



THE 27TH POLISH MALACOLOGICAL SEMINAR

SEMINAR REPORT

This year the Polish Malacological Seminar, the annual meeting of Polish malacologists (often plus some neighbours) was held in Tleń, not far from the city of Toruń, from the 6th till the 8th of April. It was the 27th Seminar, so we shall be thirty soon. Tleń is a tiny little village, surrounded by forests and lakes with a few good holiday centres and a very decent hotel where we all stayed and performed all the essential activities, such as having sessions, eating, drinking, discussing etc. Though the weather was not ideal, some of us skipped some sessions (because anyway they could read the abstracts in the Abstract Book) to walk

around the lakes and see the first forest flowers of the spring.

The organising institutions were: the Mikołaj Kopernik University in Toruń and the Association of Polish Malacologists; the organising committee included ELŻBIETA ŻBIKOWSKA, ANNA NOWAKOWSKA, ANNA CICHY and JAROSŁAW KOBAK, all from Toruń. Good job! And thanks! Our sponsors included President of Toruń and two companies, one producing chemicals for nucleic acid and protein analyses (Macherey-Nagel), another – equipment and chemicals for water quality analyses (Hamilton). The com-



Fig. 1. Just before we left for the excursion. Note the malaco-bag with the red snail on it. Photo: A. SULIKOWSKA-DROZD

No.	Discipline	Number of papers/posters				
		2007	2008	2009	2010	2011
1	Ecology	20	25	18	14	19
2	Life histories	7	7	8	10	8
3	Conservation	2	4	7	4	3
4	Fossil molluscs	6	4	4	3	6
5	Applied malacology	2	5	4	8	8
6	Parasitology	3	6	4	2	3
7	Faunistics	2	4	5	9	11
8	Methodology	3	0	2	0	4
9	Physiology	1	0	1	3	7
10	Structure (histology, cytology, shell)	0	0	5	1	2
11	Variation	2	3	1	1	1
12	Systematics	2	4	3	2	1
13	Molecular genetics	3	1	3	1	1
14	Collections	0	3	1	2	2
15	Others (general, behaviour, archaeology)	3	3	5	2	2
16	History of malacology	0	0	2	1	1

panies had stalls where you could get all kinds of information about their products and even order things for your institution. Thank you, sponsors! Our thanks go also to the chair-persons: EWA STWORZEWICZ, ANDRZEJ LESICKI, JAN KOZŁOWSKI, KRZYSZTOF LEWANDOWSKI and ANDRZEJ PIECHOCKI (and I, but I find it embarrassing to thank myself, even on behalf of the participants).

The list of participants included 63 people, but a few (precisely 10) failed to arrive. These ten included OF COURSE our eastern neighbours from Zhytomyr University in Ukraine; they play the same trick every year. Needless to say, the remaining participants, that is those who actually participated, arrived and left at different hours and on different days. All these comings and goings (and not-comings in some instances)



Fig. 2. Preparing to hang a poster. Photo: author

resulted in the maximum population abundance of 53 people. This year there were no foreign guests.

Every participant was given the following items: a very nice conference bag with a funny snail and a proper inscription on it, a Toruń University mug, a pen, the programme and the Abstract Book. The Abstract Book was edited by TOMASZ KAŁUSKI, JAROSŁAW KOBAK and PATRYCJA CIELUCH and had a *Bielzia coeruleans* on the cover. Thank you, Editors!

The opening ceremony (Wednesday, 6th) was, fortunately, very brief (20 minutes only!), with a few words from the Organisers. It was directly followed by the first and second sessions and then – after lunch – by the third. Quite a lot of sessions and discussion for the first day, I can tell you! As if it were not enough, the first poster session followed all this. Nevertheless we managed to have quite a successful grill party in the evening, though we were a bit rained upon. The next day (Thursday, 7th) included sessions 4, 5 and 6, as well as poster session 2, the Association's general assembly and the banquet. All Friday was the excursion but some people had left already so we were not many. The excursion went to a nearby hydro power station where we could see how it worked (we usually only read about such things, mainly while reading about alien species of freshwater molluscs) and also admire some very ancient hydrotechnical equipment on a small exhibition. Then we went to Toruń; the old town in Toruń is very, very beautiful. The only bad thing was that it was cold and it rained from time to time.

