at an assessment of the Roman snail population in the northern Mazovian voivodeship from the viewpoint of its possible exploitation. According to literature data the snail is rare in the area. Assessment of its presence and basic population parameters included several districts (Wyszków, Mława, Maków Mazowiecki, Ostrów Mazowiecka, Ostrołęka) with 53 sites and two additional sites in Podlaskie voivodeship. The habitats selected were potentially favourable for the snail. Four-five persons searched an area of a few hundred square metres for 15–20 minutes in each site for the snails or shells; when these were found, samples were taken from four plots, 5 x 5 m each. The snails were counted, measured, weighed, their maturity was assessed, as well as density and biomass per 100 m^2, and the size structure. In the studied area the Roman snail occurs only in some of the studied anthropogenic habitats and is absent from natural habitats. It was found only in 9% sites (and only 6 for Mazovian voivodeship). In those sites its density (13–27 indiv./100 m^2), biomass (220–450 g/100 m^2), and size structure of the populations do not depart from the corresponding parameters in the areas of Poland where it is frequent. The total area inhabited by the Roman snail in Mazovian voivodeship is very small, less than 50 km^2. The absence of Roman snail (and also of other big gastropods) in the studied area may have natural reasons – favouable habitats are few, small in area and far apart. Historical reasons may also be important: in the northern and central parts of Poland the Roman snail was artificially introduced, first in Middle Ages and then in the 18th c. Mazovia, because of its history and social structure, had no larger centres interested in introduction of the Roman snail as edible animal. The snail is rare in the studied area, found only in few anthropogenic habitats and its exploitation is not advisable for both commercial and species protection reasons.

THE EFFECT OF ENVIROMENTAL FACTORS ON THE MALACOFAUNA OF THE LIWIEC RIVER

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The effect of enviromental factors (chemical parameters of water, seasonality) on the number of mollusc species and their density in the Liwiec river (the longest tributary to the Bug River, E. Poland) was studied in 1998–2000 and 2002. Mollusc and water samples were taken in 12 sites along the whole river, in the spring, summer and autumn. Analysis of water quality included temperature, pH, conductivity, oxygen concentration, nitrates, calcium and chlorine ions, and BZT_5 parameter. Aquatic plants were identified in each site. The recorded molluscs included 20 species of snails and 5 bivalves. The most important habitat factor was the kind of bottom; the most numerous species and the highest abundance were found on clayey-muddy and sandy-muddy bottom. Among the physico-chemical parameters of water, increased concentrations of phosphate and nitrate ions had a negative effect on the occurrence of the malacofauna. There was a positive correlation between the calcium ion concentration and the number of species and snail density. No great seasonal changes in mean mollusc density were observed. Somewhat more numerous mollusc species were observed in the autumn, compared to the remaining seasons.

MODERN RESEARCH TECHNIQUES IN MALACOLOGY

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Some modern research equipment at present is interdisciplinary and used in very different disciplines of science, such as physics, commercial materials science, criminology, archaeology or biology. Electron microscopes, both scanning and transmission, as well as Roentgen microanalysers are among such devices. Such research techniques are becoming increasingly more available; they offer an insight into microscale of the history of the earth, surrounding world and in some cases make it possible to predict future. In this paper we present possible applications of scanning electron microscope with Roentgen microanalyser EDS in malacology; we use a helicid snail as an example. We show methods of peparing soft tissues for SEM examination and the results of morphological studies; of determining the qualitative and quantitative chemical composition of the shell using dispersion of Roentgen radiation. We present a short characteristics and basic working principles of SEM and EDS.

INFLUENCE OF TEMPERATURE ON THE OXYGEN CONSUMPTION RATE IN THE HOST-PARASITE SYSTEM *VIVIPARUS VIVIPARUS* – TREMATODA

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The intensity of animal's metabolism is often determined as the intensity of gas exchange or respiration. The oxygen consumption rate is the most accessible and reliable index of metabolic rate. Considering the advantages of this index, we tried to trace the temperature influence on the oxygen consumption rate in trematode-infected and uninfected snails. We used *Viviparus viviparus* and two trematode species: *Leucochloridiomorpha constantiae* Muller and *Cercaria bolschewensis* Cotova. Adult snails were collected from the littoral zone of the upper Kaniv Reservoir and lake Babje (Dnipro River, Kiev) in May 2006. The animals were maintained at the mean temperature of 19.8°C in de-chlorinated freshwater for at least a week before the experiment. After acclimation the snails were placed in two aquaria at the mean temperature of 27.5°C (high temperature variant) and 22.8°C (control variant) and kept during 30 days. A comparison of dissection results of these two samples indicated some peculiarity in the infection indices. The snails from lake Babje were more infected then those from the littoral zone of the Dnipro River. In particular, snails from the littoral of the river were infected by *L. constantinae* with the prevalence (PI) – 12%; *L. constantiae* and *C. bolschewensis* were found out in lake Babje with PI of 10% and 19%, respectively. This was the decisive factor in selection of sampling sites. Oxygen concentration in the water was determined with the Vinkler method. The results revealed the following trends in the reponse to temperature: 1) in the high temperature variant a greater proportion of infected snails survived, compared to the uninfected snails (8% for the high temperature variant and 13% for the control variant); 2) the parasite population included 68 and 82% metacercariae, 32 and 18% rediae and cercariae for the high temperature and control variants, respectively. This may reflect a higher development rate of the parasite at high temperatures; 3) the oxygen consumption rate was higher in the high temperature variant (maximum 1.18 mg O_2/h), compared to the control (maximum 0.82 mg O_2/h). In the control variant the oxygen consumption rate per hour increased (from 0.38 to 0.82 mg O_2/h) with increasing infection and decreased (from 0.81 to 0.31 mg O_2/h), when the number of parasites exceeded 3,000 per snail. In the high temperature variant, the beginning in the oxygen consumption rate decreased with the increasing infection (from 1.06 to 0.54 mg O_2/h), and then increased (from 0.70 to 1.18 mg O_2/h), when the total infection exceeded 1,000 trematode per snail. The rate of metabolic processes increases with temperature. Survival of the infected specimens at high temperatures may indicate acclimation the host-parasite systems to environmental conditions.

POPULATION OF THE INVASIVE SNAIL *MELANOIDES TUBERCULATUS* (O. F. MÜLLER) IN THE KONIN ECOSYSTEM

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Melanoides tuberculatus is native to waters of Africa, S. Asia, Northern Australia and Madagascar; it is an expansive species which is associated with its parthenogenic reproduction and great ecological plasticity. In Poland its first occurrence in open waters was observed in 2000 in a discharge canal of the Pątnów hydropower plant which is a part of the system of heated Konin lakes (central Poland). In subsequent years no live idividuals were found there; only shells were collected. The species is a popular aquarium animal and the reason for its presence in the Konin ecosystem was probably an accidental introduction. However, the quick disappearance of the species from the habitat where it occured in great numbers (a few hundred individuals per square metre) is not explained. The shells collected in 2006 were both those of adults and of juveniles; shells 15–30 mm long were the most numerous (66%). The shell parameters (n=300) were the following: shell height 7.60–34.52 mm (mean 20.4), shell width 2.81–11.09 mm (mean 6.3), body whorl height 3.79–16.50 mm (mean 9.5), aperture height 2.71–11.32 mm (mean 6.4), aperture width 1.68–6.66 mm (mean 3.9), number of worls 9–11 (mean 11).

HEAVY METAL ACCUMULATION IN BIVALVES AND BOTTOM DEPOSITS OF THE KONIN LAKES

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The Konin lakes, with their power plants Konin and Pątnów, are exposed to pollution. The emission includes a high proportion of heavy metals. Bivalves are among organisms used to estimate pollution of aquatic environment with heavy metals. The bivalve fauna of the lakes includes *Sinanodonta woodiana* (Lea) and *Dreissena polymorpha* (Pall.). Concentration

of Cu, Zn, Pb and Cd in these bivalves and in the bottom deposits of the lakes and their connecting canals was studied. Concentration of zinc and cadmium in the bottom deposits did not exceed the values given as geochemical background for Polish lakes; concentration of lead and copper exceeded the background values. Bivalves from the lakes accumulated in their tissues more heavy metals than their conspecifics living in other regions of Poland. Higher concentrations of heavy metals were found in the tissues of *S. woodiana* compared to *D. polymorpha*. Also concentration of Cu and Zn in the shells of *S. woodiana* was higher than in *D. polymorpha*. The highest concentration of heavy metals was found in tissues of *S. woodiana* from the initial cooling reservoir. The results indicate that the concentration of metals in the bivalve tissues, besides the content in the environment, depends on the bivalve growth rate and filtration rate. This is especially well visible in the case of *S. woodiana* from heated waters.

