



THE 20TH POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

After more than ten years of wandering all over the country (for those who are interested: see reports from the previous seminars in *Folia Malacologica* 7: 261, 8: 285, 9: 101, 10: 33, 11: 103, and the history of Polish malacology in *Folia Malacologica* 7: 275–291) the Association of Polish Malacologists went back to its birth place – Krościenko on the Dunajec River, in the Pieniny Mts. And for good reason: it was the 20th Seminar, we had to celebrate properly and also show young people what the place was like.

The 20th Polish Malacological Seminar was held in Krościenko, on March 31st–April 2nd 2004. The main organiser was EWA STWORZEWICZ (Polish Academy of Sciences, Cracow), who was responsible for the most difficult part of the job: accommodation, food, and cash. Co-organisers, who prepared the abstract book, badges and scientific programme, and who are by now well used to it, were TOMASZ K. MALTZ & BEATA M. POKRYSZKO. Though, because of some organisational problems, the previous seminar had taken place only six months earlier (September 2003), the attendance was very good, perhaps because of the 20th birthday and the celebration. There were more than 60 people, most of them with lectures, posters, short communications etc. As usual, most of them either arrived after the Seminar began or departed before it ended (or both). This year we invited some neighbours: Ukraininan and Czech malacologists. The number of foreign (not so very foreign anymore) guests was six, and they all seemed to like the meeting. Some could not appear in person but at least submitted their abstracts.

The problems discussed included terrestrial and aquatic ecology and faunistics, snail and bivalve physiology, palaeomalacology, taxonomy and variation, life cycles, genetics, bionomics and population biology of gastropods and bivalves, growth patterns, parasites, karyology, introduced species and species protection, and applied aspects of malacology. Most of the 54 contributions (34) dealt with various aspects of aquatic molluscs, a tendency that has been observed for more than ten years now. Young malacologists were very many, and some with very good posters/papers.

Some sessions took place on the first of April, and the organising committee was afraid that most lectures on that day might not be quite serious. Actually only one was scientifically frivolous – about *Rhinogradentia*, by TOMASZ UMIŃSKI who even managed to find some characters shared by these mysterious creatures and snails. The posters (more than twenty) were all very beautiful; there was no best-poster contest but we all liked the poster brought by our Czech colleague, LUCIE JUŘIČKOVÁ, about the malacofauna of castle ruins. Some posters were not quite serious either: three of four, prepared quickly by a few people in their rooms, showed funny photos from the previous nineteen seminars.

The General Assembly of The Association of Polish Malacologists elected the new Council. The new President is ANDRZEJ LESICKI (Adam Mickiewicz University, Poznań), formerly Treasurer – congratulations!

Most of us stayed in one hotel, only one or two people preferred to seek accommodation elsewhere. Placing all in one hotel is a very good arrangement, since it favours unofficial discussions and all sorts of parties. One evening ANNA ABRASZEWSKA-KOWALCZYK showed us her great pictures from her yacht cruise (see the first abstract below). For the seminar dinner we chose a very nice inn, with a good local highlander atmosphere, and very good food. There were also other attractions. The Guide to Terrestrial Gastropods of Poland by ANDRZEJ WIKTOR was still warm from the printers shop. Those who joined the queue early enough, could buy it, those at the end had to order it from the publisher after the meeting. An artist, RENATA BŁASZCZAK, had a small stall and sold hand-painted snail cards and tiles.

Because the lectures and posters were so many, we had only one short excursion – to Červený Kláštor in Slovakia, just across the border from Krościenko, where we visited an old castle (and some shopped for good Slovak plum vodka). Another, unofficial, excursion to the site of *Pupilla alpicola* in Niedzica was for some of the terrestrial people who decided to skip one aquatic session. Those who did not feel up to sitting through all the sessions could also visit the Mu-



seum of the Pieniny National Park in Krościenko. The weather was good, and the Pieniny Mts are great for snailing – we would have liked to stay a bit longer.

The Book of Abstracts, as usual hastily produced two days before the Seminar started (why do you people ALWAYS send your abstracts the very last moment!?), with a *Vertigo*, *Unio* and *Papilloderma* on the cover, includes abstracts ranging from a few lines to more than one page, most of them in Polish and some few in English. Other malacologists should

know what we do. The abstracts have been translated (but this time not abbreviated) behind the authors' back. The affiliations are given just as they were in the Abstract Book.

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ABSTRACTS FROM THE 20TH POLISH MALACOLOGICAL SEMINAR

ISLANDS OF THE INDIAN OCEAN AS SEEN BY A NATURALIST – A YACHT CRUISE FROM DARWIN TO DURBAN

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In 2002 the author took part in another (after Pacific) stage of the round-the-world cruise on the yacht MARIA. During the four-month cruise (6.000 Nm) across the Southern Indian Ocean, from Australia to South Africa, the crew visited several islands. Those interesting from natural history viewpoint were: uninhabited coral atoll Ashmore in the Australian shelf, with its abundant population of sea snakes; Cocos Keeling atoll, which inspired Darwin to formulate his theory of atoll formation; Christmas Island, volcanic, covered in a tropical forest and famous for its phosphate resources and an abundant population of the crabs: *Gecarcoides natalis* and *Birgus latro*; deforested Rodriguez Island (Mascarenes), which, within the last 200 years, lost about a dozen endemic bird and reptile species, including the solitary bird (Le Solitaire) *Pezophaps solitaria*, and is now trying to stop the devastation and introduce active protection, aided by IUCN WWF programmes; Reunion Island with its active volcano La Fournaise and the 3,000 peak, Piton de Neige, the top of an inactive volcano in which people live, and the climate favours cultivation of vines and citrus fruits.

DYNAMICS OF OCCURRENCE OF LARVAL STAGES OF *DREISSENA POLYMORPHA* (PALLAS, 1771) IN THE SULEJOWSKI RESERVOIR

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The zebra mussel was introduced in the Sulejowski Reservoir in 1997; its distribution, abundance and

population structure were studied not much later. In 2000 and 2002 the research focused on planktonic development stages. Zooplankton samples, taken from May to October in the upper, mid and lower parts of the reservoir, showed that larvae of *D. polymorpha* appeared in the first decade of May, when the water temperature was 17–19°C, and were present till the end of September. The maximum density, observed in the second decade of July, was over 200,000 indiv. m⁻³. Four development stages were distinguished: planktonic larva – trochofora, D-shaped veliger, veliconcha and pediveliger, transitory to sedentary life. The density of larvae was the highest in the lower part of the reservoir (at the dam). Feeding development stages (veliconcha and pediveliger) reached significantly larger sizes in that part of the reservoir. Reproduction continued throughout the summer, and the highest density of early development stages was observed in May and June. No significant differences were found in the density of *Dreissena* larvae between the surface and benthic parts of the reservoir. The larvae constituted 0.7–74% individuals of the whole zooplankton, varying between months and along the reservoir.

SHELL ASSEMBLAGES ON SHORES OF CRATER LAKES NEAR ROME

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Polska Akademia Umiejętności

In 2001 and 2003, within the cooperation agreement between the Polish Academy of Arts and Sciences and the University of La Sapienza in Rome, we studied thanatocoenoses deposited on lake shores in the province of Lazio (central Italy). The first stage focused on Lake Albano, located among the hills of Coli Albani, ca. 25 km SE of Rome, the next stage included also the neighbouring Lake Nemi and a much larger Lake Brazziano, located 30 km NW of Rome. Already in the first stage *Planorbella duryi*, a species not previously recorded from Italy or from natural localities elsewhere in Europe, was found to occur in



Lake Albano. The analysis of the material made it possible to characterise the population and reconstruct the migration route of the species. In the next stage we studied supralittoral shell assemblages, found on the shores of all three lakes. The thanatocoenosis found on a narrow beach of fine basalt sand, extending along the NW and N shores of Lake Albano, just above the shore line, included *Planorbella duryi*, constituting over 80%, as well as *Bithynia tentaculata*, *B. leachi*, *Physa acuta* and *Lymnaea auricularia*; other species of aquatic molluscs (*Gyraulus laevis*, *G. albus*, *Armiger crista*, *Ancylus fluviatilis*, *Lymnaea peregra*, *Pisidium nitidum*) formed only an admixture. Terrestrial snail shells were sporadically found. A different thanatocoenosis was found on a narrow terrace 2–3 m above the lake. *Bithynia leachi* was abundant, other water molluscs, including *Planorbella duryi*, were less numerous, while the proportion of land snails was considerable (e.g. *Lauria cylindracea*, *Xerotricha conspurcata*, *Discus rotundatus*). Only very poor shell assemblages were found along the vegetated and sometimes rocky shores of the small Lake Nemi. They included few shells representing *Planorbella duryi*, *Bithynia tentaculata*, *Physa acuta*, *Lymnaea auricularia* and *Pisidium nitidum*. Likewise, thanatocoenoses of the beaches of an extensive, flow crater Lake Brazziano were poor. Almost only single shells of *Lymnaea auricularia* were found on its S shore, near Angillara, while along W shore, near Brazziano, the thanatocoenoses were richer and included aquatic snails: *Theodoxus fluviatilis*, *Bithynia leachi*, *B. tentaculata*, *Physa acuta* and *Lymnaea auricularia*, with few terrestrial species (*Xerotricha conspurcata*, *Discus rotundatus*, *Succinea oblonga*). In contrast to the other two lakes, *Planorbella* was absent while *Theodoxus* was present. The differences in thanatocoenoses reflect both the differences in the composition of malacoenoses of particular lakes, and conditions of accumulation of the material in the littoral zone. The conditions are favourable only where beach sands are deposited, much less so where gravel beds form, and unfavourable at rocky or vegetated shores. Two thanatocoenoses of Lake Albano formed at different water level and different dynamics of the littoral. It is very characteristic that shells of *Planorbella duryi* are present only in lakes of the Albano Hills near Castel Gandolfo and Genzano. This is probably associated with specific microclimatic characters of Colli Albani, as well as with the course and conditions of migrations of the species. It is likely that it reached Lake Albano with ornamental aquatic plants, imported from tropical countries to the gardens of the Pope's residence, or through aquarists. Even if it had been introduced in Lake Brazziano, it would not have found an adequate habitat.

MOLLUSC ASSEMBLAGES OF LATE HOLOCENE CALCAREOUS TUFAS OF THE FLYSH CARPATHIANS

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Recent calcareous tufas are very common in the flysh Carpathians. Such deposits most often have a form of calcareous dripstones or crusts on boulders in stream beds, close to waterfalls, springs and limestone flushes. Their number is difficult to estimate but no doubt exceeds a thousand. Larger outcrops in the form of cones or lenses are much less frequent. Their main part is formed of hard, porous travertines, sometimes with insets or layers of more loosely-structured tufas. The tufas often contain mollusc assemblages. A detailed analysis of 27 sites located between the Poprad River valley in the east and the Soła valley in the west yielded 66 snail and bivalve species represented by ca. 5,000 specimens, found in 54 samples. The mollusc assemblages were very much varied, and the following types could be distinguished. The first and most common is poor in species but often abounds in specimens. Aquatic species dominate, mainly those typical of springs (*Bithynella austriaca*), while other taxa are sporadic. Sometimes virtually mono-species associations are found. The assemblage characterises the commonest type of recent tufas – spring tufa. An assemblage with dominance of woodland and/or mesophilic species is slightly less common. It has a more varied species composition. It is usually found on terraces of small streams, in fault zones usually rich in small flushes. Assemblages with numerous mesophilic and meadow species occur in tufas forming on terraces of streams flowing through deforested and often agricultural areas. In the last case they usually contain species associated with human activities, mainly ploughing the soil. Other types of assemblages appeared in single sites, of very specific geomorphological, geological and hydrological conditions. The composition and character of the assemblages are clearly associated with habitat conditions in the nearest surroundings. Results of studies on recent tufas may be useful for reconstruction of deposition of fossil tufas, recognition of mechanisms of sedimentation and preservation of mollusc shells in such deposits. They make it possible to compare the degree to which subfossil mollusc assemblages correspond to habitat conditions in which freshwater carbonate deposits are formed. The studies were funded by the State Committee for Scientific research, grant no. 10.25.140.20

TERRESTRIAL GASTROPODS OF KIELCE

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Urban malacofauna in Poland has been studied in Warsaw, Łódź, Wrocław and Cracow, and several towns of Pomerania. In 2000–2001 terrestrial gastropods were studied quantitatively in 20 sites in Kielce. Kielce is an old town, with a history dating back to the 11th c. The large geological diversity of the town, numerous carbonate outcrops, ore beds and hydrological conditions favoured mining and quarrying of rocks and ore. Within the town boundaries, 2 km from the centre, there are quarries of Devonian limestone: Wietrznia, Kadzielnia and Ślichowice, abandoned over 40 years ago; at present they are protected objects. Another object important from natural history viewpoint is the forest-landscape reserve Karczówka. The town includes extensive areas of rock mining. Fifty two gastropod species were found in Kielce. The richest malacocoenoses were those of the Karczówka hill (31 species) and of the geological reserves Wietrznia and Ślichowice (21). The old, historic cemetery harbours 22 species, the ancient park – 14, the recreation park – 16, the reserve Sufraganiec – 8. The structure of the malacocoenoses indicates that the most disturbed habitats are cemeteries and the park in the town centre. Biogeographical analysis suggests that the reserve Karczówka and the limestone quarries provide a route of south to north migration of some species. Several species rare in the Świętokrzyskie Mts were found in Kielce: *Cecilioides acicula*, *Clausilia bidentata*, *Bradybaena fruticum*, *Arianta arbustorum*, *Cepaea hortensis*, *C. nemoralis* and *Helix lutescens*. Compared to gastropod faunas of several other towns, the malacofauna of Kielce is among the richest in terms of the number of species.