Now to the actual contents of the Seminar – and statistics again. The programme contained 36 oral presentations and 30 posters. Not all the lectures were delivered and not all the poster presenters arrived but



Fig. 3. Poster-presenting makes one thirsty. Photo: author

the programme was full and, compared to the previous seminar, the oral presentation:poster ratio shifted slightly in favour of the posters. This seems to be the general tendency. The snail:bivalve ratio was 3.47:1 (thus much higher than 2.33:1 in 2010 and 2.35:1 in 2009, for more ratios from earlier years see Seminar Reports in *Folia Malacologica* 2006–2010), the land:water ratio was 1.54:1 (1.5:1 in 2010 and 0.94:1 in 2009), and thus almost the same as last year. The ratio of one-author presentation to presentations with two or more authors was 0.37:1 (more than twice smaller than the last year 0.85:1; it is fashionable now to form cooperatives), and the ratio of papers/posters presented by girls versus boys was 1.24:1 (1.88:1 in 2010). The recent:fossil ratio was exactly 10:1.

The table contains more statistics, with the presentations divided – for the sake of comparison – into the same categories as last year. It is always necessary to assign some presentations to more than one category. The numbers do not show any obvious trend within the last five years.



Fig. 4. Grill party on a rather cold night. Photo: author

A few topics and presentations are worth mentioning. First of all, last year we were joined by two pharmacologists who are, nevertheless, interested in molluscs; they deal with the mechanics and chemistry of snail movement. All the presentations were good or very good, but there were some (both papers and posters) we found especially delightful: the one about sexual behaviour of *Deroceras* by MICHAŁ CZYŻ with co-authors, the one about differences in reproductive strategies between populations of *Alinda biplicata* by ANNA SULIKOWSKA-DROZD with co-author, the one about behavioural defence of *Dreissena* against the roach by JAROSŁAW KOBAK with co-author, the comparative study of reproduction of three closely related species of *Pisidium* by STANISŁAW MYZYK and the one about experimental introduction of *Cepaea nemoralis* by MAŁGORZATA OŹGO with co-author and the one about the Baltic fauna by ANDRZEJ PIECHOCKI with co-author.

During the General Assembly it was decided that the next seminar would be organised by the Poznań malacologists who are many; it will probably be the village we went to in 2009.

The abstracts below include all the abstracts from the Abstract Book, even those whose authors never arrived. Most of them have been translated and some rather brutally reduced in length by the author of this report.

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ABSTRACTS OF THE 27TH POLISH MALACOLOGICAL SEMINAR

WATER BODIES OF THE FLOODPLAIN OF THE MIDDLE PILICA RIVER AS HABITATS OF *ANODONTA CYGNEA*

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Twenty water bodies of the floodplain of the middle Pilica on a 30 km section between Pratkowice and Placówka were checked for the occurrence of *Anodonta cygnea* in the summer 2010. The water bodies were located in an open, often agricultural landscape. Five of them were dried, and only the reed-covered bottom indicated their existence. Two were dead river channels, 0.5–1 km long, connected to the river. Two of the oxbows were connected to the river, the remaining ones were isolated. Few live specimens were found in a fertile and well vegetated oxbow, connected to the river, near the village of Pratkowice. Another oxbow, separated from the river by a dyke, held a unionid community composed of *Anodonta cygnea*, *Unio tumidus* and *U. pictorum*. The bivalves represented older age classes (+5, +6), and all had much corroded periostracum. Many of the Pilica oxbows are at an advanced stage of succession which does not favour *A. cygnea*. Since the studied section of the river has calm, muddy bays where *A. cygnea* could exist, the reservoir Pratkowice 3 would be worth monitoring with respect to biogenic substances, and the ditch connecting the oxbow with the river should be periodically deepened; the willow thickets near the ditch should be cut back in order to maintain the bivalve population.

LATE GLACIAL AND EARLY HOLOCENE FAUNA OF THE TUFA IN GROŃ AT PODHALE

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The region of Podhale holds many sites of calcareous tufas. Some of them started forming at the end of the last glaciation. One of them is the tufa in the village of Groń. The carbonate deposits crop out in a small right-bank tributary to the Leśnica stream. The tufa profile is 2.4 m thick. Its bottom contains slope loams with many sharp-edged rock fragments. The upper part includes calcareous tufas with a few beds of hard porous travertines. The whole profile contains mollusc shells. The mollusc assemblages are rather poor but vary in their structure and composi-