MOLLUSCS AND OSTRACODS FROM THE LATE GLACIAL AND EARLY HOLOCENE DEPOSITS OF THE MIDDLE COAST OF SOUTHERN BALTIC

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Profiles from drilling in the bottom of lakes Kopań and Bukowo and a similar profile from the region of Darłówko were used in the studies. The profile from lake Kopań, 12.1 m b. s. l. deep contained a lacustrine series 2.4 m thick, overlain by a series of organic and silty muds with freshwater fauna, 4.5–5.0 m thick. The mollusc and ostracod assemblages are typical of freshwater environment, while some species may indicate changing depositional conditions (*Pisidium amnicum* (Müller), *P. casertanum* Poli, *P. casertanum* f. *ponderosa* Stelfox, *P. conventus* Clessin, *Cytherissa lacustris* (Sars), *Candona angulata* Müller, *C. neglecta* Sars, *Limnocythere inopinata* (Baird), *Cyclocypris laevis* (Müller)). The bottom part of the Bukowo profile (10.0–8.40 m b. s. l.) contains only freshwater ostracods (*Candona neglecta* Sars, *Cytherissa lacustris* (Sars), *Cypridopsis viduua* (Müller), *Cyclocypris laevis* (Müller)) and no molluscs. Above (7.8–2.4 m b. s. l.) a marine (euryhaline) ostracod *Cyprideis torosa* (Jones) and a marine foraminifer *Hippocrepina flexibills* (Wiesner) appear. The mixture of freshwater and marine faunas may indicate short-term transgressions of sea water into the lakes. The presence of plant and shell debris, wood fragments and vivianite granules in the profile from Bukowo, as well as the peat dated as 5,912±85 years BP, indicate a disappearance of an intially deep lake. A similar date (5,415±110 years BP) was obtained for the layer of peat at the depth 4.75 m b. s. l. in the region of Darłówko which covers a series of muddy-silty lacustrine deposits 4.2 m deep. They contain only freshwater fauna: *Pisidium casertanum* Poli, *P. conventus* Clessin, *Valvata piscinalis* f. *antiqua* (Müller), *Candona angulata* Müller, *C. neglecta* Sars, *Limnocythere inopinata* (Baird), *Cyclocypris laevis* (Müller). Pre-boreal age of the beginning of lacustrine accumulation is confirmed by the date obtained for the bottom part of the deposit in a profile from Bobolin; its accumulation started 9,885±450 years BP; the peat layer in the upper part of the profile was dated as 4,280±55 years BP. The results indicate that the lacustrine deposits in the studied area were accumulated in deep thaw basins in the zone of ground moraine; the accumulation started in the early Pre-boreal period. The faunal assemblages confirm that the deposits were formed in lakes.

POPULATION DYNAMICS AND STRUCTURE OF *ANISUS LEUCOSTOMUS* AND *SEGMENTINA NITIDA* (PLANORBIDAE) IN PERIODICALLY DRYING MIDFIELD POOLS

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Anisus leucostomus and *Segmentina nitida* are most often found in ephemereal water bodies, where they can survive due to an array of anatomical and physiological adaptations. Our objective was to check if their life cycles showed any modifications which would facilitate living in such habitats. The studies included four periodical pools which usually dry for 5–8 months a year, are small (370–740 m^2) and shallow (up to 1.5 m), and only on the margins are surrounded by emerged vegetation. In three of them *A. leucostomus* and *S. nitida* are the only snails, in the fourth also *Lymnaea stagnalis*, *Planorbarius corneus* and *Armiger crista* are present. Three sampling sites were selected in each pool. Samples were taken in 2004 and 2005, every two weeks from April till the drying up of the pools; on each occasion 10 samples were taken from each site with a hydrobiological net. A total of 2,409 individuals of *A. leucostomus* and 505 *S. nitida* were collected; the snails were divided into size classes: (I) shell width to 2 mm; (II) 2–2.9 mm; (III) 3–3.9 mm; (IV) 4–4.9 mm; (V) more than 5 mm. In the case of *A. leucostomus* in early spring in all populations the largest individuals prevailed (classes III and IV). In subsequent sampling periods the proportion of small individuals increased gradually. Just before the ponds dried almost only small individuals were present (classes I and II). In the whole study period the number of *A. leucostomus* increased considerably; this pertained mainly to the smallest individuals. Popu-

lations of *S. nitida* in the spring consisted almost only of the smallest snails (classes I and II); empty shells of classes III–IV were also noted. Later, snails of larger classes increased in proportion while the total density decreased; just before the pools dried only individuals of classes III and IV were present. The differences in the dynamics of the population structure of the two species may reflect differences in their reproductive strategies. *A. leucostomus* shows a typical "r" strategy: intense reproduction followed by rapid growth. Nearly all old individuals die before the pool dries, and juveniles estivate. Though they are numerous, only few survive the dry period. When the pool fills again in early spring they grow rapidly to start reproducing in April. Only a low number of adult *S. nitida* estivates; they start reproducing the moment the pool fills, and then die. The juveniles, less numerous than those of *A. leucostomus*, grow to reach 3–6 mm shell width before the pool dries, and then estivate.

SHELL VARIATION IN *DISCUS* FITZINGER, 1833 (GASTROPODA: PULMONATA: ENDODONTIDAE)

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In Europe the genus *Discus* Fitzinger, 1833 is represented by two subgenera: *Gonyodiscus* Fitzinger, 1833 with *D. rotundatus* (O. F. Müller, 1774) and *D. perspectivus* (Megerle von Mühlfeld, 1818), and *Discus* s. str. with *D. ruderatus* (Férussac, 1821). The classification is based on shell characters, radula and genitalia. Studies on shell variation of *D. rotundatus* and *D. ruderatus* were to ascertain if variation among laboratory-bred individuals differed from such variation observed in natural populations. The analysis included the number of whorls, shell height, body whorl height, aperture height, aperture width, shell major and minor diameter, umbilicus major and minor diameter, shell height/major diameter ratio, relative height of body whorl, relative umbilicus diameter and umbilicus major/minor diameter ratio. The material of *D. rotundatus* included 899 shells from laboratory culture and from populations from Poland, Austria, Italy, Portugal and Switzerland; that of *D. ruderatus* (148 shells), apart from laboratory specimens, included specimens from the Polish Sudetes, Baberhäuser and Karlsbrunn. Variation ranges of most shell characters in laboratory specimens of *D. rotundatus* and *D. ruderatus* were much wider than those found in natural populations. The natural populations of each species differed statistically significantly among themselves in many characters but the differences were much smaller. Laboratory-bred *D. perspectivus* showed a tendency to produce scalariform shells or descending and partly detached body whorl. Laboratory-bred *D. rotundatus* and *D. ruderatus* tended to form a descending body whorl; in all three species the descending/detached part of the body whorl was formed after sexual maturity had been attained.

LIFE CYCLES OF THE POLISH CLAUSILIIDS – KNOWNS AND UNKNOWNS

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Out of 177 terrestrial gastropods recorded from Poland, life cycles are completely known in 13 (7%) cases; only some life cycle parameters are known in 32 (18%) cases, most often based on field observations. Out of the 24 clausiliid species, literature data, often fragmentary, pertain to 13 species (54%): *Ruthenica filograna*, *Macrogastra plicatula*, *M. ventricosa*, *Clausilia bidentata*, *C. dubia* and *Laciniaria plicata* (fragmentary data from laboratory observations), *Balea perversa*, *Cochlodina laminata*, *Charpentieria ornata*, *Alinda biplicata*, *Vestia gulo* and *Bulgarica cana* (life cycles partly known based on field and laboratory observations) and *Vestia elata* (complete data from field observations). Reproductive biology is not known in detail in any representative of the family occurring in Poland. Out of 13 endangered (Red List) and five legally protected clausiliids, four have been studied partly or fragmentarily: *Vestia elata*, *Balea perversa*, *Vestia gulo* and *Charpentieria ornata*. At present the following species are being studied in the laboratory and in the field: *Ruthenica filograna*, *Bulgarica cana*, *Vestia gulo*, *V. turgida* and *Charpentieria ornata*; recently started laboratory observations include also *Cochlodina orthostoma*, *Macrogastra latestriata*, *M. tumida*, *M. ventricosa*, *Clausilia parvula*, *Laciniaria plicata*, *Balea stabilis*, *Cochlodina laminata*, *Alinda biplicata* and *Vestia elata*. Histological studies on the development and seasonal activity of the gonad include *C. laminata*, *Ch. ornata*, *M. ventricosa*, *A. biplicata*, *V. gulo* and *V. turgida*. Based on literature information and our own observations it has been found, among others, that most clausiliid species are oviparous, though some species show egg-retention and facultative, environment-dependent ovoviviparity (*Vestia elata*, *V. turgida*), or obligatory ovoviviparity (*Ruthenica filograna*, *Alinda biplicata*, *Balea perversa*). For oviparous species the following parameters have been estimated: egg size, appearance and number per batch, egg-laying period, time of incubation and hatching, growth rate till ultimate size.