THE EFFECT OF WATER DEPRIVATION ON UNIONIDS

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The material included 807 individuals of various unionid species (*Bataviana musiva*, *Unio conus*, *U. rostratus*, *Pseudanodonta complanata*, *Anodonta cygnea*, *Colletopterum piscinale*). The animals were placed in containers with humid sand from the same locality as the bivalves, 0–60 mm deep, at a density of 14–16 individuals 0.1 m⁻². The bivalves were weighed every 24 hrs, and their mortality was assessed. Water-deprived bivalves showed a higher mobility: they crawled in search of water. Crawling was observed in 1/3 examined *B. musiva*, *U. conus*, *A. cygnea* and *C. piscinale*. It

took place during the first two days. 2/3 individuals of these species and all *U. rostratus* and *P. complanata* displayed no such reaction. The next defensive reaction was tight closing of shell valves, which minimized water loss from the pallial cavity and body surface. Some bivalves (20% *B. musiva*) buried themselves in humid sand before closing their shells. In natural conditions unionids can survive water deprivation for 8–36 days (*A. cygnea* (36 days) > *U. rostratus* (28) > *B. musiva* (20) > *U. conus* (19) > *C. piscinale* (15) > *P. complanata* (8)). Different shell structure (no hinge, thin shell of Anodontinae and Pseudanodontinae) does not decrease resistance to water deprivation. Resistance of *A. cygnea* may be explained by adaptation to life in stagnant waters where the water table fluctuates more rapidly and more often, compared to fast-flowing rivers. *P. complanata* does not stand water deprivation well and is susceptible to water level changes in rivers. In *B. musiva* the limit of lethal water loss is 31.4–59.2% wet body mass (irrespective of shell mass), in *U. conus* – 11–69.3, in *U. rostratus* – 37.2–71, in *A. cygnea* – 23–56.1, in *C. piscinale* – 22.9–58, in *P. complanata* – 22.3–58.4%. Some individuals may lose half of their wet body weight and remain alive.

ANODONTA WOODIANA (LEA, 1834) FROM THE HEATED KONIN LAKES MATURED IN AQUARIA

[this abstract has been accidentally omitted from the Abstract Book of the Slupsk Seminar (2003); it is published now, with apologies to the Authors]

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In September 1998 *Anodonta woodiana* was caught in three reservoirs of the cooling system of the Konin and Pątnów power plants: Lake Licheńskie, of mean water temperature of 26°C, initial cooling reservoir of 32°C and a discharge canal of 30°C. Bivalves from each reservoir were kept separately in identical thermal and oxygen conditions in aerated aquaria of 200 l. They were fed with *Daphnia* sp. After six months the bivalves were killed and their gonads preserved in formalin. Only ovaries were processed further. Sections 4 µm thick were stained with Heidenhein hematoxylin. Assessment and measurements of oocytes and cysts were performed with computer image analysis. In each sample phase 1 (f₁) oocytes, intermediate 2/3 oocytes and f₄, i.e. mature oocytes, were observed. The mean diameter of f₄ oocytes was, for particular groups, 50.9 µm, 43.3 µm, 41.3 µm. The percentage of all oocytes in the phases mentioned above in one cyst in relation to the cyst area was 52.4%, 35.2% and 42.9%. The proportion of f₄ oocytes in each group

was similar and amounted to 31–28%. The mean cyst diameter ranged from 222.4 μm to 182 μm . Individuals from Lake Licheńskie which, prior to transfer to the aquarium, lived at the lowest temperature, adapted to the artificial conditions the best. Their oocyte parameters were statistically significantly different from those found in the remaining groups. Irrespective of the temperature in their native lakes, female bivalves transferred to aquaria and kept at room temperature (much lower than that in their earlier habitat) reached maturity. This indicates a possibility of further expansion to lakes of a temperature typical of our climate.

PRELIMINARY STUDIES ON THE FERTILITY OF SNAILS OF THE GENUS *ACHATINA*

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African snails of the genus *Achatina* are kept for culinary purposes in France, Spain and also Far East, e.g. China, Vietnam or Singapore. In many areas *Achatina* farming is the main form of snail culture. The reasons are: easy farming, large mass of adult snails (*Achatina* sp. reaches 150 mm shell height and 250 g weight), high fertility and fast growth. The hermaphroditic snails, following copulation, lay eggs in the soil. The eggs are spherical, calcified, have rough white-creamy shells. They were incubated in containers with soil (chernozem with admixture of peat) at 18–20°C and proper humidity conditions (soil humidity ca. 80%). Young snails hatched after 4–14 days. The lack of detailed data on the reproductive potential of the snails of the genus *Achatina* induced us to attempt a study on their fertility. The number and measurements of eggs laid by two individuals of *Achatina* were compared. The results were the following: individual 1: shell height 77.5 mm, mass 58.74 g, number of eggs – 216, egg diameter 4.3–5.4 mm, egg mass 0.031–0.056 g; individual 2: shell height 81 mm, mass 73.9 g, number of eggs 228, egg diameter 4.1–4.6 mm, egg mass 0.028–0.050 g. The studies will be continued.

INTERPOPULATION GENETIC DIFFERENTIATION OF *BRADYBAENA FRUTICUM* AND *ARIANTA ARBUSTORUM*

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Population genetic structure and interpopulation genetic differences were studied in two helicoids: *Bradybaena fruticum* (O. F. Müller, 1774) and *Arianta*

arbustorum (Linnaeus, 1758), with allozyme electrophoresis on cellulose acetate. The material was collected in S Poland: from 16 populations of *B. fruticum* and 9 of *A. arbustorum*; in some sites the species were sympatric. Both species showed considerable deviations from the Hardy-Weinberg equilibrium, resulting probably from the presence of several generations, Wahlund effect, division into subpopulations and differential selection (epistatic selection did not seem to play a major part, as evidenced by the values of D statistics). The species, of roughly similar bionomics, showed different degree of inter-population differentiation. The mean θ value (Wright's F_{ST}), quantifying differences between subpopulations of a divided population, was 0.224 for *B. fruticum* and 0.270 for *A. arbustorum*, and the resulting estimates of gene flow Nm were 0.866 and 0.676, respectively. The differentiation was thus higher in *A. arbustorum*, the gene flow higher in *B. fruticum*. In both species in some cases the gene flow was low for close and high for remote populations. Correspondence analysis for allele frequency, UPGMA cluster analysis and non-linear multidimensional scaling showed no clear geographical differentiation in either species. However, Mantel tests for *B. fruticum* showed a statistically significant correlation between genetic distance (θ and Cavalli-Sforza and Edwards distance) and geographical distance between populations. No such dependence was found for *A. arbustorum*. The explanation for the differences may be sought in the history of the species in S Poland. Their present differentiation is a result of: (1) time elapsed since invasion of the studied area, (2) low intensity of migration of these semi-sedentary animals, (3) low chances for reproductive success of an immigrant in a new population, (4) new mutations (probably frequent in strongly polymorphic snails). Observations on biology and distribution, and phylogeographic mtDNA analyses indicate that *A. arbustorum* has survived the last glaciation in situ, while *B. fruticum* arrived only later. Invasion of new sites must have taken place gradually, hence the initial geographical differentiation. Later differential selection, new mutations and an array of random factors caused a gradual increase in differences, which sometimes became very high between close populations. The longer time available for these processes in *A. arbustorum* resulted in a complete lack of correlation between the genetic distance and the geographical distance between populations. Snails invading new sites encountered no competition, but those immigrating into already existing populations were probably unable to win the competition with autochthonous snails. This aspect is only rarely appreciated when considering migrations: reaching a new site does not mean that the new arrival will survive and produce progeny whose fitness will at least equal that of autochthonous individuals.

FAUNA AND ECOLOGY OF FRESHWATER MOLLUSCS OF THE DNESTR LIMAN

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The Dnestr liman is located in the south of Ukraine and is the largest open liman in the Odessa district. It is freshwater, the salinity increasing southward and changing seasonally and according to the wind strength and direction. The aim of our studies was to assess the composition and ecological parameters of freshwater mollusc fauna of the Dnestr liman. Observations were conducted in spring (May 2000–2003) near Bielgorod-Dniestrovskiy. Water temperature, turbidity, pH, oxygen content, chloride content were registered (Table 1), as well as flow velocity and vegetation. All the factors were favourable for the malacofauna. Five or six (depending on the classification system) mollusc species were recorded (Table 2). The dominants were *L. palustris* and *P. planorbis*. Molluscs occurred in masses in shallow littoral where the water was well heated (favouring reproduction). In this zone, on muddy deposits with sparse vegetation, in nearly stagnant water, the density was ca. 20–30 indiv. m⁻². In the main bed, with a slow current and greater depth, only single individuals of *L. stagnalis* and *P. purpura* were found. The most favourable conditions for pulmonate snails are found in the littoral shallows. The lack of flow, small depth and muddy substratum favour development of aquatic vegetation which provides substrate and food for molluscs. The dominance of *L. palustris* and *P. planorbis*, which can survive drought, reflects the periodical character of these parts of the liman.

Table 1. Basic ecological parameters of the water of the Dnestr liman

Year	Water temperature [°C]	Turbidity	pH	Oxygen [mg dm ⁻³]	Chlorides [mg dm ⁻³]
2000	+16	3.65	8.05	11.48	358.9
2001	+10	3.77	8.00	8.24	6,935.5
2002	+16	0.35	8.30	9.10	5,286.5

Table 2. Species composition of molluscs of the Dnestr liman

Species names according to:	
STAROBOGATOV's system	European system
<i>Planorbarius purpura</i>	<i>Planorbarius corneus</i>
<i>Planorbis planorbis</i>	<i>Planorbis planorbis</i>
<i>Lymnaea stagnalis</i>	<i>Lymnaea stagnalis</i>
<i>Lymnaea palustris</i>	<i>Lymnaea palustris</i>
<i>Lymnaea fontinalis</i>	<i>Lymnaea ovata</i>
<i>Lymnaea ovata</i>	

MOLLUSCS OF THE BAVARIAN FOREST NATIONAL PARK (GERMANY)

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Based on a complex malacozoological investigation in 2003, a total of 64 species (59 terrestrial gastropod species, 1 aquatic gastropod species and 4 bivalve species) were recorded from 45 localities in the Bavarian Forest National Park. Woodland species dominated (34 species – 53.13%). Besides, 24 mesophilous species (37.5%), 1 wetland species (1.56%) and 5 aquatic species (7.81%) were found. No open-country species were recorded. The terrestrial malacofauna is dominated by woodland communities, including some sensitive woodland species which occur in preserved fragments of deciduous and mixed forests surrounded by planted spruce forests. Of prime importance are the records of Alpine elements *Macrogastrabadia* and *Petasina edentula*. From the zoogeographical viewpoint, the Arctic-Alpine *Vertigo arctica*, never recorded from the area in the past, is the most important snail in the studied malacofauna. Boreo-Alpine species: *Discus ruderratus*, *Vertigo substriata*, *Vertigo alpestris*, *Clausilia cruciata* and a relic *Perpolita petronella*, classified as typical mountain elements in C Europe, were recorded from numerous sites at elevations of 670–1,150 m. Twenty two species (over 34% malacofauna of the Bavarian Forest) are on the Red List of Bavaria: 7 as critically endangered, 10 as endangered and 5 as vulnerable. Though the research did not focus primarily on the inventory of freshwater molluscs, four aquatic species were found which are new for the area. *Pisidium nitidum* is classified as an endangered species. Compared with earlier data on the malacofauna of the Bavarian Forest, 21 species were added to the list, and 3 could not be confirmed. A comparison of mollusc faunas of the Bavarian Forest and the Bohemian Forest, based on recent and earlier data, revealed some differences in their composition, with 67 species present in the former and 75 in the latter area. Several ruderal and synanthropic species, such as *Limax maximus*, *Boettgerilla pallens*, *Arion distinctus*, *A. fasciatus* and *A. lusitanicus*, were found to occur syntopically with sensitive woodland species.

ANODONTA CYGNEA IN WESTERN POMERANIA

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Anodonta cygnea is becoming increasingly rare in Poland. The probable reason is progressive disappearance and pollution of adequate water bodies. In



Western Pomerania it was found only in the Gulf of Szczecin and the estuary section of the Odra River; the information dates from the 1960s and 1970s. This is associated with the rarity of the bivalve, but mainly with the lack of pertinent studies in the area of Western Pomerania. During the author's field work and based on literature data new localities of the species were recorded. It was found in the following sites: Odra River between the city of Szczecin and the Gulf of Szczecin; Gulf of Szczecin; floodplain of the Odra River within the landscape park Dolina Dolnej Odry; city of Szczecin: Lake Dąbie and Kanał Zielony; lakes Myśliborskie, Białe, Łubie, Miedwie, Będgoszcz, Binowskie, Świdwie, Mętno, Jeleńskie. Further investigations should reveal new sites and enable preparing a protection plan for the species in Western Pomerania.