tion. In the lower part cold-loving taxa dominate, and the faunal composition is not varied. In the middle part the proportion of mesophiles increases, and shade-loving species associated with continental climate appear. The richest and most diverse malacofauna is found in the topmost layer. It is characterised by the absence of cold-loving forms and a considerable proportion of forest-dwellers. Also taxa of specific ecological requirements are well represented. The sequence indicates climatically-induced environmental changes. At first, the dominant kind of habitat was an open and rather damp tundra. Later it was replaced by shaded, forested habitats, with coniferous and then deciduous forests. The observed sequence of faunistic assemblages makes it possible to draw stratigraphic conclusions. The slope deposits underlying the tufa and the oldest carbonate deposits formed in cold climatic conditions during the Younger Dryas. The higher part of the profile is associated with the Lower and Middle Holocene. The interpretation is supported by the gradual disappearance of cold-loving forms, with the increasing abundance of shade-loving species and appearance of ecologically fastidious taxa.

REDEPOSITION OF SHELL MATERIAL AND ITS SIGNIFICANCE FOR PALAEOGEOGRAPHICAL INTERPRETATIONS

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Redeposition of material is common and associated with erosion, transport and accumulation. It can involve components of the same age but representing different sedimentation environments, components of different age and deposited at different times and environments, or it can have a mixed character, combining the two above variants. The intensity and scale of redeposition depend on the geological factors and on the resistance of the material that undergoes translocation. Mollusc shells quickly lose their organic components and become decalcified, thus becoming less resistant to physical and chemical processes that affect them during erosion, transport and accumulation. Because during most geological processes the intensity of such phenomena is high, the possibility of shell translocation seems to be small and can take place only over a limited distance. This pertains especially to shells which have been washed out of older deposits. Studies on contemporarily accumu-

lated malacocoenoses from flood debris seem to confirm this thesis. At the same time, considering the specificity of palaeomalacological analyses, it is not always true that the faunas with molluscs from different types of habitats are mixed and as such can provide no basis for palaeoenvironmental or stratigraphic reconstructions, since their components have become redeposited.

SCLEROCRONOLOGY IN DETERMINING THE AGE OF *SINANODONTA WOODIANA*

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Annual increments on hard parts of amphibians, reptiles, fishes and molluscs provide information on their age, growth and age-size dependence. Sclerochronology deals with chemical composition and physical structure of growing hard parts in the context of the conditions in which they are formed; it can be used to determine age, to reconstruct environmental changes that took place during the growth or to ascertain periods of growth inhibition. Our material included shells of *Sinanodonta woodiana* from the Czesławicki pond in the Barycz Valley. Shell strips 4 mm wide, cut out with a diamond saw 125 mm in diameter and 0.5 mm thick, were used for the analysis. The cuts were made along the line from the umbo to the basis; prior to cutting the shell was mounted on a metal stand. One edge of the strip was glued to a glass plate, so that the other edge could be manually polished with corundum powder and diamond powder. The external growth lines corresponded to the internal lines which were visible on the cross-section. The variation in the number of internal lines which had formed during the shell growth indicated differences in the growth rate. Further studies will aim at determining the moments of and reasons for growth inhibition; the summer growth lines will be analysed on the background of temperature changes.

THE UNIQUE CHARACTER OF THE ŚWIĘTOKRZYSKI REGION IN THE LIGHT OF MALACOFANISTIC STUDIES

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The flora and fauna of the Świętokrzyskie Mts have many montane characters; the mountains hold outcrops of deposits from the Cambrian till the Quaternary, the climate is montane, and the rivers form gorges and swampy areas with peat bogs of various succession stages. The number of mollusc species recorded from the Świętokrzyskie Mts is 142 (100 terrestrial gastropods, 24 freshwater snails, 18 bivalves). Recent studies revealed the occurrence of 11 species not recorded earlier: *Vertigo moulinsiana* (Dupuy, 1849), *V. angustior* Jeffreys, 1833, *Vitrea subrimata* (Reinhardt, 1871), *Euconulus alderi* (Gray, 1840), *Limax maximus* Linnaeus, 1758, *Cecilioides acicula* (O. F. Müller, 1774), *Clausilia bidentata* (Ström, 1765), *Arianta arbustorum* (Linnaeus, 1758), *Cepaea hortensis* (O. F. Müller, 1774), *C. nemoralis* (Linnaeus, 1758) and *Helix lutescens* Rossmässler, 1837; the occurrence of *Helicigona lapicida* (Linnaeus, 1758) was confirmed. The rare freshwater snail *Anisus vorticulus* (Troschel, 1834) was recorded there. Montane species constitute 16% of the fauna. The Alpine species *Vitrea subrimata* occurs in the geological reserve Wąwóz w Skalach. The wetlands at the confluence of the rivers Biała and Czarna Nida hold rare species of *Vertigo*: *V. moulinsiana* and *V. angustior*.