PROPOSED NEW ECOLOGICAL CLASSIFICATION OF TERRESTRIAL GASTROPODS

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Ecological analysis of extant terrestrial malacocoenoses is possible because conditions in their preferred habitats can be determined empirically. Such malacocoenoses often provide guidelines for describing palaeoenvironments, hence correct ecologial classification of species is very important. Numerous such classifications have been proposed (e.g. LOŻEK 1955, 1964, SPARKS 1961, PIECHOCKI 1977, ALEXANDROWICZ 1987), mainly for the needs of researchers dealing with subfossil assemblages. Using such systems for extant malacocoenoses is rendered difficult by incompleteness of species lists (absence of slugs) and/or complex, very often unclear division criteria. The classification proposed here, on the one hand considering some assumptions of the earlier systems, on the other based on the most recent data on the ecology of terrestrial gastropods, is aimed at facilitating ecological analysis of extant terrestrial malacocoenoses. The species are divided in two major groups: native and introduced/synanthropic. The latter fall into subcategories: externally and internally synanthropic. Each native species is categorised based on four criteria: habitat (woodland, open or indifferent), humidity requirements (higrophile, mesophile, xerophile or indifferent), calcium requirements (calciphile or indifferent) and preference to rocks, boulders or screes (petrophile or indifferent). First the species were assigned to habitat-related groups, and within each such group to subgroups according to the scheme: habitat → humidity → calcium → rocks/boulders. All possible combinations add up to 50 ecological groups, 38 of which are actually represented in the native terrestrial malacofauna.

MOBILITY OF *BULGARICA CANA* IN ITS NATURAL HABITAT

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Mobility of *Bulgarica cana* (Held, 1836) was studied in a plot of ash-alder forest of 1,600 m^2 (40 × 40 m) in the Romincka Forest (NE. Poland). Individual marking in the period October 2005–September 2006 included 309 individuals. The snails were marked with unique combinations of three colours of nail varnish and released where they were caught; 173 marked individuals were recaptured. Trees on which the snails were sitting were plotted on the map. Additionally, from August 31st till September 4th 2006 both the occupied tree and the position on the tree (height above ground) were checked for the marked individuals. During the studies c. 50% snails did not change trees, the other 50% moved to other trees. Among these, about half covered only a short distance – up to 5 m. The longest distances covered were 16 m (during 50 days) and 13 m (during 20 days). The mean speed was 20 cm/day (5.8 m/month). Within 24 hours the snails covered a mean distance of 33 cm; 25% individuals remained inactive, most covered less than 75 cm, and 10% individuals covered a distance of more than 1 m. The distances covered during the day and during the night differed significantly (20 and 40 cm, respectively, within 12 h). The mobility was also affected by humidity; the snails covered a mean distance of 40 cm/12 h on rainy days and during nights, and only 20 cm/12 h in dry weather. Some individuals remained inactive irrespective of the conditions. The greatest distance – 140 cm (during 12 h) – was covered by a snail during a rainy night. Most individuals of *B. cana* show a small mobility. The mobility depends both on the time of the day and on the weather (humidity).

ACCOMPANYING FAUNA OF *BULGARICA CANA* (HELD)

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In 2001–2006 68 forest localities in Poland were sampled for terrestrial malacocoenoses; 45 of them included *Bulgarica cana*. The distribution of the species includes essentially the entire Poland, but in many areas it is rare. Since life cycle of *B. cana* is at present being studied, we took the opportunity to analyse its accompanying fauna. Samples were taken with standard methods; all the samples met the completeness criteria. The studied malacocoenoses came from Białowieża Forest (9 sites), Romincka Forest (4), Pieniny Mts (9), Bieszczady Mts (7) and the Bieszczady foothills (16). The total number of species accompanying *B. cana* was 82, the number of species per malacocoenosis ranging from 18 to 43. In the southern part of the country (mountain areas) malacocoenoses with *B. cana* included a total of 77 species, the number of species per malacocoenosis being 21–43 (mean 31.1); the respective values for the northern (lowland) sites were 49 and 18–37 (25.9). Thirty three species were recorded only for mountain malacocoenoses (the absence of four of them in lowland malacocoenoses could be accidental), six – only in lowland malacocoenoses (where the absence of three could be accidental). Forty two species (including *B. cana*) were common to both types of malaco-

coenoses, the overall Nei similarity was 0.70. The heterogeneity of the malacocoenoses as expressed by Whittaker's indices was I = 2.8, I_{max} = 1.9 and was higher for the mountain sites (I = 2.5, I_{max} = 1.8) compared to the lowlands (I = 1.9, I_{max} = 1.3). The following species were found to accompany *B. cana* in 90% or more sites in both regions: *Carychium tridentatum, Columella edentula, Vertigo pusilla, Punctum pygmaeum* and *Aegopinella pura*; in the lowlands also *Cochlicopa lubrica, Discus ruderatus, D. rotundatus, Vitrea crystallina, Nesovitrea hammonis, Euconulus fulvus, Cochlodina laminata, Macrogastra ventricosa, M. plicatula, Laciniaria plicata, Bradybaena fruticum* and *Perforatella bidentata*, and in the mountains *Acanthinula aculeata, Vitrea diaphana, Aegopinella epipedostoma, Macrogastra tumida, Vestia gulo, Perforatella vicina, Chilostoma faunstinum* and *Isognomostoma isognomostoma*.

GASTROPODS OF THE NATURE RESERVE "WIELKI LAS" IN THE LIGHT OF EARLIER STUDIES – AN ATTEMPT AT A LONG-TERM MONITORING

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The nature reserve "Wielki Las", a *Ficario-Ulmetum* of 3 ha, was first studied by A. Dzięczkowski in 1975, both qualitatively and quantitatively (Oekland quadrats of 20 × 20 cm). His studies revealed 36 species. In 2005 we re-surveyed the site using the same method and recorded only 22 species. In 1975 the dominant species were *Carychium tridentatum, Cochlicopa lubrica, Vitrea crystallina* and *Macrogastra plicatula*. In 2005 the dominants were the same except *Carychium tridentatum*, which was a subrecedent. A comparison of ecological groups confirmed the earlier observations. The species which were no longer present in the reserve were either typical forest-dwellers (e.g. *Carychium minimum*) or higrophiles (*Vitrina pellucida*). The changes result from human interference both in the nature reserve itself and in the surrounding and sometimes rather remote areas: considerable thinning of the tree stands, significant decrease in the ground water level. We could not compare our species list with the earlier one because Dzięczkowski did not include a list of all species recorded in his paper. Long term monitoring is possible only when complete data sets are available; the moral is that we should include complete species lists in our papers.

USE OF ROENTGEN MICROANALYSER EDS IN MALACOLOGICAL STUDIES – EXAMPLE OF *CEPAEA VINDOBONENSIS* (FÉRUSSAC, 1821)

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Roentgen microanalyser EDS was used for microchemical studies on the shell of *Cepaea vindobonensis* and rocks on which the species occurs. The material inluded carbonate and carbonate-silicate rocks collected in Lubelska and Kielecko-Sandomierska uplands (nature reserve Podzamcze in Bychawa, Kazimierski Landscape Park in Nasiłów, nature reserve Wietrznia in Kielce). The comparison of microchemical composition of the shells and rocks indicates an effect of substratum on the composition of shells of *C. vindobonensis*. The effect is pronounced to a varied degree, depending on the rock composition. The variation in the chemical composition of the shell of *C. vindobonensis* is also affected by anthropogenic factors. In industrial areas (region of Puławy, Kozienice, Warsaw) concentration of some trace elements in the shell is higher. In non-industrial regions the higher content of some elements is associated with hypergenic factors (erosion, secondary concentration of elements).