SELECTED ASPECTS OF THE EFFECT OF MALACOFAUNA ON THE FUNCTIONING OF A LARGE LOWLAND DAM RESERVOIR (ZEGRZYŃSKI RESERVOIR, CENTRAL POLAND)

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Molluscs are important components of the macrobenthos of the Zegrzyński Reservoir, especially because of their high proportion in the total biomass. The abundance of malacocoenoses, as well as their dominance structure and size structure of dominant species influence the importance of malacofauna for the functioning of the ecosystem. An attempt was made at an estimate of the role of molluscs in accumulation of phosphorus and heavy metals (Cu, Zn, Mn, Fe, Pb, Cd), compared to quantities of these elements in the water and bottom deposits and their load and retention in the Zegrzyński Reservoir. Calculations of filtration activity of molluscs and biodeposition of phosphorus and heavy metals with faeces (and pseudofaeces) made it possible to estimate the effect of malacofauna on circulation of these elements in the reservoir's ecosystem. Another objective of the studies was an analysis of phosphorus and heavy metals transfer in short food chains where molluscs formed one of the links. Phosphorus and heavy metals contained in molluscs living on the bottom of the Zegrzyński Reservoir constituted a small part of the annual retention of these elements in the reservoir, and of the quantity contained in the bottom deposits (most often below 1%, P – several %), but compared to the content of these elements in the water – up to ca. 48% for heavy metals and over 90% for phosphorus. The calculations indicate that flow of phosphorus, and to an even greater extent that of heavy metals, through malacocoenoses, many times

exceeds the quantities of these elements accumulated in mollusc tissues and shells. It was estimated that the participation of the trophic pathway in heavy metal transfer is rather slight (greater for phosphorus), much smaller than the quantities of these elements contained in molluscs, since a part of them bound in shells and mineral granules in tissues is biologically unavailable to potential consumers. A large part of the pool of these elements contained in shells is excluded from circulation for many years.

MOLLUSCS AND HUMAN IMPACT – RUINS OF CASTLES AND BIG CITIES

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Mollusc fauna of three big cities in the Czech Republic was investigated, and malacocoenoses of substitute habitats and of fragments of natural habitats on the outskirts of the cities were characterised. A total of 152 species were recorded from 270 localities. The highest number of species occurred in Prague, as a consequence of its great geological and vegetational diversity. Ecological and zoogeographical composition of the malacocoenoses was analysed; some species proved to be characteristic of either central or marginal parts of urban areas. The species were classified with respect to their tolerance to human impact. Cities represent a substitute biocentre of characteristic mollusc communities. Castle ruins have become very specific habitats. Their substratum is locally enriched by lime, and their disintegrated walls have changed into artificial scree, thus providing a variety of microhabitats. Ecological and zoogeographical composition of the castle communities was analysed relation to the whole Czech malacofauna. The occurrence of 112 species (70% terrestrial fauna of the Czech republic) was recorded. Data from 114 castles were processed with STATISTICA and CANOCO (Multivariate Analysis of Ecological Data). The constrained unimodal CCA method was used for the description of species response to environmental variables. From the 32 original variables, 9 environmental variables were chosen in a regression analysis using the method of forward selection. These variables conclusively explain 52% species variability. A model without limestone (co-variable) was used to show the influence of the so-called castle phenomenon on species variability as a single factor. The model shows especially the influence of phytogeographical areas, the state of the ruin, the time of destruction and the degree of castle isolation on species variability. The snail communities inhabiting the ruins of castles reached the highest species diversity. The ruins offer favourable conditions for some rare snail species. Castle ruins are not only an important landscape dominant

feature, but often islands of species diversity and refuges of rare species, especially in areas of poor substratum. Cities and castles represent a rich spectrum of human-affected habitats, and harbour characteristic malacocoenoses, different from those of the surrounding landscape. Human influence does not always cause a decrease in species diversity – in some situations it has an opposite effect. The castles are an example of such a situation.

PLANT EXTRACTS AS A MEANS OF PROTECTING WHEAT SEEDS AGAINST SLUGS

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According to agricultural statistics, 77.1% of all cultivations in Poland are cereals, and among these 23.5% is cultivations of winter wheat; the area of its cultivations is increasing. In regions especially susceptible to slug damage the proportion of wheat cultivations ranges from 75 to 80%. Slugs, mainly *Arion lusitanicus* and *Deroceras reticulatum*, damage wheat seeds and seedlings, causing sometimes great losses. Preliminary tests were aimed at an estimate of the effect of extract of selected plant species on feeding of *A. lusitanicus*. Extracts of 10 species of herbaceous plants were tested, among others knotgrass and two species of geranium. The values of tastiness indices of winter wheat seeds, treated with these extracts, indicate a great diversity of their effect. Seeds treated with 6% extract of knotgrass were the most readily consumed; seeds treated with extracts from geranium and plantain were the least attractive. The effect of herb extracts on the feeding of slugs on wheat seeds is much varied. Individual extracts may stimulate or inhibit slug feeding. Extracts from plants which are not accepted by slugs, applied to winter wheat seeds, may limit feeding of *A. lusitanicus* and the seed damage caused by the species.

FACTORS AFFECTING ATTACHMENT STRENGTH OF THE ZEBRA MUSSEL (*DREISSENA POLYMORPHA*)

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The zebra mussel retains its ability to attach to the substratum with byssus throughout life. Studies on its attachment strength may provide important information on the bivalve condition and on the substratum quality from the viewpoint of settling individuals. In natural conditions, factors that may affect attachment strength include, among others, kind and way of ex-

posure of the substratum, presence of predators and population density. Laboratory experiments allow a separation of these factors and assessment of their effect on the bivalves, as well as detecting possible interactions between them. Mussels used for the experiment were caught by a scuba diver at the dam of the Włocławek reservoir (Vistula). The attachment strength was measured with a dynamometer joined to pincers for grasping the examined specimen. The number of individuals which did not attach to the substratum during the experiment was also analysed. The results showed no effect of the substratum position or light on the attachment strength. However, lighting increased the number of individuals which remained unattached after one day exposure. The attachment strength depended on the quality of substratum (ordered from the best to the worst: resocart > aluminium > PCV > rubber > zinc > resocart covered with Penaten cream), surface roughness, degree of development of biofilm, presence of substances emitted by conspecific individuals (also damaged) and the time of exposure. The interaction between the time of exposure and the kind of substratum was also important; on some substrata the maximum strength of attachment was reached earlier than on other kinds.

LITHOGLYPHUS NATICOIDES (C. PFEIFFER, 1828) – INVASIVE OR BECOMING EXTINCT IN POLAND?

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The freshwater malacofauna of Poland includes at least seven alien species of different origin, expansion rate and abundance in invaded habitats. One of the little known and rarely studied species is a Pontic prosobranch *Lithoglyphus naticoides*. In 1830–1930 it invaded, with considerable aid from humans, large, slow-flowing lowland rivers of Central and partly Western Europe. After 1930 the expansion stopped, only an increase in abundance was observed in already invaded areas. In Poland, with progressing eutrophication and water pollution, receding of numerous mollusc species has been observed for years, as well as decrease in abundance and in vertical range of other species. The phenomenon was best studied for *Dreissena polymorpha* and unionids, but it has been noted also for snails, especially prosobranchs. The scanty available data indicate retreat of *L. naticoides* from earlier invaded large rivers. Its abundance is decreasing, and in some sites it is disappearing completely. At present it is regarded as endangered and it is proposed that it should be included in the list of protected species. At the same time a permanent presence of its population was observed in a strongly eutrophicated Lake Mikołajskie (Mazurian lakes), in



a habitat atypical for it (no flow, considerable depth). This may indicate two simultaneous and opposite phenomena: retreat from rivers and invasion of stagnant waters.

PRELIMINARY STUDIES ON THE DIVERSITY OF MALACOCOENOSSES IN AN ISOLATED AND HUMAN-TRANSFORMED FOREST COMPLEX DUSZNIKI

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The study, started in May 2003, includes 5 sampling plots in the forest complex Duszniki, located 27 km N of Poznań (UTM: WU 91). The plots adjoin each other but differ in the soil structure, vegetation and age of tree stands. Originally they formed a part of a uniform oak-hornbeam forest with an admixture of larch, but changed their character as a result of clear-felling. The plots represent various degrees of anthropogenic transformations of an oak-hornbeam forest in Wielkopolska. Two plots (D-I and D-II) are located in an old tree stand (>120 years), one has an admixture of larch, the third (D-III) is a hornbeam stand of ca. 60 years, grown in a clear-felled area. Two (D-IV and D-V) are ca. 20-years old clear-felled plots, with oak planted on them directly after clear-felling. The planting failed and in both plots a natural plant succession is observed. In D-IV there is a natural expansion of hazel and birch, in D-V – ash-trees. During the eight month period of quantitative studies, with monthly sampling from May till December 2003, in five plots a total of 320 samples were taken with Oekland frame of 25 × 25 cm. In all, 559 specimens of terrestrial gastropods were collected, representing 19 species of 10 families. Preliminary analysis indicates a characteristic structure of the malacocoenosis, with *Nesovitrea hammonis* as superdominant and *Cochlicopa lubricella* and *Vallonia costata* as eudominants. With respect to frequency, *N. hammonis* (19.7%) is subconstant, and *Cochlicopa lubricella* (7.5%) – an accessory species. The remaining species are accidental, with respect to abundance being dominants (5.2–9.5%), subdominants (2.3–5.0%), recedents (1.4–2.0%) and subrecedents (0.2–0.9%). The mean snail density is 28 indiv. m⁻², and the species diversity index (H') – 2.12. Plot D-V, with its natural expansion of ash-trees, proved to be the richest in species (19) and individuals (mean density 117.2 indiv. m⁻²) and has the highest species diversity index (H'=2.19).

PREFERENCES OF *DEROCERAS RETICULATUM*, *ARION LUSITANICUS* AND *ARION RUFUS* TO VARIOUS PLANT SPECIES

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Pest slugs (Agriolimacidae and Arionidae) have a wide food spectrum. Besides cereals and vegetables, they consume cultivated medicinal and ornamental plants. Food preferences are species-specific. Some plants are readily eaten while others are completely ignored. The knowledge of attractiveness of plant species to slugs is necessary to devise alternative methods of pest control. The studies focus on use of various species of herbs as alternative food for slugs, or use of plant chemical compounds to limit consumption of cultivated plants by slugs. The first stage is to determine slug preferences and acceptance of various plant species, and recognising foraging behaviour of slugs. The paper presents results of studies on preferences and acceptance of selected species of herbs and rape-seed for *Deroceras reticulatum*, *Arion lusitanicus* and *Arion rufus*. Attractiveness of 20 plant species for the three slug species was assessed in controlled conditions, in choice and no-choice tests. The rate and degree of damage to seedlings and leaves were estimated in consecutive days of slug foraging; plant species preferred and avoided by slugs were identified. Among the 20 plant species, *D. reticulatum*, *A. lusitanicus* and *A. rufus* preferred seedlings and leaves of *Brassica napus* and *Datura stramonium*, and did not accept *Geranium robertianum*. Preferences to the remaining plant species varied between slugs. The preferred and avoided plants will be studied further with a view of applying them for protection of cultivated plants against slugs.

VARIATION IN THE ACTIVITY OF INORGANIC PYROPHOSPHATASE IN THE ALBUMEN GLAND OF *HELIX ASPERSA ASPERSA* (GASTROPODA, PULMONATA, HELICIDAE)

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Glycogen and galactogen synthesis takes place in the albumen gland of *Helix aspersa aspersa*, its intensity depending on the activity versus hibernation of the snails. Fluctuations in synthesis of the two polysaccharides should correspond to changes in the activity of inorganic pyrophosphatase (EC 3.6.1.1) in the albumen gland, since the enzyme is a part of the pathway of glycogen synthesis from UDP-glucose. The arising energy-rich inorganic pyrophosphate (PPi) is controlled by inorganic pyrophosphatase (PPase) which



catalyses PPi hydrolysis and release of inorganic phosphate (Pi) in the presence of magnesium ions. PPase activity was determined in the albumen gland of *Helix aspersa aspersa*, examined each month in the annual cycle (1999–2001). Snails were always dissected at 9 a.m. Isolated albumen glands were homogenised, the enzymatic reaction was conducted in supernatants, and the resulting inorganic phosphate was determined with the method of Toshiba & Yoshimura. In each homogenate total protein was determined with Lowry's method. The proper activity of PPase was determined based on the results, and its changes were statistically analysed. The PPase activity was the highest during hibernation (September–December): 38.4–53.3 mU mg⁻¹ protein, and before reproduction (January–April): 33.2 mU mg⁻¹ protein, while during the active period – in May and June – it was very low (1.8–3.5 mU mg⁻¹ protein).

CHARACTERISTICS OF THE POPULATION OF *ANODONTA WOODIANA* (LEA, 1834) IN THE KONIN SYSTEM

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Anodonta woodiana (Lea, 1834), originating from SE Asia, has spread outside its original range with fishes. It was brought to Poland from Hungary, with stock material of herbivorous fishes in mid 1980s. Higher water temperature and turbulence in the system of heated Konin lakes provided good conditions for its development. Genetic analyses did not confirm STAROBOGATOV's hypothesis about introduction of several unionid species from Asia. They show that only one species – *A. woodiana* – lives in the Konin lakes. Shells of *A. woodiana* found in these lakes were circular-oval in outline, convex in their mid part and had a strongly marked ala. The shape variation was wide. Shell morphology and colour are influenced by a variety of factors, the most important being the character of substratum, flow intensity and the degree of heating which enhances growth rate. Bivalves from the warmest flow canals had the lowest shells, those of lenitic and moderately heated zones – the highest. Bivalves with flattened shells occurred in the warmest habitats. The growth was more intense in habitats of higher temperature: in summer the bivalves reached 80% annual increment. The growth was the fastest in individuals aged one and two years. In older bivalves the increment did not exceed 2 cm per year. In cooler zones individuals of shell length of 70–115 mm dominated, in moderately heated – 90–125 mm, in the warmest – 120–160 mm. The bivalves usually formed colonies. The largest colonies were found at the depth of 1.5–2.5 m. Abundance and biomass were the lowest in the coolest lakes and canals, the highest – in

the warmest discharge canals and in the initial cooling reservoir. The maximum density in those places was 60 indiv. m⁻², and the biomass 25 kg m⁻². The population of *A. woodiana* from the Konin lakes consisted mainly of individuals aged 3–5 years. Size-age groups were the most numerous in the initial cooling reservoir. The oldest individuals, aged 10 years, reached length of 230–240 mm. No sexual dimorphism was observed in *A. woodiana*. The sex ratio in the population indicates a clear prevalence of males (over 70%). Numerous hermaphroditic individuals and grouping into colonies in unstable habitat conditions might increase reproductive success.