NEW LOCALITIES OF *VERTIGO ANGUSTIOR* JEFFREYS, 1833 IN SOUTHERN, SOUTH-EASTERN AND NORTHERN POLAND

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The distribution of *Vertigo angustior* Jeffreys, 1833 in Poland is still incompletely known. The studies in 2007–2010 revealed some new localities of the species and provided new data on its ecological requirements. The species lives in calcium-rich wetlands: environs of oxbows, *Molinia* meadows, and alkaline fens. It is found on sedges where it climbs up to 15–25 cm above ground. The sites in the region are undergoing eutrophication. *Epipactis palustris* is an indicator of favourable conditions for *V. angustior*. In the south of Poland, in the Carpathians, the uplands and the Sandomierz Basin, with their prevailing fens developing in lake basins, on river terraces, slopes and in karst

dolines, only few sites hold *V. angustior*. In the Świętokrzyskie Mts and in the Nida Basin fens develop in river gorges, karst dolines and deflation areas of oxbows; *V. angustior* occurs in the fen Pakosław on the Hżeckie Foreland, and in the southern belt of Kampinos Forest in the Masovian Lowland. The alkaline fens in the north of Poland have a character of flushes, sedge beds and moss communities; Manowo near Koszalin is an example of a site holding *V. angustior*. In all, thirty three new sites of *V. angustior* were found in Poland in 2007–2010.

NEW LOCALITIES OF *VERTIGO MOULINSIANA* (DUPUY, 1849) IN SOUTH-EASTERN, CENTRAL AND NORTHERN POLAND

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Vertigo moulinsiana (Dupuy, 1849), whose distribution in Poland is still incompletely known, is an Atlantic-Mediterranean species of a wide but disjunct distribution. Its distribution in Poland in the Early Holocene was wider than it is now. Its requirements are mainly hydrogeological, with the proper water level. During the vegetation season it stays on plants up to 30–50 cm above the ground or water table; it is associated with *Glyceria maxima*, *Carex riparia*, *C. paniculata*, *C. elata*, *Cladium mariscus*, *Phragmites australis*, *Typha latifolia*, *T. angustifolia*, *Spharganium erectum*, *Iris pseudacorus*, *Phalaris arundinacea*. The climate and calcium content are also important. *V. moulinsiana* prefers environs of oxbows, eutrophic water bodies, river valleys, chalk fens and sedge beds. The 2007–2010 inventory revealed 18 new localities of the species. In the Świętokrzyskie Mts it occurs only in the environs of Chęciny, at the confluence of the rivers Biała and Czarna Nida. Other localities are situated in the Hżeckie Foreland, in Wólka Bodzechowska, in the Krasna and Biała Nida river valleys. It finds favourable conditions also in the southern part of the Łódź Upland and the Pilica River valley, as well as in the southern belt of wetlands in Kampinos Forest.

METAPOPULATION STUDIES ON *HELIX POMATIA* L. IN THE ENVIRONS OF THE MORASKO CAMPUS, ADAM MICKIEWICZ UNIVERSITY IN POZNAŃ

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The Roman snail (*Helix pomatia* L.) is the only commercially exploited mollusc in Poland; at the same time it is partly protected. Population studies on its distribution and abundance are necessary. The studies on the spatial distribution, structure and dynamics of the local population of *H. pomatia* near the Morasko Campus started in 2010. Their main objective was to establish whether the species formed a metapopulation or an array of isolated local populations, and to devise the most precise method of estimating its population abundance. In March–September 2010 the observations included an area of ca. 4 km². Forty eight local populations were found. Individual snails were GPS-located and entered into a database. All the snails were individually marked, measured and weighed. The individual areas resulting from the whole-season observations served as the basis to generate areas occupied by members of each local population. No individuals were observed to migrate between the local populations, but the one-year study does not allow to exclude the existence of a metapopulation. There are no data on the dynamics of individual populations in space and time. Urbanisation and natural barriers (e.g. water courses) may effectively isolate local populations but from time to time an opportunity may appear to overcome the barriers.