COMPARISON OF BIONOMICS OF *VALVATA CRISTATA, V. MACROSTOMA* AND *V. PISCINALIS*

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Eggs of the three species of *Valvata* are covered by two envelopes; the big egg cell occupies 65–96% chamber volume. Eggs of *V. cristata* are usually slightly smaller than those of *V. macrostoma* and *V. piscinalis* (on an average by 10–20%). Cocoons of *V. cristata* are cylindrical and arcuately bent, with a single row of eggs; those of *V. macrostoma* and *V. piscinalis* are usually ovate (often with an additional mucus tunicle), and eggs irregularly arranged or forming a dextral spiral. The number of eggs per coccoon depends on the snail size, feeding conditions and season. The maximum numbers were: *V. cristata* 16, *V. macrostoma* 34, *V. piscinalis* 76. At the time of cocoon deposition the egg cells are usually at the stage of oocyte I (insemination inside the snail's body, fertilisation after cocoon deposition). The duration of embryonic development is negatively correlated with the incubation temperature. In *V. cristata* and *V. macrostoma* the course of embryonic development is smilar (e.g. duration of one cell division, total duration of embryonic development), it is slightly different in *V. piscinalis*. Embryonic shells of *V. cristata* are usually composed of

0.50–0.62 whorl, while those of *V. macrostoma* and *V. piscinalis* usually of 0.75 whorl. In the laboratory, in optimum food conditions, the time from hatching to female maturity in *V. cristata* is c. 3 months, in *V. macrostoma* 3–4 months, in *V. piscinalis* c. 2 months (snails hatched in the spring often start reproducing at the end of summer). In such conditions the life span of *V. cristata* and *V. macrostoma* is c. 1 year, in *V. piscinalis* c. 6 months. In very unfavourable food conditions the time to maturity is extended to 1–2 years, and the life span of *V. cristata* and *V. macrostoma* to 2–3 years, and in *V. piscinalis* to 1.5–2 years. Depending on the life span cocoons are laid during 1–3 seasons (*V. cristata* and *V. macrostoma*) or 1–2 seasons (*V. piscinalis*). Maximum numbers of cocoons and eggs produced during lifetime are: in *V. cristata* – 105 cocoons (353 eggs), *V. macrostoma* – 166 cocoons (1,436 eggs), *V. piscinalis* – 113 cocoons (2,862 eggs) (for snails kept in pairs or groups, converted to the number per snail). Snails kept singly and thus deprived of the possibility to copulate lay mostly few cocoons and eggs. Uniparental reproduction (successful i.e. resulting in hatching) was observed only in one individual of *V. cristata* in the second reproductive season. Shell variation in *V. cristata* is rather small, but infection with trematode larvae causes atypical growth (descending whorl). Shell variation range in *V. macrostoma* and *V. piscinalis* is wide. Spiral (sinistral) opercula of adult *Valvata* reach a maximum of 10–12 whorls. In *V. cristata* and *V. macrostoma* the number of operculum whorls is c. 3 times higher than the number of shell whorls, in *V. piscinalis* c. it is twice higher. Besides, in *V. piscinalis* the body whorl is usually very wide and has a characteristic surface sculpture. At present the three species are placed in different subgenera: *V. (Valvata) cristata*, *V. (Tropidina) macrostoma* and *V. (Cincinna) piscinalis*. My observations indicate clear differences in bionomics between *V. cristata* and the other two species (smaller eggs and embryonic shells, different cocoon structure, uniparental reproduction). The differences between *V. macrostoma* and *V. piscinalis* are smaller and pertain among other things to the course of embryonic development, operculum structure and effect of feeding conditions on life span.

DO SNAILS LIVE UNDER STRESS?

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Stress is an organism's reaction to new habitat challenges: changes in food availability, humidity etc. One kind of stress is oxidation stress. Oxygen, though necessary for an animal to stay alive, has a toxic effect because of free radical formation. Oxidation stress may occur during normal physiological activity, during controlled or enforced reduction of the metabolic rate. Intertidal molluscs show seasonal changes of metabolic rate in response to changes in temperature, salinity, oxygen content and food availability. Such changes are also shown by terrestrial molluscs which fall into torpor in order not to dry out or freeze. Thus they should be able to cope with oxidation stress. In order to check if Roman snail is capable of defence against free radical damage we measured concentration of reduced glutathione (GSH) in its selected tissues. Glutathione is among the most widespread antioxidants dealing with free radical damage. It is produced by all eukaryotic cells and its concentration in such cells is rather high. Reduced glutathione is responsible for proper redox potential. It plays an important role in removal of hydrogen peroxide and lipid peroxides, takes part in mechanisms controlling the rate of lipid peroxidation. Experiments involved snails collected in the summer during full activity (control), naturally estivating snails, and snails whose estivation was interrupted by placing them in high humidity conditions. All snails were collected in the field immediately before the experiment. A half of estivating snails were placed in a high humidity chamber to interrupt estivation. The snails were decapitated and kidney and liver were taken for GSH measurements with modified Ellman's method. All goups showed a higher GSH concentration in the liver compared to the kidney. GSH concentration in the liver of control and estivating snails was statistically significantly higher ($p<0.05$) compared to snails whose estivation was interrupted. We assume that the snails prepare for the oxidation stress associated with estivation and subsequent increase in metabolic rate through increased glutathione synthesis. Hence the higher GSH concentration in control individuals prepared for potential stress, and in estivating snails which are bound to undergo oxidation stress.

MOLECULAR CHARACTERISTICS OF THE 5' END OF cDNA OF α SUBUNIT OF NaK-ATPASE FROM *HELIX POMATIA*

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NaK-ATPase is an enzyme actively transporting Na^+ and K^+ cations across animal cell membranes. The necessary energy is derived from ATP hydrolysis. The sodium-potassium pump controls the cell volume, maintains membrane potential, and is the driving force of active transport of sugars and aminoacids. It

is an integral membrane protein and is composed of two subunits: α and β. In the plasmalemma it functions as a tetramere $\alpha_2\beta_2$. Subunit α has a highly conservative aminoacid sequence which may be used for phylogenetic studies on eumetazoans. Available data on sequences of α subunits of NaK-ATPase in mollusc cell membranes are very scanty. We present a characteristics of a 479-nucleotide sequence of 5' end of cDNA of this subunit in *Helix pomatia*. Computer analysis made it possible to identify within it an open reading frame encoding a polypeptide fragment of α subunit 125 aminoacids long. Examination of hydrophobic profile of the obtained polypeptide showed that the fragment amplified by us was built of three transmembrane domains while in other animals α subunits of full length have ten such domains. The results we presented previously made it possible to identify five transmembrane domains located on the 3' end of the polypeptide. This till now we identified eight out of ten transmembrane domains of α subunit of the sodium-potassium pump of the Roman snail. Our current experiments are aimed at sequencing the remaining two domains of the subunit.

PUPILLOIDEA (PUPILLIDAE, VERTIGINIDAE, VALLONIIDAE, GASTROCOPTINAE) OF THE ALTAY – A TRAVEL IN SPACE AND TIME

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Based on material collected during two expeditions (2005 and 2006) the following pupilloid species were recorded from the Altay: *Vallonia pulchella* (O. F. Müller), *V. kamtschatica* Likharev, *V. costata* (O. F. Müller), *V. ladacensis* (Nevill), *V. tenuilabris* (A. Braun), *Gastrocopta theeli* (Westerlund), *Vertigo substriata* (Jeffreys), V. *microsphaera* Shileyko, *V. pygmaea* (Draparnaud), *V. ronnebyensis* (Westerlund), *V. genesii* (Gredler), *V. pseudosubstriata* Ložek, *V. parcedentata* (A. Braun), *V. alpestris* Alder, *Vertigo* n. sp., *Columella edentula* (Draparnaud), *C. columella* (Martens), *C. intermedia* Skileyko et Almukhambetova, *Truncatellina cylindrica* (Férussac), *Gibbulinopsis* n. sp., *Pupilla muscorum* (Linnaeus), *P. alpicola* (Charpentier), *P. alabiella* Shileyko, *Pupilla* n. sp. 1, *Pupilla* n. sp. 2, *Pupilla* n. sp. 3. Of these 26 species 12 are extant in Europe (c. 5,000 km away) or in rather remote localities in Europe and Asia, eight only in Asia, while three are known from the Pleistocene of Europe (two of these are extant also in other places in Asia, one in the mountains of Asia and in an isolated site in Norway); another three are at present known only from the Altay. The fairly numerous localities of species otherwise known from the Pleistocene of Europe (*Vallonia tenuilabris, Vertigo pseudosubstriata, Vertigo parcedentata*) provided crucial information for palaeoecological interpretation of European fossil sites. The rich material of *Vertigo microsphaera* and *Columella intermedia*, previously known as single specimens, made it possible to provide more precise descriptions and specify variability ranges of the species.