MOLLUSC FAUNA OF SELECTED FISH PONDS IN THE DISTRICT NOWA BRZEŹNICA

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The fish farm, located NW of the village Prusicko in the Warta River valley, includes seven ponds of ca. 36 ha area and specializes in carp (*Cyprinus carpio* (L.)). Quantitative and qualitative diversity of malacofauna of three of the ponds was studied in 1998–1999. In each mollusc were collected from 1 m² area. The ponds were selected based on their size, diversity and abundance of macrophytes, surroundings and accessibility of sites. The vegetation was little varied. Two to 10 species of macrophytes were found per site. They were mainly euryoecious (e.g. *Myriophyllum spicatum* (L.)). Wave-resistant species inhabiting larger water bodies were also present (e.g. *Phragmites australis* (Trin.)). Physico-chemical analysis of water showed differences between the ponds. The aim of the study was determining the structure of the malacocoenoses (frequency, dominance), species diversity and richness, as well as the effect of various factors on the occurrence of molluscs in the ponds. A total of 770 specimens were collected, representing 14 species: 13 snails (live specimens) and 1 bivalve (empty shells). The number of species in individual sites ranged from 0 to 10. *Anisus vortex* (L.), *Lymnaea stagnalis* (L.), *Radix peregra* (O.F. Müll.) and *Planorbium corneum* (L.) were common and abundant. The malacofauna did not differ much between the ponds. The main differences pertained to abundance of the species recorded. The malacofauna is composed of ubiquitous species, found in a variety of aquatic habitats and preferring stagnant waters. Most of them are resistant to changes in habitat conditions. The general poverty of the malacofauna is associated with the high density of fish; it has been repeatedly demonstrated that fish limit the occurrence of molluscs in fish ponds.

SCROBICULARIA PLANA (DA COSTA)
IN HOLOCENE DEPOSITS OF THE VISTULA BAR
(STEGNA)

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A bivalve of the family Scrobiculariidae: *Scrobicularia plana* (Da Costa) was found in deposits of the Vistula Bar (Stegna), in samples from three bore holes (Stegna 1, 2 and 4) up to 23.0 m deep. Lower parts of two profiles: Stegna 2 (from 23.0 to 15.3 m) and Stegna 4 (22.0–16.5 m) contained lacustrine-fluviatile (delta) deposits, represented by sands with nests of organic matter. They contained no malacofauna. Above these deposits, in sandy silts and sands with admixture of organic matter, at depths of 10.70–9.0 m (Stegna 2), in sands at depths of 10.40–9.10 m (Stegna 4), and in the third profile (Stegna 1) in sandy silts and sands, depth 13.0–8.0 m, *Scrobicularia plana* occurred with some other marine species, common in the coastal zone of S Baltic (*Hydrobia ulvae* (Pennant), *H. ventrosa* (Montagu), *Cerastoderma glaucum* (Poiret), *Macoma balthica* (Linnaeus), *Mytilus edulis* Linnaeus). The topmost parts of the profiles contained marine sands, with shells of *C. glaucum*. Pollen analysis of the silts indicates Atlantic period. Also radiocarbon dates ^{14}C confirm the age and are $7,300 \pm 90$ and $7,100 \pm 80$ years BP. *S. plana* is a euryhaline species of salty waters, typical of boreal and lusitanic zones. It inhabits strongly silted (silty, clayey), sandy or muddy bottom of deeper coastal areas. It occurs in W Baltic and in the Danish Straits, North Sea. At present it does not occur in S Baltic and thus can serve as an indicator of its past salinity, since it inhabits waters of salinity over 14 psu and is regarded as an indicator species for deposits of the Littorina sea on our coast.

PRELIMINARY STUDIES ON AESTIVATION SITES
OF *ANISUS LEUCOSTOMUS* MILLET, 1813
AND *SEGMENTINA NITIDA* O. F. MÜLLER, 1774
IN TEMPORARY WATER BODIES

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Studies included three small midfield ponds in the Kaźmierz district (W Wielkopolska). The ponds are located along a line of ca. 2 km, and their catchment area includes only cultivated fields. They have no flow, are isolated from other water bodies and in summer they dry out. Their area and maximum depth are similar but they differ in vegetation. The aim of the study is

to determine habitat selectivity in *Anisus leucostomus* and *Segmentina nitida* with respect to aestivation during drought. The species are among the most drought-resistant. Snail density was assessed in places of different distance from the shore, maximum depth in spring and degree of vegetation coverage. The distribution estimates were based on 90 soil samples, 30 from each pond, taken along the pond diameter at 1 m intervals. The samples were taken in August 2003, from dry ponds, with a metal cylinder of 0.2355 m² area (=30 cylinders of 10 cm diameter, stuck in the bottom 5 cm deep, from each pond). A total of 334 specimens of *A. leucostomus* and 169 specimens of *S. nitida* were collected. The density of *A. leucostomus* ranged from 0 to 43 indiv. per sample (78.5 cm²), that of *S. nitida* – from 0 to 22 indiv. per sample. In dry ponds the density of aestivating *S. nitida* was positively correlated with the density of plants ($r=0.275$; $p=0.033$) and depth ($r=0.284$; $p=0.045$). The density of *A. leucostomus* was correlated only with the vegetation density ($r=0.327$; $p=0.015$). The observations suggest that individuals of *S. nitida* migrate to deeper places of higher substratum humidity with progressing drying out; no such migration was observed in *A. leucostomus*.

CHANGES IN LITTORAL MALACOCOENOSES
OF LAKE PAPROCAŃSKIE
(KOTLINA OŚWIECIMSKA)

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Lake Paprocańskie, 132 ha in area and 2.5 mln m³ in total capacity, originated in 1870 as a result of damming the Gostynka River for the needs of the (now nonexistent) ironworks. Studies on littoral mollusc communities, started in 2003, took place 13 years after recultivation of the lake. The recultivation involved complete emptying of the lake, cleaning its bottom, removing silt and decreasing bottom level by 0.5 m over 110 ha, reinforcing shores with stones and needled cloth, and mowing macrophytes. The 1990–1994 and 2003 studies included analysis of malacoenoses, physico-chemical parameters of water and qualitative diversity of macrophytes. Molluscs were collected from a variety of substrata, e.g. stones, submerged parts of *Glyceria maxima* (Hartm.) Holmb. and *Nymphaea alba* (L.). In 1990 only *Radix peregra* (O. F. Müller, 1774) was found in the lake. In 1992–94 eudominants were *R. peregra* (O. F. Müller, 1774) and *Gyraulus albus* (O. F. Müller, 1774). *Planorbis planorbis* (Linnaeus, 1758), *Segmentina nitida* (O. F. Müller, 1774) and *Physella acuta* (Draparnaud, 1805) were eudominants in 2003, while *R. peregra* (O. F. Müller, 1774) and *G. albus* (O. F. Müller, 1774) were only sub-recedents at that time. The only bivalve in the lake was *Anodonta anatina* (Linnaeus, 1758). Frequency analy-



sis (χ^2 test) showed no statistically significant dependence between the qualitative and quantitative diversity of molluscs and the kind of substratum. Only the density of *Ph. acuta* (Draparnaud, 1805) was statistically significantly correlated (Pearson) with the total alkalinity ($r=0.98$, $p<0.05$) and total water hardness ($r=0.99$, $p<0.05$). In Lake Paprocańskie nymphaeids are represented by legally protected *Nuphar lutea* (L.) Sibth. & Sm. and *Nymphaea alba* (L.).

MORPHOLOGICAL AND PHYSICO-CHEMICAL SHELL CHARACTERS OF *HELIX* FROM NATURAL AND FARMED POPULATIONS

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Mechanical resistance of shell is important from the viewpoint of processing of *Helix*; it prevents damage during cleaning and sorting in process lines. In 2003 the following shell characters were studied with respect to their effect on the maximum mechanical puncture force (J) measured with texture analyser: shell mass, diameter, height, width, thickness and capacity, height/width ratio, solidity index [shell mass x (width x height)⁻¹ x 100], calcium and phosphorus content. In summer (July-August) air humidity, temperature and cloudiness were recorded for both natural and farmed populations. Two farmed populations of *Helix aspersa aspersa*, two of *H. aspersa maxima* and *Helix pomatia* aged 1+ to 3+ were used in the studies. Samples of adult *H. aspersa* came from the laboratory culture in soil-filled containers, from an unheated glasshouse, a field enclosure, and also snails raised in natural conditions were collected. A total of 20 snail samples were examined, 15–30 specimens per sample. It was found that shell mass, thickness and solidity as well as maximum puncture force were negatively correlated with phosphorus and calcium content. Likewise, shell diameter was negatively correlated with calcium content, and less clearly with phosphorus content. Calcium and phosphorus content in shells decreased with the snail's age, which was observed in *Helix pomatia* aged 1+–3+. Shells of both wild-living *H. aspersa* and *H. pomatia* in respective age classes contained more calcium and phosphorus than shells of farmed snails. Among the farmed snails, the lowest mechanical resistance was displayed by snails matured in laboratory, the highest – by those from the glasshouse where the temperature and light intensity were high and air humidity low. The decrease in calcium content with shell growth is probably associated with increasing thickness and development of crystalline structures which, reinforcing the shell structure, contain in their crystal lattice proportionately less calcium, compared to amorphous carbonates.

SHELL VARIATION IN *UNIO TUMIDUS* PHILIPSSON, 1788 FROM THE WARM CANAL OF THE POWER PLANT DOLNA ODRA

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Samples of *Unio tumidus* were taken from the warm canal of the power plant Dolna Odra near Nowy Czarnów. Because the power plant uses water for cooling purposes, the temperature in the canal is higher compared to the Odra Wschodnia. Shells were collected in autumn and winter of 2003/2004. All were shells of dead specimens. The objective of the study was an analysis of metric shell characters and their interrelationships, based on *U. tumidus* (Philipsson, 1788) which lives in cooling water discharged by the power plant. Eighty seven shells were measured. The smallest specimen was 6.78 cm shell length (L), the largest – 9.68 cm. The height (H) ranged from 3.29 to 4.83 cm, width (D) – from 2.17 to 3.21 cm. The length of ligamentum (LG), was within 1.19–3.94 cm. Shell variation was analysed based on the dependence between H/L, D/H, D/L, LG/L, LG/H, LG/D, and the values were compared with literature data.

EFFECT OF ACCLIMATION ON THE ACTIVITY OF FRUCTOSE-1,6-BISPHOSPHATASE IN SELECTED TISSUES OF *POMACEA BRIDGESII* (REEVE)

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Effect of acclimation on the activity of fructose-1,6-bisphosphatase (FBPase) (EC 3.1.3.11) was studied for hepatopancreas, kidney and foot muscle of *Pomacea bridgesii* (Reeve). FBPase, in the presence of divalent ions (Mg^{+2} , Zn^{+2} , Co^{+2} , Mn^{+2}), hydrolyses fructose-1,6-bisphosphate to fructose-6-phosphate and inorganic phosphate. In vertebrates two isoenzymes of FBPase are present: liver isozyme – a regulatory enzyme of gluconeogenesis, and muscle isozyme taking part in synthesis of glycogen from lactate. Snails ($n=12$) originated from the laboratory culture of the Department of Animal Physiology. They were kept in aerated aquaria of 13 l capacity, in water of constant temperature ($28^{\circ}C \pm 1^{\circ}C$). They were fed daily with a multi-component feed Vitabin (Tropical produce). The material included mature specimens, of mean body mass 16.1 g, and shell diameter and height 3.7 and 4.0 cm, respectively. The snails were acclimated for 3 days at $28^{\circ}C$ and $15^{\circ}C \pm 0.5^{\circ}C$, monitor-



ing temperature changes with EBI-2T-312 recorder (Ebro Electronic GmbH, Germany). The tissues were removed, homogenised and centrifuged at 14,000 g at 4°C. FBPase activity was determined in the resulting supernatant, measuring the quantity of released inorganic phosphate at 25°C. As a result of proteolytic modification, FBPase changes its kinetic properties: optimum pH and sensitivity to AMP inhibition. Because of this, the activity was determined at pH 7.5 and 9.3 and the activity ratio at pH 9.3/7.5 was calculated; hepatopancreas and kidney homogenates were subject to thermal denaturation, molecular filtration, and $I_{0.5}$ value for AMP was determined for thus purified FBPase. It was found that FBPase activity in hepatopancreas of snails acclimated at a lower temperature (15°C) increased, compared to snails acclimated at 28°C. The mean activity of the enzyme for snails acclimated at 15°C was $1.01 \pm 0.04 \text{ U g}^{-1}$ tissue, at 28°C – $0.74 \pm 0.12 \text{ U g}^{-1}$ tissue. No statistically significant differences in $I_{0.5}$ value for AMP were found between the two experimental groups. The values were 3.96 ± 0.86 for snails acclimated at 15°C and 4.67 ± 1.52 for snails acclimated at 28°C. No changes in FBPase activity were observed in the kidney and foot muscle of the acclimated snails. The mean FBPase activity in the kidney of snails acclimated at 15°C and 28°C was $0.41 \pm 0.07 \text{ U g}^{-1}$ tissue and $0.37 \pm 0.09 \text{ U g}^{-1}$ tissue, respectively, and in the foot muscle $0.16 \pm 0.07 \text{ U g}^{-1}$ tissue and $0.12 \pm 0.03 \text{ U g}^{-1}$ tissue. In the kidney and foot muscle, like in hepatopancreas, no statistically significant changes were found in $I_{0.5}$ values for AMP. The values in the kidney were 3.37 ± 0.81 and 3.53 ± 0.64 , and in the foot muscle 4.46 ± 1.38 and 4.63 ± 1.07 for animals acclimated at 15°C and 28°C, respectively. In both groups the activity ratio for pH 9.3/7.5 in the hepatopancreas did not exceed 0.44, in the kidney 0.36, and in the foot muscle 0.40, which indicates that the differences in the activity of the enzyme were not caused by its proteolysis. The statistically significant increase in FBPase activity in the hepatopancreas indicates an intensified gluconeogenesis. The results are compatible with those obtained for frogs acclimated at 5°C and 25°C.