GASTROPODS IN THE ROOK'S (*CORVUS FRUGILEGUS*) FOOD

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The 2009–2010 studies in the Sama river system were aimed at inventorying the corvid breeding colonies; the malacological results were a side-effect. Empty shells of *Helix pomatia* and *Cepaea nemoralis*, and a few shells of *Arianta arbustorum* were noticed under some nest-bearing trees in the largest colony. The material included 253 shells of *H. pomatia* and 198 shells of *C. nemoralis* found under 36 pine trees with a total of 121 nests; there were no shells under the remaining

trees. The size of the Roman snails eaten by the rook was distinctly smaller than the mean adult size for the area. The size selection was probably dictated by the easy access to the snail's body. Only 9.9% of the shells bore traces of pecking or had damaged apertures. Five specimens had remains of epiphragms indicating that they had been consumed at the beginning of the breeding season. In 74% of the cases *C. nemoralis* were yellow, with various numbers of bands; among the shells with contrasting colouration (1–5 bands) 95% were yellow. The proportion of unbanded shells was the smallest. Of all morphs (yellow, brown and pink) they constituted less than 28%. In order to ascertain if the birds prefer some morphs and ignore others, the morph frequency in the local snail population should be determined. In the observed colony not all the birds learned to eat *Cepaea*; the number of shells suggests that the snails are a diet supplement rather than the basic food. Because of its habit of catching *Cepaea* and cracking it by dropping it onto the ground, the rook may contribute to the snail's dispersal.

FRESHWATER SNAILS AS HOSTS OF PROGENETIC STAGES OF DIGENEA

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Earlier sexual maturity reached by morphologically larval or juvenile organisms is called progenesis or neoteny. Progenetic stages of digenean trematodes occur in intermediate hosts II, and the phenomenon is obligatory or facultative. The studies on infection of freshwater snails with digenean larvae were conducted in 2008–2010 in three lakes of the Brodnickie Lakeland. Quantitative samples were taken in order to characterise the malacological background of the occurrence of Digenea, with three methods: "time" method (2008), sampling from the bottom surface using dredge nets and from the aquatic vegetation (2009), and with a frame (2010). A total of 9,824 molluscs of 21 species were examined. Progenetic forms of *Diplodiscus subclavatus* (Pallas, 1760) were found in lakes Strażym and Zbiczno in 15 out of the 1,658 examined specimens of *Viviparus contectus*. The prevalence ranged from 0.3 to 3.6% and was the highest in lake Strażym. Progenetic stages of *D. subclavatus* appeared already in May, and were also recorded in August and September. Only in lake Strażym the trematode occurred also as cercaria in *Planorbis planorbis* (2.3%) and *Anisus vortex* (5.0%) which are intermediate hosts I. In the first year of studies the proportion of *V. contectus* in the malacological samples from all three lakes was similar (ca. 20%), while that of *P. planorbis* and *A. vortex* was the highest in lake Strażym (5.4%). In lake Strażym, where

progenetic forms of *D. subclavatus* were the most abundant, *V. contectus* selected mostly the bottom and *P. planorbis* and *A. vortex* – the macrophytes. In 2010 the density of *V. contectus* in all the lakes was the highest in August, that of *P. planorbis* and *A. vortex* – in September. In both cases the maximum density was observed in lake Strażym. The presence of *D. subclavatus* in *V. contectus* is the first observed case of the trematode using the snail as host. Most probably the invasion takes place via digestive tract which is favoured by the habitat preferences of *Viviparus*. The facultative life cycle of the parasite facilitates its transmission, increases its chances of surviving winter and probably accelerates its development in the next vegetation season.

THE EFFECT OF PHYSICO-CHEMICAL CONDITIONS ON THE SHAPE OF GROWTH CURVES OF *ANODONTA ANATINA* (LINNAEUS, 1758)

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The shape of growth curves reflects both life strategies of organisms and the pressure from biotic and abiotic factors. Samples of ca. 200 specimens of *Anodonta anatina* (Linnaeus, 1758) from a total of 18 populations from lakes of north-eastern Poland were taken within comparative studies on the species in September of 2008 and 2009. The growth curves were calculated separately for females and males from each population through fitting the age and size data in Bertalanffy's equation. Data on physico-chemical parameters of the lake waters were derived from the monitoring by the Voivodeship Inspectorate of Environment Protection in Olsztyn. The analysis of the growth curves revealed a considerable variation in the growth of male and female *A. anatina* in the gradient of the studied physico-chemical parameters of the water. The studies were financed by grant NN304117633 from the Ministry of Science and Higher Education in 2007–2011.