MOLLUSCS IN THE COOLING PONDS AND THEIR IMPACT ON THE NUCLEAR POWER PLANTS

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In Ukraine there are 42 large thermal (TPP) and five nuclear power plants (NPP); many of them use special cooling reservoirs. This study included all cooling ponds of Ukrainian NPP and the Konin lakes of Poland. The resevoirs hold more than 10 species of bivalves and more than 20 snail species. The species of greatest interest at present is *Sinanodonta woodiana* (Lea) in the Konin lakes (1993). Today it is also found in Ukraine in the Danube delta, but not in the cooling ponds. One of the most widespread and abundant species in the cooling ponds is *Dreissena polymorpha* (Pallas). The reservoir of Chernobyl NPP, not used as cooling pond since 2000, holds two species: *D. polymorpha* and *D. bugensis* (Andr). The population of the last species in the reservoir is one of the northernmost in the distribution area. Zebra mussels were absent in the reservoir of Khmelnitskiy NPP for more than 10 years, probably because of its isolated position; it was probably invaded in 2002. Our results confirm that the increased temperature does not favour the existence of native mollusc fauna, but can promote invasion of alien species, including thermophilous organisms. The distribution of molluscs in the reservoirs with a thermal gradient is usually correlated with the temperature. The temperature allowing for survival of individuals is higher than that permitting the existence of stable colonies: *Dreissena* can occur at 32–33°C, but stable colonies exist at the temperature not exceeding 27°C. The distribution of colonies of the two species of *Dreissena* in the periphyton and benthos of the ChNPP reservoir shows that both occupy the same habitats, but the abundance of *D. polymorpha* is by one order lower. The biomass in the periphyton on stones (mean for the whole reservoir) was 18,660.6 g/m^2 for *D. bugensis* and 1,373.0 g/m^2 for *D. polymorpha*. In the benthos, at the depth of 5 m, the biomass was 2,257.1 and 219.0 g/m^2, respectively. The development of *Dreissena* was positively correlated with both diversity and species richness of the zoobenthos and periphyton: the largest number of zoobenthos species was observed at the depth of 5 m, where the biomass of *Dreissena* was very high. A high biomass of

D. polymorpha was observed in the reservoir of KhNPP: 19.7 kg/m^2, and even more in the intake channel on concrete. On the bottom many individuals are attached to live unionids and their empty shells. The mass of *Dreissena* per unionid shell was up to 90 g when the weight of the "host" was about 25 g. Molluscs often hinder the work of water supply systems of TPP and NPP as a result of fouling and transport of live molluscs and shells by the currents of the reservoir and intake channels. For example, the total mass of zebra mussels in the intake channel of ChNPP in the summer of 2005 exceeded 1,000 tonnes. Also snails contribute to the problem: the very large biomass of *Viviparus* (a few kg/m^2) in the intake area of Zmievskaya NPP causes significant biological hindrances. Hydrobiological monitoring is the first step to control biological hindrances in water supply systems of TPP and NPP.

MALACOFAUNA OF DEPOSITS OF SMALL KARST FORMS IN LIMESTONE OUTCROPS OF EASTERN PODHALE

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The study included outcrops of the Pieniny Rock Belt, built of various lithological links of the Czorsztyn unit. The largest outcrops in the area have names, e.g. Cisowa Skała, Obłazowa Skała, Korowa Skała, Skały Kramnica or Falsztyn. Numerous and diverse karst forms developed in the outcrops: niches, crevices or small caves. They are partly or wholly filled with deposits washed down from slopes, and with material derived directly from the cave roofs and walls. Two types of deposits are the most frequent. The first type includes yellow or brown deposits composed of dusty and less often silty fraction, with embedded limestone lumps from 10 cm to 0.5 m in size. The second type includes initial rendzinas, usually with an abundant limestone skeleton. The thickness of the deposits ranges from 10 cm to a few metres. The deposits contain abundant mollusc remains, often accompanied by teeth and bones of small mammals. Samples were taken from six localities. Mollusc assemblages are characteristic for different climatic periods which indicates different age of the deposits. The oldest assemblages are associated with late glacial – younger Dryas, and include *Semilimax kotulae* West., *Vertigo modesta* (Vald), *Vertigo genesii* (Gred.), *Vertigo geyeri* Lindh. and *Columella columella* (G. Mart.). Forest assemblages correpond to a warmer climatic phase of Holocene age and include *Discus ruderatus* (Fér.), *Ena montana* (Drap.) and *Arianta arbustorum* (L.). The fauna of the deposits from small karst forms corresponds mainly to late Holocene and resembles the extant fauna of the outcrops. Variation in the composition and structure of the mollusc assemblages of the small karst forms makes it possible to reconstruct environmental changes resulting mostly from the climate modified by local conditions on individual outcrops.

A WAVE-POWERED SWIMMING DEVICE

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Swimming by means of a cyclic, undulating movement of lateral fins or whole body is a frequent mode of locomotion of aquatic animals, like skates. Among molluscs such a mode is used by cephalopods, especially squids and cuttlefish. It is a slow motion, with a possibility of quick change of direction; and is effected by horizontal fins attached to the sides of the body. Cyclic undulating movement of whole body is found in some pelagic opisthobranchs, some leeches and some flatworms. Observations on the mode of swimming of cephalopods *Sepioteuthis sepioidea, Sepia officialis,* and a skate *Potamotrygon motoro*, provided an inspiration for constructing a device propelled by undulating movement of lateral fins. Parameters of the propelling wave were anaysed based on films and photographs and in turn served as the basis for designing the device. The device is the first ever using the cyclic undulating movement of two lateral fins. The constructed model is about 50 cm long. The structure is catamaran-like with two hulls connected by a cross-beam. On the pylon of the cross-beam there is a cylindrical propelling unit submerged in the water. In the stern and bow part the unit has elliptical casings. The device is provided with a direct current engine DC, with a belt transmission that transfers the drive to crankshafts. The engine is powered through a cable. Fins situated on the sides and creating undulating movement are effectors. Each fin is built of seven rods connected by an elastic fabric. The consecutive rods move up and down in a vertical plane, perpendicular to the device axis. The device is made mainly of polyacethal and a light alloy. Tests in a tank performed in November 2006 showed good parameters, especially a surprisingly high coefficient of hydrodynamic efficiency, c. 0.35, at the speed of c. 35 km/h. No turbulence was observed. A device using a cephalopod-like swimming mode may become a new technical solution for a variety of purposes. This may pertain especially to environment-friendly vessels used in strict nature reserve for scientific purposes, and also vessels used for recreation and military purposes.

MAXIMUM SIZE OF *DREISSENA POLYMORPHA* (PALL.) IN THE KONIN HEATED LAKE SYSTEM AND ITS SPATIO-TEMPORAL DISTRIBUTION

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Maximum shell size, weight and maximum age of bivalves reflect genetic factors in given habitat conditions and are thus regarded as good characteristics of the ecological condition of populations. The analysis of spatio-temporal diversity of maximum values of weight, length and age of *Dreissena polymorpha* Pall. in the Konin system of heated lakes was based on data from the summers 1993–2006. It was found that increased inflow of heated water caused a decrease in the maximum age of the mussels (maximum age in the lake remote from water discharge – 4–5 years, in a moderately heated lake – 2 years). The life cycle of the mussel in the zones of discharge of heated water did not exceed one year, and the maximum shell size was comparable to that of mussels 2–3 years old from habitats of natural thermal regime. The maximum age of the mussels based on shells from the least heated lake (Ślesińskie) was 6–7 years. Smaller size and lower age of mussels from the Konin lakes, compared to mussels from natural water bodies, was observed already in the 1970s. In conditions of minimum and moderate effect of heated water (range of annual effective temperatures – 3,547–5,259 degree-days) the maximum individual mass was characteristic for years of higher water temperature (4,493–5,193 degree-days). The greatest maximum wet mass (3.6–4.3 g) was found in the canal of the fastest flow (0.33 m/s). In canals with slower flow the mussel mass was 2.57±0.12g. During somewhat cooler summers (3,875–4,123 degree-days) the maximum mass in various habitats of the system did not exceed 0.62–1.14 g. In the immediate vicinity of discharge of heated water (7,373–7,770 degree-days) the maximum mass of the mussels was 1.97±0.08 g. In 2003–2006 in most studied habitats the size and mass of the mussels were found to have decreased. The maximum shell size of live individuals compared to shells collected from the bottom of the lakes decreased 1.2–1.5 times, the maximum mass – 1.7–4 times. Only in the least heated lake Ślesińskie the greatest shell length (28.4 mm) was within the lowest range of maximum shell length for mussels from natural lakes of Poland (27.0–39.5 mm); the maximum length of empty shells from that lake was 34.6 mm. Linear growth and mass increment of the mussels from the hated waters ecosystem depend on the temperatue but also on such significant factors as hydrochemistry and trophic level of the reservoir and thus do not reflect exclusively the effect of temperature on the bivalve metabolism.