THE EFFECT OF LOW TEMPERATURE AND AUTUMN PHOTOPERIOD ON FROST RESISTANCE OF *HELIX POMATIA* L. IN SUMMER

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Mollusc body contains 90% water and is thus likely to freeze completely in winter. Considering data on strategies of adaptation to negative winter temperatures in poikilothermic vertebrates and in-

sects, it seems likely that such strategies may be used also by *Helix*. Physiological and morphological changes might suggest that molluscs, like vertebrates, actively prepare for winter since some mollusc species (*Helix aspersa*) are able to survive even when 40–60% water in their organism freezes. Also other mollusc species show seasonal changes in frost resistance, with its increase in winter. The ability to decrease freezing temperature is associated, among others, with changes in concentration of kryoprotective substances which prevent freezing. Based on preliminary studies we found increased content of glycerol and glucose in the haemolymph of *Helix pomatia* in winter. In order to test if the winter frost resistance is the effect of cold or a seasonal adaptation, we studied the influence of different thermal conditions and photoperiod on the content of kryoprotective substances in the haemolymph of *H. pomatia* in summer. Two groups of individuals were acclimated in a thermal chamber at 5°C, with photoperiods of 16L:8D and 8L:16D during three weeks. Half of the specimens were subject to biochemical examination, the remaining ones were transferred to a chamber of 0°C and constant darkness. After two weeks the content of kryoprotective substances was examined again. To check the ability to survive sudden changes of temperature, half of the individuals from the control group (caught in the field) were transferred to a chamber of 0°C, and after two weeks examined biochemically. Three-week acclimation of snails at 5°C in short day conditions caused a significant increase in glycerol content in their haemolymph, compared to the control group, but there was no change in glucose concentration. Acclimation in long day conditions caused no changes in the concentration of either substance. Glycerol concentration in the haemolymph in snails acclimated at 5°C (8L:16D) in summer was nearly three times higher than in autumn, but it did not differ significantly from the concentration in snails examined in the middle of winter. Glucose concentration did not differ significantly between the groups. Exposure to the temperature of 0°C caused no changes in glycerol and glucose concentration in snails caught in the field, or in snails earlier acclimated to cold in short day conditions. Earlier effect of decreased temperature (5°C) and long day caused a decrease in glucose concentration at 0°C. The results suggest that glycerol concentration in the haemolymph of *H. pomatia* is correlated with season, since development of response to cold in summer depends on the photoperiod which is characteristic of autumn. Besides, contrary to hibernating frogs, snails do not use glucose for protection against frost.



ACTIVITY OF PYRUVATE KINASE IN HIBERNATING *HELIX POMATIA* L.

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Pyruvate kinase (PK, EC 2.7.1.40) is a key enzyme of glycolysis. Changes in its activity may indicate changes in carbohydrate metabolism in various physiological states in animals. Unpurified enzyme preparations were obtained with standard methods of homogenisation and centrifugation of extracts from foot muscle and hepatopancreas of *Helix pomatia* L. which had hibernated for a varied period of time. PK activity was measured with standard spectrophotometric method, based on measurements of changes in NADH concentration in lactate dehydrogenase-catalysed reaction coupled with PK-catalysed reaction. PK activity in organs of hibernating snails was compared to that activity in organs of active snails caught in the field and kept in the laboratory for a short time. It was found that: 1. PK activity in the foot muscle exceeds such activity in the hepatopancreas; 2. during hibernation PK activity increases in both organs; 3. after hibernation ceases, PK activity in the muscles quickly returns to its control level, while in the hepatopancreas the process is much slower. In starving snails, like in hibernating snails, PK activity increases in the muscles and hepatopancreas. This indicates a possibility of increase in utilisation of carbohydrate reserves during hibernation.

SELECTED BIVALVE SPECIES OF THE ESTUARY SECTION OF THE SŁUPIA AND ŁUPAWA RIVERS

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Mouths of the rivers Słupia and Łupawa are proper estuaries. They are characterised by considerable changes in water salinity which puts high demands on

organisms and implies a strong selection. Only extremely euryhaline species which, besides, are capable of resisting strong and variable water currents, can exist in these conditions. The substratum in the estuaries is fine grey sand enriched with bottom deposits brought by the rivers. This is another adversity from the viewpoint of the organisms. The area adjoins a piece of land which is little used agriculturally and rather sparsely populated. As a result, the anthropogenic effect on marine habitats is rather slight. At the Łupawa mouth also the presence of the Słowiński National Park limits the negative anthropogenic influence. The studies were carried out in a 3-mile coastal zone of the Baltic, in the regions of estuaries of the Słupia and Łupawa in 1999–2002. Sampling sites were distributed along two profiles for each river, perpendicular to the shore line, located 1 mile west and east of the mouth of the Słupia and Łupawa. The material was collected with Van Veen grab of 0.1 m² area.

HABITAT EFFECT ON THE FREQUENCY OF MORPHS IN *CEPAEA NEMORALIS*

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Cepaea nemoralis displays a distinct shell polymorphism which involves both ground-colour (yellow, pink or brown) and banding (from 0 to 5 bands in various combinations). Since the colour and banding affect the quantity of solar energy absorbed by the snail, it is assumed that they have a selection value. The dependence between various habitat components and the frequency of morphs was studied mainly in western Europe where the climatic conditions for the species are optimum. This study was carried out in south-eastern Poland, where the climate is probably one of the factors limiting further eastward expansion of the snail. The sites of *C. nemoralis* were divided into sunny and shaded. The frequency of yellow shells in sunny sites was 79%, in shaded sites – 53%; in sunny sites pink shells constituted only 21%, in shaded sites – 47%. The polymorphism index in

Table 1. Occurrence of molluscs in the estuary regions of Słupia and Łupawa: – unstudied sections, + single individuals, ++ high density

Species	Słupia estuary										Łupawa estuary									
	0.25		0.5		1		2		3		0.25		0.5		1		2		3	
	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E
<i>Mytilus edulis</i>	0	0	0	0	0	0	0	0	0	0	0	0	+	0	+	+	0	0	0	0
<i>Cardium glaucum</i>	-	-	+	0	0	+	++	+	+	++	0	0	0	+	0	0	++	++	+	++
<i>Mya arenaria</i>	-	-	+	+	0	++	0	+	0	+	0	0	0	0	0	0	0	0	0	0
<i>Macoma balthica</i>	-	-	+	0	+	+	++	+	-	++	0	0	0	0	0	0	+	0	++	0



sunny sites was significantly lower compared to shaded sites, which indicates that the selection pressure may eliminate some morphs in extreme climatic conditions. The analysis of literature data suggests that the north-to-south increase in the frequency of yellow shells, observed in Europe, involves both open and shaded localities, but in any region yellow shells are more frequent in open than in shaded sites. It seems important to consider this fact in geographical analyses of variation of *C. nemoralis*.

AGE-RELATED CHANGES IN MORPHOMETRIC CORRELATIONS OF *UNIO PICTORUM* INFECTED AND UNINFECTED WITH *ASPIDOGASTER CONCHICOLA*

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Unio pictorum is a host of *Aspidogaster conchicola*. The objective of our studies was explaining the effect of this parasite on morphometric correlations in various age classes of *U. pictorum*. Eighty seven specimens were collected in November 2003 in the Hnylopjat' river (Zhytomir district). Body mass, mass of soft parts, mass of kidney and hepatopancreas were determined with laboratory balance. The heart was dried with paper and weighed with torsion balance. Parasites were found in the pericardium and kidney of the bivalves. Morphometric correlations indicating functional changes induced by parasite invasion were used to estimate the effect of *A. conchicola* on internal organs of the bivalves. Correlation between the mass of heart, kidney and hepatopancreas with the total body mass (S_1 , N_1 , W_1) and the mass of soft parts (S_2 , N_2 , W_2) was calculated. The age of molluscs was determined based on shell increment combined with the number of lines on the anterior muscle field. Correlations were analysed with variance analysis. As a result of parasite invasion, in *U. pictorum* the proportion of heart mass increases, e.g. in animals aged five years S_1 increases to 38.5%, six years – to 24.1%, seven years – to 26.9%. S_2 increases to 28.5–44.5%. Similar changes involve kidney; N_1 increased to 16.6–24.8%, N_2 – to 21.4–40.8%. Invasion of *A. conchicola* caused increase in the proportion of kidney (N_1) in molluscs aged five, compared to those aged six ($p=95.8\%$). No changes were observed for the hepatopancreas. The results confirm that bivalves attacked by parasites compensate for the negative effect of invasion with increased metabolism rate, which leads to increased relative mass of heart and kidney in all age classes.

ANATOMICAL STUDIES ON LITHOGLYPHIDAE OF UKRAINE

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Till now details of penis structure in Lithoglyphidae from Ukrainian rivers have not been sufficiently studied. It is the first time that some morphological characters of the penis can be used to solve taxonomic problems within the group. Penis structure was examined in four taxa from Ukrainian rivers: *L. apertus*, *L. pyramidatus*, *L. naticoides* with subspecies *L. n. naticoides* and *L. n. berolinensis* (according to STAROBOGATOV's system). Length/width and width/length ratios of the penis were calculated. Statistical analysis demonstrated that the ratios are suitable for distinguishing between *L. n. berolinensis* on the one hand and *L. apertus* and *L. pyramidatus* on the other. Discriminant analysis of morphological correlations of the penis indicates a possibility of applying such characters for unequivocal identification of *L. apertus*. Hierarchical cluster analysis revealed a certain similarity between *L. apertus* and *L. pyramidatus*, *L. n. berolinensis* and *L. n. naticoides*. It was possible to confirm the species status of *L. apertus*, *L. n. naticoides* and *L. n. berolinensis* do not differ sufficiently and should be regarded as conspecific (*L. naticoides*). The analysed penis characters do not allow determination of the taxonomic status of *L. pyramidatus*.

OCCURRENCE OF SPHAERIID BIVALVES IN VARIOUS TYPES OF FRESHWATER HABITATS

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Quantitative studies included 18 lakes in the forests Bory Tucholskie, and 10 springs, 12 river sections and 9 oxbows located in Central Poland. In lake littoral the most common species was *Pisidium henslowianum* (frequency 64.4%), followed by *P. casertanum* and *P. nitidum* (44.4% each), *P. subtruncatum* (31.0%), *P. amnicum* (28.9%), *P. supinum* (26.7%), *P. crassum* (24.4%), *P. lilljeborgii* and *P. moitessierianum* (22.2% each). The habitat harboured a total of 15 species and one variety of sphaeriids. The density of individual species varied from 10 to 430 indiv. m^{-2} . In reocrene springs the most common and the most abundant species was *P. personatum* (frequency 46.7 %, density up to 2,700 indiv. m^{-2}), while in a holocene spring *P. subtruncatum* dominated (density 2,220 indiv. m^{-2}). The remaining sphaeriids found in springs (5 species) showed much lower frequency and density. Thirteen sphaeriid species and one variety were found in the rivers. The most common were *P. subtruncatum*

(33.3% samples), *P. supinum* (31.3%) and *P. casertanum* (24.3%). In small rivers abundant populations of *P. personatum* (up to 4,350 indiv. m⁻²) and *P. subtruncatum* (1,130 indiv. m⁻²) were observed, while in large rivers the most abundant sphaeriid was *P. supinum* (1,390 indiv. m⁻²). The oxbow fauna included 12 species, the most common being *P. subtruncatum* (23.2%), *Sphaerium corneum* (22.0%) and *P. nitidum* (13.7%). Rather high densities, sporadically exceeding 1,000 indiv. m⁻², were reached by *P. henslowanum*, *P. subtruncatum* and *S. corneum*. Comparative analysis of all the samples collected (containing Sphaeriidae and empty) showed that the actual density of the bivalves in stagnant water bodies and rivers was much lower than that found in places of their occurrence. The highest mean densities (1,000 indiv. m⁻² and higher) were characteristic of small rivers and springs. In large rivers they ranged from 200 to 600 indiv. m⁻², in lake littoral they were usually below 200 indiv. m⁻². Oxbows created the least favourable conditions for the existence of abundant sphaeriid populations which was associated with oxygen deficits in the deposits and deeper layers of water.