CAN SEXUAL BEHAVIOUR SERVE TO IDENTIFY SPECIES? AN EXAMPLE OF TWO SLUGS OF THE GENUS *DEROCERAS*

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Slugs of the genus *Deroceras* Rafinesque, 1820 include small forms, morphologically and anatomically diverse. Only pests have been studied in detail; information on most other species is limited to morphology and type localities. The structure of the genitalia is regarded as the most diverse and species-specific. The function of many components of the genitalia (e.g. sarcobelum) remains unknown. The diversity of the genitalia is accompanied by diverse mating behaviour. The behaviour includes four stages: precourtship, courtship, copulation and postcopulatory behaviour. Each phase includes different behavioural pattern and is of different duration. The pattern is very characteristic, making it possible to distinguish species without killing and dissecting the slugs. The presented results pertain to identification of *D. praecox* and the still undescribed *Deroceras* species A on the basis of behavioural characters. Pairs of slugs were recorded during various stages of mating. Analysis of the slowed-down film made it possible to detect subtle differences in the phase of copulation which lasted ca. 2 seconds. Despite the absence of morphological differences and the small morphological differences between *D. praecox* and species A the two forms differ in each phase of mating.

USING 3D SCANNING IN ALLOMETRIC STUDIES ON *HELIX POMATIA*

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Each year the Roman snail is commercially exploited and at the same time it is partly legally protected. Collecting permissions are issued in May; the only parameter that is controlled during the collection, and qualifying the specimen as collectable, is the shell diameter which should be >30 mm. Allometric analysis is among the recent methodological trends in ecological, physiological, medical and pharmaceutical studies. Biometrical characteristics of spatially complicated structures, obtained with the use of traditional methods, is burdened with a large error. The most modern techniques, such as 3D scanning, make it possible to measure e.g. shell volume with great accuracy. Our results represent the first attempt at im-

plementing the technique in studies on the biology of *Helix pomatia* – a species of great economic importance. The preliminary allometric analysis included 30 randomly selected individuals from one population. The index of calibration of volume against mass, shell height and width against mass and body whorl height against the total shell height was determined.

USEFULNESS OF PLANT EXTRACTS, INFUSIONS AND DECOCTIONS FOR LIMITING OF FEEDING OF *CEPAEA HORTENSIS* (O. F. MÜLLER, 1774)

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Great numbers of slugs and snails in the garden do not please the garden owners. When occurring in masses, the gastropods can completely destroy the plants or at least deprive them of their decorative value. On the other hand, recently there has been an increasing tendency to limit the use of molluscicides which are not always effective; not all garden owners like chemicals in their surroundings. Molluscicides can negatively affect organisms other than molluscs; simple collecting of the gastropods or using natural substances are good alternatives. Laboratory tests were aimed at checking possible deterrent effects of infusions, decoctions and extracts of five plant species on *Cepaea hortensis*. The plants were *Tagetes erecta* L., *Cyclamen hederifolium* Aiton, *Hypericum perforatum* L., *Paeonia officinalis* L. and *Ageratum houstonianum* Mill. The *Cyclamen* infusion and *Tagetes* extract showed the best deterring properties, with the smallest proportion of plant mass consumed.

NEW LOCALITIES OF *MONACHA CARTUSIANA* IN THE ENVIRONS OF POZNAŃ

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In Wielkopolska *Monacha cartusiana*, regarded as an invasive species, was previously known only from two localities in Poznań where it was first found in 2002. During the last two years the species was found in another five sites in Poznań and its environs. All the sites have a similar vegetation structure (wasteland covered by tall grass and perennials); their area ranges from 0.6 to 1.4 ha. The most likely way of dispersal of *M. cartusiana* in the area is accidental transport of the snails by vehicles.

THE EFFECT OF HUMIC ACID ON METAL ACCUMULATION BY *UNIO TUMIDUS*

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We studied the effect of humic acid on cadmium and copper accumulation by *Unio tumidus* Linnaeus, 1758. The bivalves were caught in an oxbow of the Nida in Pińczów (Świętokrzyskie voivodeship). The experiment included two series. In one the bivalves were kept in solutions of cadmium ions (250, 500, 1000 mg/l) during 24 hours; parallelly other bivalves were exposed to the same concentrations of cadmium ions in the presence of humic acid (28.8 mg/l). In the second series the bivalves were exposed to copper ions (50, 100, 200 mg/l) with and without humic acid (28.8 mg/l) during 24 hours. After the exposure, cadmium and copper levels were measured in the gills, hepatopancreas, foot and mantle. Accumulation of cadmium and copper in the bivalve's organs depended on their concentration in the environment. The gills accumulated the greatest and the foot – the smallest quantities of the two metals. Humic acid increased cadmium accumulation in all the organs. The bivalves kept in 200 mg/l solution of Cu ions in the presence of humic acid accumulated more copper in their gills, compared to the bivalves kept in the same solution without humic acid. Humic acid decreased copper accumulation in the hepatopancreas, foot and mantle.