HABITAT PREFERENCES OF *POTAMOPYRGUS ANTIPODARUM* (GRAY, 1843) IN ANTHROPOGENIC WATER BODIES

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Silesian Upland is considerably transformed as a result of many centuries of industry and urbanisation. One of the results is appearance of new, anthropogenic reservoirs in the area with no natural water bodies; these are the only refuges for aquatic organisms. Such reservoirs, especially those located close to industrial dumps, are often much polluted. On the other hand, they harbour many organisms, including molluscs, with wide ecological tolerance. One of the species recorded from Silesian Upland rather recently (first record Dzierżno Duże, 1986) is *Potamopyrgus antipodarum*. It originates from New Zealand and appeared in Europe in the scond half of the 19th c. In inland waters of Poland it was first observed in 1933 in lake Tarląg near Inowrocław. In 2005–2006 12 aquatic habitats in Silesian Upland, in the cities of Bytom and Świętochłowice were studied with respect to their malacofauna. The reservoirs differed in their origin, size, water supply, and their common character is their location near industrial dumps. Samples were taken monthly from May till October; sampling points, 0.25 m^2 each, were selected based on habitat diversity. Eleven snail species were recorded. In four reservoirs the most abundant snail (34.5–91.2%) was *P. antipodarum*. In one reservoir only single specimens of the species were found in one sample. The reservoirs where *P. antipodarum* was abundant were the richest both quantitatively (2,973 specimens) and qualitatively (10 species). They harboured another alien species – *Physella acuta*. *P. antipodarum* occurred near the shores of the reservoirs, up to 30 cm deep and insolated for most of the day. *P. antipodarum* occurred on various kinds of bottom deposits, but was more frequent and more abundant on hard substrata deriving from the adjacent dumps: slag from ironworks kilns and stones from coal mines. The vegetation of the sites was composed of *Phragmites australis, Typha angustifolia, Myriophyllum spicatum, Najas marina, Ceratophyllum submersum* and *Polygonum amphibium*. Individuals of *P. antipodarum* were found on the bottom of the reservoirs, less often on rotting vegetation and never on live macrophytes. The reservoirs where *P. antipodarum* was absent had a muddy bottom, with few hard components; their vegetation was varied. Among such reservoirs only one harboured *Physella acuta* and one – *Ferissia wautieri*.

DOUBLY UNIPARENTAL INHERITANCE OF MITOCHONDRIAL DNA IN *ANODONTA ANATINA* (BIVALVIA: UNIONIDAE)

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A particular kind of mtDNA inheritance, called doubly uniparental inheritance (DUI), has been described in five bivalve families (Mytilidae, Veneridae, Hyriidae, Margaritiferidae, Unionidae), in rather few species, based on sequences of single genes. In the case of DUI two types of mtDNA are observed: F type, inherited from the mother, and M type inherited from the father. Females have only F type, males have both types of mtDNA, type M being located in the gonads and type F in the somatic tissues. The separate tissue location results in independent evolution of the two lineages of mtDNA and in increasing divergence. The greatest M-F divergences (28–34%) have been observed in freshwater bivalves (Unionidae). Based on them, and considering the fossil record of Unionidae and Margaritiferidae, the time of divergence of M and F lineages in these bivalves has been estimated as 450 mln years. The taxonomic distribution of DUI is poorly understood. Many researchers use only somatic tissues as DNA sources in their studies, obtaining only F haplotype of mtDNA, and thus neglect the possible M identification and discovery of DUI. Among freshwater bivalves for which DUI has been demonstrated, only *Anodonta woodiana* occurs in Poland. My studies were aimed at finding DUI in other bivalve species in Poland, based on analysis of sequence of mitochondrial DNA of the gene of subunit I of cytochrome oxidase (*cox1*). The studies revealed doubly uniparental inheritance in *Anodonta anatina*. Sequences of a fragment of *cox1* gene, 648–710 base pairs long, were obtained for F and M haplotypes. Among F sequences two haplotypes were identified which differed in one nucleotide substitution of transition type (T/C), resulting in 0.2% variation among F types of the species. The differences between F and M haplotypes were 29–32%. The sequences have been submitted to the Gene Bank (F-type: EF440346-47, M type: EF440348).

SPATIAL AND GENETIC VARIATION OF TERRESTRIAL SLUGS *ARION LUSITANICUS* AND *ARION RUFUS* IN POLAND

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Some slugs are economically important pests. *Arion lusitanicus* (Mabille, 1868), recently introduced in Poland, is a synanthrope and a serious pest of agricultural crops and ornamental plants. It was first recorded from the subcarpathian region, Albigowa and then Łańcut and Rzeszów; later it was found in Opole, Małopolskie and Silesian voivodeships. In its external appearance the slug does not differ from the native *Arion rufus* (Linnaeus, 1758); their identification is possible only based on genital characters. *A. rufus* has its eastern distribution border in Poland, and occurs in the western part of the country; in the east of Poland it has isolated, mainly synanthropic localities. Like *A. lusitanicus*, it is a serious pest. Both species tend to occur in masses and have a tendency to expansion. In recent years a considerable increase in spatial variation of the two species was observed in Poland. Field observations indicate that *A. lusitanicus* and *A. rufus* occupy different habitats. Our aim was to trace the present distribution and directions of expansion of the two species in Poland, and to recognise their genetic structure. The material was collected in 2006 and included 10 specimens from each of nine populations. The specimens were identified based on their genital organs. *A. lusitanicus* was represented by six populations: Łańcut, Rzeszów, Poznachowice, Zawadka, Małujowice and Bielsko-Biała, *A. rufus* by three populations from Mielno, Szalejów Górny and Limanowa. Genetic studies involved sequencing mitochondrial gene for cytochrome oxidase, subunit I (*cox1*) for 30 specimens of *A. lusitanicus* and 15 *A. rufus*. For both species the obtained sequence of *cox1* was 675 base pairs long; 16 polymorphic loci were found for *A. lusitanicus* and nine for *A. rufus*. Thirty specimens of *A. lusitanicus* represented four haplotypes with frequencies ranging from 0.500 (G1) to 0.033 (G4). Three populations were monomorphic; populations from Bielsko-Biała and Zawadka had identical haplotypes (G1), those from Poznachowice – a different haplotype (G2). The remaining populations had two haplotypes each, one being always more frequent (frequency 0.8) the other rare (0.2). Populations from Łańcut and Rzeszów had the same two haplotypes but with different frequencies. Genetic differentiation between the four haplotypes ranged from 3% (haplotypes 2 and 3) to 21% (haplotypes G1 and G2), and pertained to two and 14 nucleotide substitutions, respectively, within the 675 compared nucleotides. For 15 specimens from three populations of *A. rufus* four haplotypes were identified. Only one population was polymorphic (Limanowa) and had genotypes G3 and G4, of frequencies 0.8 and 0.2, respectively. The remaining populations, Mielno and Szalejów, were monomorphic, with haplotypes G1 and G2, respectively. The smallest genetic diversity was observed between haplotypes G2 and G4, and G3 and G4 (4%), the largest (10%) pertaining to seven nucleotide substitutions, between G1 and G3. Both species showed a large interpopulation variation. It suggests a mixed origin of the Polish populations which might result from

multiple, independent introductions from Western Europe. The hypothesis should be verified during further research.