SNAILS OF THE GENUS *HYDROBIA* IN THE POLISH COASTAL ZONE OF THE BALTIC (CENTRAL BALTIC COAST)

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Populations of snails of the genus *Hydrobia* were studied qualitatively and quantitatively in 1996–2000 in a 3-mile coastal zone of the Baltic in the region of estuaries of the rivers Wieprza, Słupia, Łupawa and Łeba. Samples were taken with Van Veen grab (0.1 m²), from transverse profiles located 1 mile E and W from the estuaries, each profile 3 miles long. Snails were collected from a total of 32 localities. Hydrobiids were represented by *Hydrobia ulvae* Pennant and *H. ventrosa* Montagu. In the studied 3-mile zone the frequency of hydrobiids was varied and amounted to: in the region of Słupia mouth 50%, Łeba 29%, Łupawa 12% and Wieprza 10%. The mean density and wet mass of hydrobioids were: in the region of Łeba mouth – 50.5 indiv. m⁻² (0–404 indiv. m⁻²), 1.27 g wet mass m⁻²; Słupia – 45.1 indiv. m⁻² (0–360 indiv. m⁻²), 1.19 g wet mass m⁻²; Wieprza – 6.4 indiv. m⁻² (0–64 indiv. m⁻²), 0.24 g wet mass m⁻²; Łupawa – 3.2 indiv. m⁻² (0–26 indiv. m⁻²), 0.13 g wet mass m⁻². Analysis of hydrobiid distribution in the studied area indicates that the snails were the most numerous at depths of 16–20 m. Hydrobiids in the studied zone reached small wet mass (max. 8.1 g wet mass m⁻²) and did not provide a rich food base for benthophagous fishes.

DISTRIBUTION OF THE BENTHIC AND PERIPHYTIC PARTS OF *DREISSENA* POPULATIONS IN THE COOLING POND OF THE CHERNOBYL NUCLEAR POWER PLANT

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The Cooling Pond of ChNPP was created by a construction of surrounding dam on the floodplain of the Pripyat River. The pond is elongated in shape and about 11 km long, in its middle part a rock embankment (training wall) was built along the reservoir to guide water from the discharge to the intake channel around all the area (ca. 18.5 km). After the 1986 accident the thermal load decreased considerably. When the NPP closed down (December 2000), the thermal regime in the reservoir became similar to that in natural water bodies of the same climatic zone. The differences in environmental conditions became minimal for hydrobionts in all the reservoir. Before the 1986 accident only one species of *Dreissena* was present in the reservoir – *D. polymorpha* Pallas. Its colonies concentrated in the little warmed part of the reservoir (cool part, C). The second species of *Dreissena* (*D. bugensis* Andr.) was observed in 1990. Zoobenthos research was carried out in summer 2002 in 19 sites at depths of 3, 5 and 10 m. The mean density at the depth of 3 m for *D. bugensis* was 2,185±1,142 indiv. m⁻², and for *D. polymorpha* – 59±44 indiv. m⁻². The biomass was 1,878.5±910.0 and 0.17±0.07 g m⁻², respectively. At the depth of 5 m the density of *D. bugensis* was 2,257±1,393 indiv. m⁻², the biomass – 1,085.7±705.1 g m⁻², the respective values for *D. polymorpha* were 219±178 indiv. m⁻² and 33.5±33.0 g m⁻². At the depth of 10 m *Dreissena* was not found. Most *Dreissena* in the benthos of the reservoir concentrated at depths of 3–5 m. Along the gradient from the former zone of intake channel to the former warm zone at the depth of 3 m the density of *D. bugensis* decreased from 2,000 to 44 indiv. m⁻², while at the depth of 5 m it increased from 5,900 to 9,000 indiv. m⁻². The mean weight of specimens of *D. bugensis* was about 1,000 mg and decreased toward the former warm zone. The mass of *D. polymorpha* was very low, ca. 2 mg, and only in the former warm zone it was about 180 mg. On the periphyton-covered stones of the training wall at the depth of 0.5 m *Dreissena* was more abundant than in the benthos. The highest density of *D. bugensis* was 25,600 indiv. m⁻², and for the other species it exceeded 4,000 indiv. m⁻². The biomass decreased from the former cold part (6,028.2–10,283.0 g m⁻²) to the former warm part (2,039.0–4,414.0 g m⁻²). The data indicate that the competitive interactions between the two species of *Dreissena* resulted in a more successful development of *D. bugensis*. The distribution of *Dreissena* in the reservoir 1.5 year after the Nuclear



Power Plant closed down and the thermal influence discontinued, was heterogeneous, which is characteristic of dam reservoirs with a thermal gradient. This work was supported by INTAS, project 01Poll-0556 RESPOND.

HOW TO CHOOSE A PROPER BIVALVE FOR REPRODUCTION – A STORY ABOUT BITTERLING (*RHODEUS SERICEUS*) AND UNIONIDS, WITH *ANODONTA WOODIANA* IN THE BACKGROUND

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Choosing a proper place for oviposition is essential for survival and development of the progeny. The bitterling is the only European fish utilizing unionid bivalves as egg-laying site. Fertilisation and early ontogeny take place in the mantle cavity of the bivalve, and the bitterling shows an array of adaptations to this mode of reproduction. Though due to the specific reproductive mode the fish avoids the cost of parental care and significantly decreases the risk of death of its progeny as a result of predation, bitterling embryos are exposed to oxygen deficits, density-dependent mortality and risk being removed by the host. Thus, maximizing the reproductive success depends on the proper choice of the bivalve. Since the choice should not be random, just before spawning the fish inspects the bivalves and assesses their quality. The criteria seem to be e.g. oxygen content in expelled water, chemical compounds (aminoacids) indicating the presence of glochidia, or the general condition of the bivalve. Earlier contacts with the fish may also be of significance. Reproductive preferences of the bitterling to five unionids were studied: *Anodonta woodiana*, *A. cygnea*, *A. anatina*, *Unio pictorum* and *U. tumidus*. All the bivalves came from water bodies where no bitterling was found, i.e. native species from the Sulejowski Reservoir and *A. woodiana* from Lake Licheńskie. The bivalves were caught in the first days of April i.e. before the bitterling spawning season. The bivalves were kept in aquaria, and on May 23rd all were individually marked and placed in 19 points in the littoral of Lake Kociołek (23rd km of the Warta-Gopło canal) at depths of 45–70 cm. After 14 days the bivalves were collected and dissected in order to assess the number of bitterling eggs and embryos. The number of eggs and embryos varied between species (Kruskal-Wallis test $H_{4,87}=65.9$; $p<0.001$), and no specimens of *A.*

woodiana contained bitterling. Embryos were the most numerous in *U. pictorum* while the remaining species did not differ significantly from one another ($H_{3,69}=34.05$; $p<0.001$; Tukey post hoc test: $\underline{U_p} \neq \underline{U_t} = \underline{A_c} = \underline{A_a}$). However laboratory observations on bitterling spawning (Brno) confirm that individuals of *A. woodiana* may be used for egg-laying. Individuals of that species were visited by both male and female bitterling, though less often than individuals of *A. anatina* (dependent test $t_{10}=3.98$; $p=0.003$ for males and $t_{10}=2.49$; $p=0.032$ for females). The frequency of inspection of *A. woodiana* did not differ significantly from that of *A. cygnea* ($t_{10}=1.54$; $p=0.155$ for females and $t_{10}=0.57$; $p=0.581$ for males). However, *A. woodiana* removed the eggs immediately i.e. in less than 2 seconds. No egg removal was observed in the two native unionids. Choice of the proper bivalve was also tested from the viewpoint of the bivalve quality expressed as the percentage of consumed oxygen (difference in O_2 concentration in the water near the inhalant and exhalant siphon). Mean values (and their standard deviation) of O_2 consumption were $A_c=21.5\pm 4.42\%$; $A_a=14.5\pm 4.13\%$; $A_w= 4.4\pm 0.85\%$. Though the three species differed in their O_2 consumption (ANOVA I: $F_{2,41}=13.3$; $p<0.001$; Tukey test: $A_c \neq A_a \neq A_w$) the choice of bivalve by the bitterling did not differ from random selection ($\chi^2=0.29$; $p=0.593$). The results confirm that, like in earlier studies, the choice of the bivalve by the fish is not random. The choice of the exotic bivalve species may be dictated by its low oxygen consumption, but the reproductive success of the fish depends on the bivalve defensive mechanism i.e. capability of removing the eggs. Removal of bitterling eggs may result from a general mechanism of expelling glochidia by the bivalve. It should be considered that *A. woodiana* co-occurs with Asian species of bitterling for a much longer time, compared to the coexistence of the European bitterling and native unionids. The situation could lead to evolution of a specific defensive behaviour. In the previous studies on the coevolution of bitterlings and bivalves no evidence for bivalve adaptation was found. Thus, asymmetry in the bivalve-fish interaction seems to result from the absence of clear incubation costs for the bivalve.

MALACOFAUNA OF FLOOD DEPOSITS IN THE SZRENIAWA VALLEY BETWEEN WOLBROM AND MIECHÓW

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Thanatocoenoses with numerous mollusc shells accumulate during floods on shores of rivers and streams. The material is sorted depending on its size

and weight. In the 2003 flood a rich organic material abounding with shells was accumulated in the Szreniawa valley between Wolbrom and Miechów. The Szreniawa catchment area is about 706.1 km², the river is 79.8 km long. The material was analysed with standard methods of malacological analysis. The mollusc fauna included 39 species represented by 9,844 specimens. The assemblage was composed of species characteristic of different habitats. The following species reached the highest values of frequency and dominance: *Cochlicopa lubrica* (C-D=5-5), *Vallonia pulchella* and *Trichia villosula* (C-D=5-4). With another three species: *Zonitoides nitidus*, *Pupilla muscorum* and *Arianta arbustorum* (C-D=5-3), they constituted 75% all collection. It is a polymictic association, characterised by high values of diversity index (TDA=0.6454–0.7980). The differentiation is moderate and expressed as ADI=0.43. The malacolospectrum MSI indicates that 74% taxa correspond to mesophilic fauna, preferring habitats of different humidity: *Cochlicopa lubrica*, *Trichia villosula*, *Carychium tridentatum*, *Laciniaria plicata* and open country fauna: *Vallonia pulchella*, *V. costata*, *Pupilla muscorum*. The remaining part is composed of higrophilous species (11%), shade-loving species (10%) and aquatic molluscs (5%). The constancy of occurrence of species in the thanatocoenosis is considerable (Ci=0.64), but only few reach high abundance (Di=0.10). The thanatocoenosis reflects the character of the environment surrounding the valley. The accumulated shell material originates mainly from malacoenoses inhabiting meadows, pastures and fields which form a wide belt along the Szreniawa bed. The high proportion of mesophilic and open-country species is typical of lowland rivers with wide valleys. Thanatocoenoses forming in such valleys are impoverished in snails living on slopes but enriched with species of the floodplain and river terraces. They include first of all snails of open and mesic habitats, as well as higrophilous species and molluscs of temporary water bodies. The work was supported by grant no. 10.10.140.034, Faculty of Geology, Geophysics and Environment Protection, Academy of Mining and Metallurgy.

NUMBER OF CHROMOSOMES IN *STAGNICOLA OCCULTA* (JACKIEWICZ, 1959)

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The number of chromosomes is applied in lymnaeid classification (Basommatophora: Lymnaeidae).

It was a basis for separating the genera *Austropeplea* Cotton, 1942 (n=16) and *Radix* Montfort, 1810 (n=17) from the remaining ones with n=18. Since the number of chromosomes in *Stagnicola occulta* (Jackiewicz, 1959) had not been studied before, we compared the number of chromosomes in some lymnaeids occurring in Poland. Metaphase chromosomes were isolated with standard cytogenetic methods for quickly dividing cells, from three sources: embryos developing in cocoons, gonads of adult individuals and long-term tissue cultures. The slides were stained with Giemza reagent or fluorescent stains (DAPI) and analysed in fluorescence microscope Axiophot or confocal LSM510/Axiovert 200n. In the slides from *Stagnicola palustris* (O.F. Müll.), *S. turricula* (Held), *Lymnaea corvus* (Gmel.) and *L. stagnalis* (L.) the observed number of chromosomes was 2n=36 or n=18. In the slides from embryos or tissue culture of *S. occulta* (Jack.) the number was 28, and in the gonad slides – 28 or 14. The chromosome number n=14 for *S. occulta* (Jack.) departs from that found in all other lymnaeids. It suggests that including this species, with three N American lymnaeids (*S. emarginata* Say, *S. elodes* Say, *S. catascopium* Say – all n=18), in the newly established genus *Catascopia* Meier-Brook et Bargues, 2002, based on molecular characters (ITS-2 sequence in rDNA gene), was ungrounded.

AQUATIC SNAILS OF THE NATURE RESERVE ŚWIDWIE

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The nature reserve Świdwie is unique in Western Pomerania, as the only one on the list of Ramsar Convention. Invertebrate fauna of Lake Świdwie, which is a part of the reserve, is practically unknown. The existing data are fragmentary and pertain to dragonflies and butterflies. The malacofauna of the lake was completely unknown. In 2002–2003 we started a study of the qualitative composition of aquatic molluscs of the lake and the neighbouring small water bodies. Fourteen species of aquatic snails were found in the lake: *Viviparus viviparus*, *V. contectus*, *Valvata piscinalis*, *Bithynia tentaculata*, *Lymnaea stagnalis*, *L. peregra*, *L. turricula*, *Planorbis planorbis*, *Anisus spirorbis*, *A. vortex*, *A. contortus*, *Gyraulus albus*, *Segmentina nitida*, *Planorbarius corneus*, *Acroloxus lacustris*. Further work will make it possible to verify the preliminary data and provide a more complete information on the malacofauna of the nature reserve.