THE CONTENT OF HEAVY METALS IN SHELLS OF *MYTILUS* SP. FROM THE ADRIATIC, BALTIC AND BLACK SEAS

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The objective of the study was the assessment of the content of heavy metals (Hg, Cd, Pb, Zn, Cu, Fe) in shells of *Mytilus* sp. from the Baltic Sea (Poland: Rowy, Dźwirzyno), Adriatic Sea (Croatia: Vodice) and Black Sea (Romania: Constanca). Hg content was measured with cold vapour atomic absorption spectrophotometry (CVAAS). The content of the remaining metals was measured with atomic flame absorption spectrometry (FAAS). Statistical analysis was done with STATISTICA. All the samples contained the metals. The highest mean content of Hg (0.007 ± 0.001 µg/g) and Pb (46.58 ± 7.95 µg/g) was de-

tected in the mussels from the Black Sea. The smallest Hg content (0.06 ± 0.002 µg/g) was observed in the bivalves from the Baltic Sea (Dźwirzyno). The highest content of Cu (8.72 ± 0.44 µg/g) and Fe ($281,03\pm 122,97$ µg/g) was detected in the mussels from the Baltic Sea (Rowy); the smallest concentrations of these metals (Cu – 8.18 ± 0.83 µg/g; Fe – 82.09 ± 26.73 µg/g) were found in the shells from Dźwirzyno. The shells from the Adriatic Sea contained the greatest quantities of Cd (4.55 ± 0.83 µg/g), the smallest mean Cd content (3.77 ± 1.19 µg/g) was detected in the shells from Rowy. Zn content was the highest in the shells from Dźwirzyno (7.38 ± 1.64 µg/g), and the lowest (5.23 ± 0.86 µg/g) in those from the Black Sea. The differences in the content of Hg, Cd, Pb, Zn and Cu between the localities were statistically insignificant. The only significant differences pertained to Fe ($F=10.83$; $p=0.0004$). Post hoc analysis showed significant differences between the shells from the Black Sea and those from Dźwirzyno ($p=0.005$) and the Adriatic Sea ($p=0.02$) and between those from Rowy, Dźwirzyno ($p=0.002$) and the Adriatic Sea ($p=0.007$).

MOLLUSCS OF MT. TUŁ NEAR CIESZYN (W. CARPATHIANS)

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The Western Carpathians, with their small content of calcium carbonate, do not create favourable conditions for preservation of mollusc shells. The outcrops of the so called Cieszyn limestone on Mt. Tuł favour such preservation. Four samples collected in 2010 contained 447 shells of 28 extant species of terrestrial snails. The number of species per sample ranged from 14 to 17, the number of specimens – from 60 to 187. A sample taken 20 years ago from Mt. Tuł was used for comparative purposes. Most species represented forest habitats. The dominance and constancy values were the highest for *Monachoides vicina*, *Balea biplicata*, *Aegopinella minor*, *Discus rotundatus* and *Orcula doliolum*. Most species were widely distributed in Europe. The malacofauna confirms the probable migration route from other parts of Europe to the south of Poland. *O. doliolum*, which is especially interesting in this respect, was subject to detailed biometrical analysis. It was not found on Pańska Góra or in the Babia Góra massif, and Mt. Tuł is its isolated locality. Early studies on Mt. Tuł revealed the presence of *Candidula unifasciata* which was also found on Pańska Góra in 1994. However, the species was not re-found in the samples from Mt. Tuł, either 20 years ago or in 2010,

which might mean that its migration route had become closed.