SNAILS OF THE GENUS *THEODOXUS* (GASTROPODA: PECTINIBRANCHIA: NERITIDAE) IN UKRAINE

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According to recent data, five species of *Theodoxus* occur in Ukraine: *Th. fluviatilis* (Linnaeus, 1758), *Th. danasteri* (Lindholm, 1908), *Th. euxinus* (Clessin, 1885), *Th. sarmaticus* (Lindholm, 1908), *Th. velox* V. Anistratenko, 1999. *Th. fluviatilis* and *Th. danasteri* are the most widespread, the remaining species occur only in the western part of the country. Members of the genus *Theodoxus* are difficult to identify because of the lack of clear conchological characters, hence the necessity for studies. In 2006–2007 *Th. fluviatilis* and *Th. danasteri* were studied in 117 sites in 19 districts of Ukraine (rivers: Prypiat, Dnieper, Dniester, Danube, Western and Southern Bug and their tributaries). The species often co-occur; their population density usually does not exceed 25–30 indiv./m^2, but sometimes reaches 100–200 indiv./m^2. *Th. fluviatilis* and *Th. danasteri* are ecologically similar: they are clearly rheophiles and sensitive to oxygen deficit. They are most often found in fast flowing rivers (0.6–1.0 m/sec.) of various size, streams, sometimes in oxbows, canals, lakes, dam reservoirs, bays and brackish waters (salinity up to 5–7‰). They are common, like other members of *Theodoxus*, in rather high quality waters (α-mesotrophic) of pH 7 or slightly higher, with a sandy-stony or muddy-stony bottom. They usually stay at the depth of 0.10–0.35 m and in the autumn at lower temperatures – at 0.5–0.9 m. Co-occurrence, ecological similarity and negligible conchological differences between *Th. fluviatilis* and *Th. danasteri* suggest that *Th. danasteri* is not a distinct species. This was confirmed by morphometric analysis of shell characters. *Th. fluviatilis* is a very variable species, with many varieties and local forms at least partly resulting from local habitat conditions.

BENTHIC MOLLUSCS IN THE COOLING POND OF THE KHMELNITSKIY NUCLEAR POWER PLANT (UKRAINE)

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The mollusc community of the cooling pond of Khmelnitskiy NPP is relatively poor. This results from the significant isolation of this pond from other big water bodies. Species of the genus *Dreissena* were absent in the pond during more than 10 years (in contrast to other cooling ponds). Zoobenthic investigations in 1998–2001 (before invasion of *Dreissena* which took place presumably in 2002–2003) revealed five species of Unionidae, Cycladidae, and three families of snails in the benthic communities. Cycladidae were characterised by the highest frequency (45–55%). their density in 1998 was 100–767 ind./m^2 and biomass was 0.09–1.03 g/m^2. They did not play a significant role in the total indices of zoobenthos, except the community of the intake canal, where these molluscs dominated in the biomass (73%). In 1999 the abundance of Cycladidae increased up to 7,200 ind./m^2 and 3.86 g/m^2 for some areas with sandy bottom. Unionid colonies were detected in the intake canal along the border between the concrete slope and the sandy bottom. Their abundance indices in 1998 were 214 ind./m^2 and 5,412.82 g/m^2. The colonies consisted of *Unio* sp. with shell length of 57–102 mm (198 ind./m^2, 4,337.02 g/m^2) and *Anodonta* sp. (16 ind./m^2, 1,075.80 g/m^2). In 1999 these colonies represented two species of *Unio*: *U. tumidus* Philipson and *U. pictorum* (L.). The abundance indices were 51.9 ind./m^2 and 1,205.93 g/m^2 but though the two species contributed equal densities, the first showed a greater biomass (69%). Four species were found in these colonies in 2001, namely *U. tumidus*, *U. pictorum*, *A. cygnea* (L.) and *A. anatina* (L.). Their abundance indices were 411 ind./m^2 and 1,348.67 g/m^2, *U. tumidus* having a considerable predominance. Its shell length was 28.2–74.7 mm, and larger individuals prevailed. The abundance indices of Unionidae were 20 ind./m^2 and 641.87 g/m^2. Their shell lenghts ranged from 57 to 102 mm for *Anodonta* and from 32 to 82 mm for *Unio*. Diving equipment was used in 2005 for investigation of the benthic communities. No unionid colonies were observed in the intake canal. A new snail species – *Acroloxus lacustris* (L.) – was detected in the pond. *Dreissena polymorpha* (Pall.) was present in the entire pond, and occupied not only artificial solid substrata but also unionid shells. *Dreissena* was detected in small numbers (1.79–63.68 g/m^2) in the benthos of the central and northern parts (8 m depth) of the cooling pond. At the same time the abundance indices of *Dreissena* in the western, eastern and southern parts (2–4 m depth) were considerable (5,008–328,857 ind./m^2 and 933.18–5,247.84 g/m^2). *U. tumidus* dominated among Unionidae. *U. pictorum* and *Anodonta* were detected only as shells in most sites. Relatively large individuals prevailed (length 19.6–83.0 mm, mean 55.4 mm). The abundance indices of Unionidae were 3–43 ind./m^2, 133.73–1,612.00 g/m^2. The biomass of *Dreissena* on live unionids was 1.1–91.5 g/ind. (mean 31 g/ind.). The maximum mass of *Dreissena* colony was observed on *Unio* of 40–50 mm length. *Dreissena polymorpha* usually forms

communities of consortive type in periphyton and benthos. Such communities however were yet not observed in the studied reservoir because of the short period of the occurrence of the bivalve and the species-poor benthic and periphytic fauna.

VARIATION IN SPATIAL STRUCTURE AND ABUNDANCE OF CLAUSILIIDS (MOLLUSCA: CLAUSILIIDAE) IN THE NATURE RESERVE DĘBNO NAD WARTĄ (W POLAND) DURING WINTERING

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Studies on the distribution and abundance of *Cochlodina laminata*, *Ruthenica filograna* and *Clausilia bidentata* in wintering conditions were based on a network of four permanent monitoring plots. Of the three clausiliids present, *C. laminata* was the most widely distributed, while the occurrence of *R. filograna* was limited to one plot. The small distribution area of the snail was compensated for by its high abundance. The distribution of clausiliids was found to depend significantly on the soil humidity and temperature, these factors were, however, dependent on the litter composition which much better explains the observed variation. Canonical analysis (CCA) showed that *R. filograna* and *C. bidentata* preferred places with a sparse herb layer and a considerable proportion of litter of hornbeam (*Carpinus betulus*) and ash (*Fraxinus excelsior*). *C. laminata* was more tolerant with respect to the herb layer proportion, and the optimum of its occurrence was associated with alder litter (*Alnus glutinosa*). All three clausiliid species avoided litter of oak (*Quercus*), sycamore (*Acer pseudo-platanus*) and aspen (*Populus tremula*).

OCCURRENCE OF *VIVIPARUS DILUVIANUS* (KUNTH) IN LOCALITIES IN THE REGION OF BIAŁA PODLASKA

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Viviparus diluvianus was known to occur in the southern part of Podlasie and northern part of Polesie, but its localities were studied to a very varied extent. This paper discusses five localities from the region of Biała Podlaska, with a short characteristis of deposits, geological situation and location in relation to the lakes of the Mazovian interglacial. Three localities (Ossówka, Hrud, Kolonia Roskosz) are located a few kilometres N of Biała Podlaska, two (Ortel Królewski and Szymanowo) are about a dozen kilometres SE of the town. Their mollusc fauna is associated with lakes that existed here during the Masovian interglacial; they were trough lakes a few km long and c. 1 km wide, extending from SW to NE (Ossówka-Hrud, Roskosz-Ortel Królewski) or from W to E (Wilczyn–Grabanów–Kaliłów–Woskrzenice–Lachówka Mała–Małaszewicze Małe). Accumulations of mollusc shells (often over 70% deposit volume) occur in their shore zones, in strata of sandy silts and fine sands, sometimes with admixtures of slightly coarser material. The mollusc-bearing deposits are located ca. 1 m deep, most often covered by dilluvial sediments. Below them sandy silts from the San 2 glaciation occur. Based on palynological analysis, the occurrence of *V. diluvianus* can be assigned to definite periods of the Masovian interglacial. The snail was not found in the initial part of the interglacial (birch-pine level). A few shells were found in Ortel Królewski in deposits from the spruce-alder level, and the mass occurrence of the snail coincides with the beginning of the yew period and continues till the interglacial optimum (hornbeam-fir level). Populations from Hrud and Kolonia Roskosz represent an undefined part of the optimum period, while in Szymanowo pollen succession indicates the end of optimum. In Ossówka shells of *V. diluvianus* are the most abundant in deposits assigned to the hornbeam-fir level (optimum); single, damaged specimens found in deposits representing post-interglacial period are probably a result of redeposition.