SHELL VARIATION IN *DREISSENA POLYMORPHA* PALL. FROM THE HEATED KONIN LAKESO. SINICYNA¹, A. KRASZEWSKI², B. ZDANOWSKI², A. SZALAJEVA¹¹Institute of Hydrobiology NAS of Ukraine,²Instytut Rybactwa Śródlądowego w Olsztynie

Variation in bivalve shell shape, thickness and colour depends on the habitat. The studies were aimed at assessing the diversity of shell morphology of the zebra mussel in the system of Konin lakes. Individual parts of the system differ in their thermal conditions and retention. *Dreissena polymorpha* was collected in 2000–2003, mainly in summer, from 30 sites. Shell length (L), height (H) and width (W) were measured in nearly 6,000 specimens. The mussels were divided in two groups: juvenile (0.25–4 mm) and adult (above 4 mm). L/H and L/W ratios were calculated. The following combinations of the shell height and width were distinguished: hw – rather low and flat; hHwW – moderately high and wide; HW – high and convex. Morphotypes hw, hHw, hwW and hHwW (20.0–76.8%) prevailed among adult mussels. Morphotypes hHW, HwW, Hw, hW and HW were rare and found only in some of the sites. Their proportion among adult mussels ranged from 0.4 to 7.0%, among juveniles – from 4.6 to 44.3%. The highest shell diversity (7–8 morphotypes, Shannon index 1.97 ± 0.12) was found in populations inhabiting canals and discharge zones of the initial cooling reservoir. A considerable diversity (4–5 morphotypes, Shannon index 1.83 ± 0.08) was displayed by the mussels from the lakes. A low diversity (Shannon index 1.15 ± 0.06) was characteristic of bivalves from lenitic and lotic habitats of poor flow. Here morphotype hHw (71.4%) or hw (76.7%) dominated. Six groups of sites were distinguished, where the mussels formed similar populations (Table 1). In lotic zones of high water temperature (groups 1 and 2) relatively high and flat shells prevailed. The proportion of high and flat shells was lower among mussels from less heated zones of lakes

and canals (groups 3, 4, 5, 6: 15.8–40.0%). Mussels inhabiting lakes and canals of the Konin system were less convex than those from unheated habitats.

OCCURRENCE OF SNAILS AND HABITAT CONDITIONS IN THE NATURE RESERVE ŁĘŻCZAK

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The nature reserve Łęczszak is a forest-pond reserve of 407.22 ha. It was established in 1957 to preserve, for scientific, natural and landscape reasons, an area of a forest of 123 ha with its ponds, an Odra oxbow with a site of *Trapa natans*, as well as trees, many of which are monuments of nature. The studies focused on qualitative and quantitative diversity of gastropods of the fish ponds within the nature reserve, as well as comparison of the fish pond malacocoenoses of the protected and unprotected areas. The studies included five of the eight ponds within the nature reserve. Samples were taken from seven sites. Seventeen gastropod species were found. Three to 16 species occurred in particular ponds. There was a mass occurrence of *Bathyomphalus contortus*, *Anisus vortex*, *Planorbis planorbis* and *Segmentina nitida*. All of them are macrophyte-dwellers, of modest food requirements and resistant to water level fluctuations, or even temporary drought. Among the analysed physico-chemical parameters only Mg^{2+} concentration affected the qualitative and quantitative diversity of gastropods. In ponds of lower Mg^{2+} content 12–16 species were found, with Mg^{2+} content increasing to 135 mg dm^{-3} , a decrease in the number of species and their density were observed. The fish ponds in the protected area are characterised by a higher gastropod diversity compared to the areas under direct anthropopressure. With respect to Gastropoda the fish ponds, even protected, do not provide a refuge for species that are rare in the country or even region.

Table 1. Morphotypes of the zebra mussel from the Konin system; sites located outside the system indicated with an asterisk

Group of sites	Dominant morphotypes				Shannon index
	hw	hHw	hwW	hHwW	
1	10.6±2.2	48.1±5.9	4.3±1.8	32.6±4.7	1.81±0.17
2	29.4±7.2	58.5±9.9	4.2±3.7	6.7±2.1	1.39±0.25
3	58.4±9.6	28.3±8.9	5.8±3.8	7.0±3.9	1.44±0.21
4	35.0±1.6	15.8±2.5	32.4±4.3	14.3±2.6	2.02±0.09
5	41.2±3.6	39.9±7.5	6.6±4.8	11.1±3.8	1.66±0.21
6	22.3±8.1	28.8±2.5	11.9±2.6	34.0±8.1	2.11±0.04
7*	13.4	1.5	55.2	25.4	1.69

ECOLOGY OF FRESHWATER MOLLUSCS OF NE POLAND – THE SCOPE OF RESEARCH

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Fifty years of studies on the ecology of molluscs by a team initially associated with the the forming department, then with the PAS Institute of Ecology, and later with the Podlasie Academy in Siedlce, can be divided in three periods. The first period (1954–1970) was mainly devoted to population studies on selected spe-

cies (*Viviparus viviparus*, *V. malleatus*, *Dreissena polymorpha*, unionids) and preliminary analyses of the malacofauna. The studies were carried out in the Vistula shoal Konfederatka near Wyszogród, in several dozen of Mazurian lakes and in Canadian water bodies near Montreal. In the second period (1971–1985) the malacofauna studies were parts of extensive state and ministry programmes, with participation of the Institute of Ecology, PAS, and other scientific centres, such as the Inland Fishery Institute in Olsztyn, Warsaw University, Agricultural University. Our malacological studies formed a part of a wide range of hydrobiological and ecological projects, often associated with practical applications. The following projects should be mentioned: study of 42 lakes of north-western Poland, of varied trophy (the so called gradient lakes); studies on the lakes of the Jorka River basin; research on the ecosystem of Lake Żarnowieckie, in connection with the planned construction of atomic power plant; on the Zegrzyński Reservoir – the source of drinking water for Warsaw. At the same time there was an array of experimental projects; the results made it possible to make global calculations and estimates of the role of molluscs in aquatic ecosystems. They included studies on filtration activity of *D. polymorpha* and unionids, feeding of *V. malleatus*, faeces production by snails, settling and mortality of early development stages of *D. polymorpha*, and growth of *D. polymorpha*. In the third period (1986–2004) our activity was multidirectional and involved cooperation with many scientific centres. One of the main problems was changes of malacofauna through time, especially long-term changes, even after several dozen years, in the Mazurian lakes and Zegrzyński Reservoir. Another project dealt with spatial variation of mollusc distribution in various ecosystems and their groups: in the lake-river system of the Krutynia River and in lake-river ecotones, in lakes (Inulec, Warniak, Wigry), dam reservoirs, Bug River floodplain water bodies, small rivers of the South Podlasie Lowland. At that time we studied interactions between various organisms: trophic relations birds – molluscs, fishes – *D. polymorpha*, covering of unionids by *D. polymorpha*, as well as accumulation and cycling of elements, especially heavy metals and nutrients, through malacocoenoses. The obtained data on the ecology of *D. polymorpha* made it possible to determine selected components of life strategy of the species in various ecological situations.

SINK-HOLE PONDS AS A HABITAT FOR FRESHWATER SNAILS

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Among anthropogenic water bodies, sink-hole ponds are characterised by specific physico-chemical

properties of water. They usually exhibit a high total hardness, considerable content of Mg^{2+} , Cl^- and nitrogen and phosphorus compounds. The structure of their malacocoenoses is influenced by the permanence of the pond, its location, age, physico-chemical character of water and bottom deposits. In areas devoid of natural aquatic habitats, they are of both landscape and ecological value: they often provide the only refuges for aquatic organisms which affects the level of biodiversity and its preservation in extremely human-devastated areas. The knowledge of the fauna of sink-hole ponds makes it possible to draw conclusions about the scale and intensity of transformations of water balance in industrial areas, and to plan a proper environment management. The studies in 98 ponds revealed the presence of 28 snail species, the most common and abundant being: *Lymnaea stagnalis*, *Radix peregra*, *Gyraulus albus* and *Planorbis cornutus*. It is noteworthy that introduced species: *Potamopyrgus antipodarum*, *Ferrissia clessiniana*, *Physella acuta*, appear in an increasing number of sink-holes. *Potamopyrgus antipodarum* causes a quantitative decrease in native species in invaded habitats and then, sometimes, their complete disappearance. The presence of *Physella acuta* and *Ferrissia clessiniana* does not affect the diversity of native gastropods.

MALACOFAUNA OF A CITY PARK – CHANGES THROUGH 40 YEARS

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In urban areas species of natural habitats become eliminated and invasion of alien species is observed. Since the changes are fairly rapid, monitoring of city faunas is necessary. The malacofauna of Łódź has not been examined as a whole, but in the 1950s and 1970s selected parks of the city were studied, the „Na Zdrowiu” park being the most intensely investigated (PIECHOCKI 1963: Mięczaki Parku Ludowego w Łodzi; PIECHOCKI & POTOCKI 1976: Nowe stanowisko *Physa acuta*...). At that time the studies included the nature reserve Polesie Konstantynowskie, located in the park and aimed at protection of the remains of the former Łódź forest (fragments of alder carr, ash-alder riverine forest and oak-hornbeam forest), and the managed park areas, as well as water bodies. Thirty three terrestrial gastropod species were found, as well as 13 species of aquatic snails and 3 bivalve species. In 2002–2003 the fauna of the „Na Zdrowiu” park was re-inventoried: 41 species of terrestrial gastropods, 12 aquatic snails and 3 bivalves were found. In the terrestrial fauna most earlier-recorded species were still present. The abundant population of rare *Oxychilus alliarius* still exists in the nature reserve. *Balea biplicata*



is also numerous; its localities in Central Poland are scattered. Among species recorded in the 1950s, some forest gastropods were not re-found: *Discus ruderatus*, *Ruthenica filograna* and *Malacolimax tenellus*. Stenoecious species are negatively affected by intense penetration by humans, which is unavoidable because of the location and function of the area. Of species not recorded earlier, the following were found: *Helix pomatia*, *Cepaea nemoralis*, *Arianta arbustorum*, *Oxychilus draparnaudi*, *Limax maximus* and *Arion rufus*. These large gastropods were probably brought with soil and ornamental plants or introduced on purpose – like *Arion rufus*, introduced in the 1960s and now very abundant. Considerable changes were observed in the composition of the malacofauna of the park ponds. In the present study the following species were found for the first time: *Viviparus contectus*, *Potamopyrgus antipodarum*, *Hippeutis complanatus* and *Anodonta cygnea*. The ponds harbour an abundant population of *Musculium lacustre*, but several species, previously abundant, were not found, including *Physa acuta*. The changes in the aquatic fauna of the „Na Zdrowiu” park could be enhanced by emptying of the reservoirs, cleaning their bottom and changes in the water supply to the ponds. New species were introduced during stocking with fish, transported by birds or released by aquarists.

“HYDROBIOIDEA” OF GREECE – AN UNKNOWN MALACOFAUNA GOING EXTINCT

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Small snails formerly included in the superfamily Hydrobioidea have been studied in Greece for a century and a half. However, the sites studied were mainly those located near known and commonly visited historical places, holiday resorts and, to a lesser extent, along the main roads. Most of the area of Greece has remained almost completely unexplored. Species reported from sites which were studied were often misidentified, and the preserved voucher materials are dry shells which do not allow for checking the taxonomic identity. Besides, at present it is known that even morphology and anatomy of the soft parts are not sufficient for an adequate phylogeny reconstruction, and for determining the taxonomic status of morphospecies it is often necessary to use molecular data. The progressing devastating exploitation of natural resources of Greece, including water which in this kind of climate is a limiting factor, results in a partial or complete destruction of localities, including type localities. Some springs are drying out, from others water is removed, still other sites become completely polluted, or else roads, buildings or even museums are where the springs used to be. During collecting

materials for the phylogeny of crucial genera of Balkan “Hydrobioidea” in September 2003 we found that the springs in Perama on Lake Pamvotis (type locality of two species and one subspecies) had completely disappeared, like springs in Kefalovriso; the spring in Kessariani had become polluted and destroyed; the fate of springs in Myli (ancient Lerna), near Githion, great springs in Kamena Vurla and in Vrysia (in each case type locality of some species) was similar. The great, pond-like spring in Velestino has dried completely as a result of bore-holes made in order to irrigate a cotton plantation. The devastation (pollution, decreased water table) involves also oligotrophic lakes (e.g. Trichonida which harboured, among others, four endemic fish species and several species of snails; now only one of them could be collected). Where anything has survived, it often appears not to be the taxon reported in literature. Though in Greece in many sites *Semisalsa* occurred allegedly, while no *Hydrobia* or *Ventrosia* were recorded, actually the situation is the reverse. What in the literature is referred to as *Semisalsa* or *Belgrandiella*, are two sets of genera, often exotic (e.g. *Litthabittella*, molecularly close to Assimineidae), and in many cases only careful morphological and molecular studies make it possible to conjecture about their relationships. Even what was regarded as typical *Bithynia* has nothing in common with the family Bithyniidae. „Hydrobioidea” of Greek springs should be protected, and first of all phylogenetic and phylogeographic studies should be undertaken, before this unusual fauna disappears completely.