SHELL PARAMETERS IN *HELICELLA OBVIA* MENKE: POPULATIONS FROM POLAND, UKRAINE AND GREECE

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The material for biometrical analysis came from the following sites: I. Poland, slope of a hill near the nature reserve Skowronno nr. Pińczów, 50°31'N, 20°32'E; II. Ukraine: suburbs of Belgorod Dnestrowskiy, near ruins of Akerman fortress, 46°28', 30°44', xerophilous vegetation; III. Greece; near Kremasti, Rhodos, 36°26', 28°13'; rocky ground with small stones and sparse vegetation. The substratum in all the sites was limestone; all were strongly insolated. Only adult specimens were included in the analysis: 30 from each of sites I and II, 20 from site III. Characters analysed were: embryonic shell width, shell increment from hatching till collection, shell width, shell height, aperture height. Statistical analysis employed non-parametric tests (ANOVA, Tukey test); the adopted criterion of statistical significance was

p<0.05. The density of live snails and shells in site II was much higher than in the remaining sites. Statistically significant differences in the embryonic whorl width were found between populations I and II. The remaining shell parameters showed statistically significant differences between each two populations. Snails from site II were larger than those from the other two sites (shell width and height); the quickest growth as expressed by the largest shell increment may suggest better condtions in site II. The snails from that site had more elevated shells (shell height; height/width ratio). The differences in the size of adult shells may result from direct habitat effect: vegetation and related size of daily temperature fluctuations which affects the duration of active feeding period.

SUBFOSSIL MOLLUSCS OF THE ŚWINA GATE

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Our studies aimed at describing stratigraphic and spatial diversity of Holocene malacofauna contained in deposits of Karsiborska and Przytorska Bars, i.e. the so called Świna Gate. The material was obtained from three sites, with a drilling device "MERES". 1. central part of the Przytorski Peninsula, core 19.2 m thick (no. 509). It contained mostly fine- and medium-grained sands with very abunant marine and brackish-water mollusc shells (21,604 specimens). The dominants were brackish water *Hydrobia ulva*e (32%) and marine *Mytilus edulis* (over 35%). The analysis made it possible to distinguish five malacofaunistic levels. 2. near town Karsibór, c. 3.7 km S of 509 (no. 518). A sandy series, 16.5 m thick, contained shells of brackish-marine molluscs (8,670 specimens), the most abundant being *Hydrobia ulvae* (49.3%) and *Cardium glaucum* (24.3%). They formed four alternating associations identified based on malacological diagram, and indices of constancy and dominance. 3. south-western part of the island of Karsibór (no. 520), depth 14.5 m. It contained sandy material with numerous intercalations of gyttja in the top part and peat and silt at the bottom. The total of 34,036 shells represented 14 species. The taxa were assigned to three ecological groups; brackish-water species constituted 79.82% material, marine species nearly 19% and freshwater species 1.21%. Differences in species composition along the profile made it possible to distinguish seven malacofaunistic levels reflecting changes in environmental conditions.

OCCURRENCE OF *UNIO CRASSUS* (BIVALVIA, UNIONIDAE) IN THE FOOTHILLS OF THE POLISH CARPATHIANS, DEPENDING ON WATER CHEMISTRY

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Unio crassus is among bivalves which used to dominate in many Polish rivers and now are undergoing a decline which is associated with deteriorating water quality. The species is legally protected and active measures should be taken to protect its habitat. This study was aimed at identifying physico-chemical properties of water that affect the occurrence of the species in the Carpathian foothills. Eight typically Carpathian rivers, generally corresponding to ecological requirements of the species (quality class II), were studied. *U. crassus* was found in four of them. Physico-chemical parameters of the *Unio*-bearing rivers were compared with those where the species was absent (water quality data from 1999–2001). All the rivers showed very low concentrations of heavy metals, however cadmium concentrtion in the *Unio*-devoid rivers, though still not exceeding the standard, was significantly higher (mean 0.0010 mg Cd/l; B=–1,253, W=7.8, p<0.005). *Unio*-bearing rivers showed an over three times higher conductivity (mean 1,282.57µS/cm; B=0.007, W=7.53, p<0.007) and significantly higher pH (mean pH=8.0; F(1.108)=10.5, p=0.002), which may indicate a higher mineralisation. The inhabited and uninhabited rivers did not differ in their oxygen concentration, all had a considerable slope and fast flow which favours oxygenation. Among the studied rivers, the species clearly prefers waters with a higher content of phosphates (mean 0,196 mg PO_4/l; F(1,108)=54,8, p<0,0001) and nitrogen compounds: ammonium ions (mean 0.48 mg NH_4/l; B=57.4, W=22.2, p<0.0001), nitrate ions (mean 1.61 mg NO_3/l; F(1.108)=6.88, p=0.01) and nitrite ions (mean 0.047 mg NO_2/l; B=15.0, W=9.6, p<0.002). The waters preferred by *U. crassus* are also characterised by a higher BZT_5 and higher saprobic index. Most of these parameters are intercorrelated. The preferred waters are slightly more eutrophic than those devoid of *U. crassus*; very subtle differences in this respect may decide about the presence or absence of the species. Exact data on chemistry of the preferred waters are of impotance when planning habitat protection.

AQUATIC MOLLUSCS AS A COMPONENT OF THE DIET OF THE CROW *CORVUS CORNIX*

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Diet of chicks of the crow *Corvus cornix* was studied in the spring 2003 in the National Park Ujście Warty. The area is flooded for a few months every year; such areas (valleys and estuaries of big rivers) are regarded as the original habitat of the crow. Remains of snails and bivalves were found in 60% food samples; they were more frequent than e.g. bird remains (22% samples). In 46 out of 80 examined samples a total of c. 86 mollusc specimens were found, representing 11 species (9 snail species and bivalves). The most frequent molluscan prey items were *Viviparus viviparus* (40% samples, 30 specimens) and *Viviparus contectus* (30% samples, 17 specimens). In seven cases only the genus could be identified as *Viviparus* (shell fragments). In the material very often (21 cases) the only remains of snails were opercula with soft parts. Probably the foraging crow removes the body plus operculum, often without damaging the shell. The samples contained also eight juvenile specimens of *Viviparus* sp., of a size indicating that they were consumed before birth, with parent individuals. Other species found in the samples were *Planorbis planorbis* (12 specimens), *Bithynia tentaculata* (5), *Valvata cristata* (3), *Bithynia leachi* (2), *Lymnaea stagnalis* and *Valvata pulchella* (1 each). The snails, except *L. stagnalis*, were represented in the material by nearly undamaged shells, swallowed whole. Bivalves were found in four samples but their precise identification was impossible. In the study area *Viviparus* is much more rare than other snails. The malacocoenoses are dominated by planorbids, the most frequent species being *P. planorbis* and *Anisus vortex*. Common prosobranchs are *B. tentaculata*, *B. leachi* and *V. cristata*. The results indicate that the crow prefers *Viviparus* to the easier available but smaller species. Previously the crow was not known to be a pedator of freshwater snails; reports on feeding on aquatic molluscs mentioned only bivalves and marine snails. In the habitat regarded as crow's original habitat freshwater snails could constitute an important diet component.

PRELIMINARY STUDIES ON INFECTION OF *POTAMOPYRGUS ANTIPODARUM* WITH DIGENEAN PARTENITES

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Potamopyrgus antipodarum, originally native to New Zealand, is at present common in Europe. In Poland it inhabits various kinds of waters; it is salinity-tolerant, parthenogenic, and small which facilitates passive dispersal. In New Zealand it is an intermediate host of many digeneans, providing the place of development for both cercariae and metacercariae. Its New Zealand populations show a high extensity of trematode infection of up to 80%. Considering the rich fauna of Digenea in populations of native molluscs it is interesting to study such fauna of Polish populations of the species. The only literature mention of trematodes in European *P. antipodarum* pertains to the genus *Sanguinicola*. Trematodes of the family Microphallidae, which include parasites of New Zealand populations of *P. antipodarum*, are represented in Poland. The aim of this study was as an estimate of natural invasion of trematodes in populations of *P. antipodarum* in selected water bodies of Bory Tucholskie, and determining the possibility of experimental infection of the snails with native trematode species. Among the 2,000 snails examined only one was infected; it came from lake Charzykowskie. Its hepatopancreas showed a patent invasion of *Sanguinicola* sp. Laboratory experiments gave positive results in case of four trematode species: metacercariae of *Rubenstrema opisthovitellinum*, *Echinostoma revolutum*, *E. spiniferum* and *Echinoparyphium aconiatum* were noted. Other variants gave no positive results. All experimentally infected snails showed a decreased viability compared to control individuals.