TWO-YEAR QUANTITATIVE STUDIES ON THE GASTROPODS OF THE PARK IN RADOJEWÓ NEAR POZNAŃ

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Quantitative samples were taken in the park in Radojewo in the summer of 1997 and in 1998. In 1997, 24 gastropod species were found in the samples, in 1998 there were 26 species. In most cases species recorded in 1997 appeared also in 1998. The differences in species composition involved mostly accidental species and subprecedents, some of them were found either only in 1997, or in 1998. *Cecilioides acicula* and *Carychium minimum* are noteworthy. In 1998, though they were in the lowest frequency class (accidents), they were dominants. The situation resulted from finding, in few places (for *Cecilioides acicula* in 4 samples, for *Carychium minimum* in 6 samples) numerous specimens. With respect to abundance, in 1997 *Vitrea crystallina* dominated, and in 1998 *Cochlicopa lubricella*. Co-occurrence (Agrell's index) differed between the years: in 1997 *Vitrina pellucida*, *Vallonia*

costata, *Aegopinella pura*, *Truncatellina costulata* and *Vitrea crystallina* co-occurred, and in 1998 – *Clausilia bidentata*, *Vallonia costata*, *Nesovitrea hammonis* and *Cochlicopa lubricella*. The only species common to both periods was *Vallonia costata*. The density in 1997 was 513 indiv. m⁻², a year later it was about twice smaller 270 indiv. m⁻². The difference may result from different weather conditions in the two seasons. The highest mean density was that of *Vitrea crystallina* (4 indiv. per sample) in 1997 and *Cochlicopa lubricella* (2 indiv. per sample) in 1998. In both periods there were no superdominants, and the number of eudominants and subprecedents was the same. The greatest differences involved the number of subdominant species (1997 – 5 species, 1998 – 2 species) and recedents (1997 – 4 species, 1998 – 8 species). In 1997 species with the highest Q values and placed in the highest intervals of the association structure diagram were *Vitrea crystallina*, *Vitrina pellucida* and *Truncatellina costulata*, in 1998 – *Cochlicopa lubricella* and *Clausilia bidentata*. Species of the highest Q values in 1997 were short lived (life span 1–2 years) and early to mature. Two of the species found in 1998 are characteristic. *Clausilia bidentata*, of a mean life span between two and five years, reaches maturity when one year old. The life span of *Cochlicopa lubricella* is one to two years, and it becomes sexually mature after the first year of life. Considering the ecological classification of LOŽEK, the number of species in particular categories is very similar between the years. However, the abundance in these categories varies very much. In 1997 the abundance was much higher than in 1998 for forest and mesophilic species.

FAUNA AND ECOLOGY OF SMALL SNAILS (MOLLUSCA: PULMONATA: PLANORBINAE) OF THE LOWER REACHES OF THE DANUBE

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Small snails play a considerable role in the functioning of hydrocenoses. These fresh-water animals are eaten by fish and water birds, they also take part in the circulation of matter in water bodies. The special interest in this group of molluscs results from the fact that they are obligate intermediate hosts to a number of trematode species – parasites of various vertebrates. Species composition, biology and ecology of intermediate hosts should be studied to devise effective means of parasite control. The material was collected in May 2003, in Ukraine, in the area between Vylkovo and Kiliya, in the water bodies of the Kiliya River branch, ponds and pools in the basin of the lower Danube. The Danube malacofauna consists of 12 species, all of which represent the subfamily Planorbinae: *Planorbis planorbis* (Linnaeus, 1758), *P. carinatus* (O. F. Müller,

1774), *Anisus vortex* (Linnaeus, 1758), *A. vorticulus* (Troschel, 1834), *A. contortus* (Linnaeus, 1758), *A. spirorbis* (Linnaeus, 1758), *A. leucostoma* (Millet, 1813), *A. septemgyratus* (Rossmässler, 1835), *A. albus* (O. F. Müller, 1774), *Armiger crista* (Linnaeus, 1758), *Segmentina nitida* (O. F. Müller, 1774), and *Hippeutis fontana* (Lightfoot, 1786). The density and species composition are greatly affected by the hydrological and hydrochemical conditions of the water bodies. Planorbine populations are abundant only in those water bodies, where the current velocity does not exceed 0.1 m s⁻¹. In the littoral zone of the main river-bed of the Danube the density is low (1–3 indiv. m⁻²). In the bays and small water bodies, overgrown with macrophytes, the density of molluscs is the highest (20–31 indiv. m⁻²). Small snails were found mainly on plants (*Lemna*, *Carex*, *Potamogeton*, *Sagittaria*), bottom sediments, and allochthonous fallen leaves. They inhabited water bodies with different kinds of bottom, but were mostly found on muddy, detritus-rich substrata. All the planorbines are shallow-water hydrobionts, they most often live in water bodies which are thoroughly warmed, at a depth of 0.05–0.3 m. The water is, as a rule, clear, with pH of 7–8.5. In the water bodies of the investigated region *P. planorbis* dominated. Its frequency was 80%. The least frequent species were *A. crista* (3%) and *H. fontana* (6%).

MALACOFAUNA OF THE ESTUARY REGION OF THE ODRA RIVER

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The malacofauna of the estuary region of the Odra River, where freshwater and marine habitats interact, was studied. Material was collected in 2001, from Roztoka Odrzańska (12 sites), the Gulf of Szczecin (77 sites) and from the Świna straits (8 sites), from various substrata: bottom deposits and macrophytes (*Phragmites australis*, *Typha angustifolia* and *Nuphar*). Characteristics of deposits (granulation, proportion of mud to silt fraction, organic matter content – TOC) and basic chemical and physical parameters of water (depth, temperature, pH, salinity, oxygen content, calcium and turbidity) were determined for each site. The results of malacological studies were correlated with physico-chemical parameters of the habitat. Fifty two mollusc species were recorded from the area, including 28 species of snails and 24 of bivalves. The occurrence of molluscs varied widely depending on the site and habitat character (bottom deposits and macrophytes). In the part of the studied region with the lowest salinity – Roztoka Odrzańska – the highest number of species was found in the deposits (34 species). *Bithynia tentaculata* and *Dreissena*



polymorpha showed the highest abundance and frequency in all the region. Also bivalves of the family Sphaeriidae were abundant in the deposits, and their occurrence depended on the depth and on the character of bottom deposits.

DISTRIBUTION AND ORIGIN OF TERRESTRIAL MALACOFUNA OF POLAND

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From biogeographical viewpoint the area of Poland is an artificial formation. However, with some simplifications, it is possible to give a general characteristics of the native malacofauna. The analysis is limited to terrestrial gastropods; freshwater snails disperse in a somewhat different way. The malacofauna of Poland is young, of migratory character. During the Ice Ages the Scandinavian glacier at least twice reached so far south that no snail species had a chance to survive. All the consecutive glaciations made the malacofauna retreat to refugia or become extinct. Latitudinal orientation of the mountain ranges caused an obstacle when migrating from north to south, and also from south to north. There are no endemics with their ranges limited to Poland. The old pre-glacial fauna did not survive, and the post-glacial period (the Ice Ages ended only ca. 10,000 years ago) was too short to allow speciation. Invasions of the area after the glacier receded took place, if not exclusively, then at least mostly from south-east or west, thus avoiding the mountains. This is reflected by many of the present distribution ranges. Among the 175 species of terrestrial gastropods recorded from Poland, only 35% inhabit more or less the whole country. A slightly higher proportion (ca. 38%) have their north-western distribution borders in the southern part of Poland. Some species have their western distribution borders or only insular localities in Poland. The isolated sites are remnants of cool or warm climatic phases; not a single species has a southern border of its main distribution range in our country. Another problem is the zoogeographical composition of our malacofauna. It is not always clear where the original range of particular species was located, though the present distribution areas are known. It is obvious that in such migratory faunas widely distributed species dominate: Holarctic, Palearctic, Euro-Siberian and European. They constitute 1/4 of the malacofauna, and when Central-European species are added, the proportion will exceed half of all species. Among the remaining groups, Carpathian species (*sensu lato*) constitute 13%, Alpine and Alpine-Carpathian 19%, while none of the remaining groups (Arctic-Alpine, Boreal-Alpine, Mediterranean) exceeds 2%. A considerable proportion (7%)

is formed by introduced species. Some of them are obvious synanthropes, but some are beginning to penetrate habitats of relatively low anthropopressure. It is characteristic that 7 out of 11 such species originate from western Europe, only 2 from the Caucasus and 1 from each N America and C America.

MOLLUSCS OF SELECTED WATER BODIES AND COURSES OF VILNIUS

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Preliminary studies on the malacofauna of selected aquatic habitats of Vilnius in 2002 included the Neris River, its tributaries: Vilnia and Cedronas, and two dam reservoirs, one on the Vilnia and another on the Cedronas. Forty eight mollusc species were recorded: 28 snail and 20 bivalve species; 36 species were represented by live individuals: 19 snails and 17 bivalves. The most numerous species were found alive in the Vilnia (23). In the dam reservoir on this river 22 were found, in the Neris – 15, in the dam reservoir on the Cedronas – 8. In the Cedronas no species was represented by live individuals. Among live molluscs of the Vilnia the most abundantly represented species were: *Lithoglyphus naticoides* (28.5% collection), *Lymnaea peregra* (12.0%), *Sphaerium corneum* (9.1%), *Valvata piscinalis* (7.5%), *Pisidium henslowanum* (7.1%), *P. subtruncatum* (6.8%), *P. nitidum* (6.6%) and *Ancylus fluviatilis* (6.3%). In the dam reservoir on the Vilnia the most numerous were *Pisidium subtruncatum* (59.8%), *P. henslowanum* (16.0%) and *Valvata piscinalis* (5.7%); in the Neris: *Lymnaea peregra* (20.7%), *Theodoxus fluviatilis* (17.8%), *Valvata piscinalis* (15.6%), *V. pulchella* (12.6%), *Lymnaea stagnalis* (9.6%) and *Pisidium pseudosphaerium* (8.1%). Among molluscs collected in the reservoir on the Cedronas 93.6% was constituted by *Pisidium casertanum*.

CADMIUM CONCENTRATION IN TISSUES AND SHELLS OF *HELICELLA OBVIA* MENKE FROM THE REGION OF BUSKO ZDRÓJ (ŚWIĘTOKRZYSKIE DISTRICT) AND OSOWIEC (PODLASIE DISTRICT)

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²Gimnazjum nr 45 w Krakowie

Live snails were collected from two sites. Site I, located near Osowiec (53°28'N, 22°40'E), is a fallow land on the margin of a pine forest, with sparse pine

saplings. Its vegetation is xeric, with dominance of *Sedum acre* L., *Erigeron canadensis* L. and *Agrostis tenuis* Sibth. The site is strongly insolated and completely open. Site II, near Busko-Zdrój (50°28'N, 20°43'E), is a slope ca. 2.5 m high, ca. 5 km from the town centre, covered, among others, by *Achillea millefolium* L., *Euphorbia cyparissas* L. and *Rosa canina* L. Both sites are within areas regarded as unpolluted. Ten adult snails from each site were selected at random. Cadmium concentration was determined in the foot, alimentary tract and shell, with atomic absorption method (AAS). The mean cadmium concentration in the snails was: in site I: foot – 90 µg g⁻¹ dry weight; alimentary tract – 40 µg g⁻¹ dry weight; shell – 12 µg g⁻¹ dry weight; in site II the respective values were: 43 µg g⁻¹ dry weight, 92 µg g⁻¹ dry weight and 13 µg g⁻¹ dry weight. Statistical analysis was done with Kruskal-Wallis ANOVA and Mann Whitney U-test. The level of p<0.05 was assumed as statistically significant. Differences in cadmium concentration in the snails from Busko Zdrój were statistically significant between the foot and alimentary tract (p=0.008) and the alimentary tract and shell (p=0.00016). No such differences were found for the snails from Osowiec (p=0.67). There were significant differences between the snails from the two sites in the content of cadmium in their alimentary tract (p=0.007). The results indicate that *Helicella obvia* may be useful for monitoring pollution with heavy metals.

THE FIRST OBSERVATION OF PARASITIC ORGANISMS IN INVASIVE BIVALVE SPECIES *SINANODONTA WOODIANA* LEA (BIVALVIA: UNIONIDAE) IN THE WATER-BODIES OF EUROPE

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At present parasitological investigations of symbiotic communities of fresh-water invasive species are important for a complex assessment of global and local biodiversity changes. Efforts of parasitologists focus on search for pathogenic organisms, potentially useful as means of biological control. A significant part of these investigations has been devoted to bivalves of the genus *Dreissena*, alien for the fresh-water ecosystems of North America. Most data indicate that the species composition of symbiotic communities of alien species is considerably richer in donor than in acceptor ecosystems. Obviously, it is important to study the structure of symbiotic communities in both donor and acceptor regions. Unfortunately, no data are available on the symbiotic fauna of another alien bivalve species – *Sinanodonta woodiana* – in the donor area – fresh-water ecosystems of Eastern (Far

East) and South-Eastern Asia. Two specimens of *S. woodiana* from the Danube-Sasyk Channel were examined for parasites. A parasitic trematode *Aspidogaster conchicola* Baer was found in the bivalves. It is a typical parasite of Holarctic unionids; it is found in the pericardial cavity and kidneys. The specimens from *S. woodiana* were mature, and their oviducts contained developed eggs. Also water mites (species still not determined) and free-living oligochaets of the genus *Chaetogaster* were found in the mantle cavity of the bivalves. Native representatives of unionids (*Unio pictorum* L., *U. tumidus* Phil., *Anodonta piscinalis* Nils.) from the same site were examined for parasitic organisms. The list of parasites which are common for these species includes: 3 ciliate species of the genus *Conchophthirus* (mantle cavity), trematodes *A. conchicola* (pericardial cavity) and *Bucephalus polymorphus* Baer (gonad), free-living oligochaets and chironomids (mantle cavity). This suggests that the parasitic community of the invasive *S. woodiana* in the acceptor, European ecosystems is at the formation stage, or that the bivalve is not an appropriate host for some native species of parasites.