LONG-TERM CHANGES IN THE MALACOFAUNA OF THE ZEGRZYŃSKI RESERVOIR

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The Zegrzyński Reservoir has been subject to hydrobiological studies since its creation in the early 1960s. The studies include environmental conditions in the reservoir and its tributary rivers, as well as communities of organisms. The reservoir, rather complicated and varied, is fed by two large rivers: Bug and Narew. It includes an extensive stagnant part and a few flow channels. Its chemical parameters vary very widely within and between years. The benthos is rich and varies among the parts of the reservoir; its composition and abundance have been found to vary between years. Besides the “soft” benthos, the Zegrzyński Reservoir holds great numbers and biomass of molluscs. They constitute over 90% of the total fresh mass of the benthos. In the first period of the reservoir’s existence the number of mollusc species was 34, later it dropped below 30. The dominant taxa were *Viviparus viviparus*, *Dreissena polymorpha*, Sphaeriidae and Unionidae. During the study period the mollusc density decreased considerably: from a few thousand individuals/m² in the 1980s to a few hundred/m² in 2007 and ca. 100/m² in 2010. The reasons for the decrease in richness and abundance are eutrophication and sewage discharge. In the last year the high water level could also affect the fauna. Despite the impoverishment the malacocoenoses are still rich, compared to other similar habitats; *V. viviparus* and *D. polymorpha* are still dominants with respect to their abundance and biomass.

TERRESTRIAL SNAILS TYPICAL OF FOREST ECOSYSTEMS OF WIELKOPOLSKA

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Intensive land use has caused considerable changes in the landscape of Wielkopolska. It is now a mosaic of fragments of natural habitats separated by human-transformed areas. The environmental changes are a result of long-lasting agricultural tradition and fast growth of urban agglomerations. At present forests occupy 25.3% of the area; most are pine

monocultures (ca. 80%). Deciduous and mixed forests constitute a small fraction. In spite of this they hold fairly numerous typically forest species which rarely occur in other habitats: *Platyla polita*, *Acanthinula aculeata*, *Merdigera obscura*, *Cochlodina laminata*, *Ruthenica filograna*, *Macrogastra plicatula*, *Clausilia bidentata*, *Bulgarica cana*, *Discus rudersatus*, *Aegopinella pura*, *Ae. nitidula* and *Monachoides incarnatus*. The distribution of individual species in Wielkopolska is illustrated on UTM maps.

POSSIBLE USE OF THE NEMATODE *PHASMARHABDITIS HERMAPHRODITA* TO LIMIT PLANT DAMAGE BY GASTROPODS

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Phasmarhabditis hermaphrodita is a parasitic nematode which is harmless for humans and animals. It can be used in gardens, as well as in ecological and other agricultural cultivations. The nematode is a component of Nemaslug (Becker Underwood, UK) and is recommended for control of various slug and snail species. Nemaslug is obtainable in most central and north European countries. Its use in Poland is limited because of the cost and the lack of detailed information on optimum application methods and efficiency in limiting local gastropod populations. Nemaslug dissolves in water and is used to spray or water plants and substratum when the temperature is 5–25°C. Following the operation the nematodes penetrate the soil in search of hosts. They enter the mantle cavity and release bacteria *Moraxella osloensis*, which penetrate the gastropod’s digestive tract. Under the effect of bacterial toxins the gastropods stop feeding and die within 7–21 days. The next nematode generation leaves the dead host and starts searching for new hosts. Preliminary studies in 2010 at the Department of Zoology, Institute of Plant Protection in Poznań, dealt with the efficiency of *P. hermaphrodita* in limiting the feeding of *A. lusitanicus* and its damage to rapeseed plants, and its effect on the condition and survival rate of the slug. The experiments were done in a climatic chamber, temperature 16°C, RH 93% and day length of 12 h. Each container was filled with soil to 1/3 height and contained 6 rapeseed plants, variety Bazyl, at the stage of 4–6 leaves. The plants and soil were sprayed with Nemaslug, at two different doses, each applied three times at six day intervals (total 3 × 5 nematodes/cm² and 3 × 10 nematodes/cm² soil surface). Two *A. lusitanicus*, starved for the previous 48 h, of mean mass 2.35 g, were placed in each container. Water-sprayed plants constituted control. The degree of plant damage was recorded during the next 31 days, using a five-degree damage scale (0, 25, 50, 75

and 100% damaged surface), healthy, ill and dead slugs were counted. Five replicates were run for each combination. The results were statistically analysed with variance analysis and Fisher's test at $\alpha=0.05$. Significant differences in the degree of damage were observed already after seven days. The plants sprayed with the dose of 2×10 nematodes/cm² were significantly less damaged than the control plants. The tendency was maintained till day 25, for both doses used (3×5 and 3×10 nematodes/cm²). *P. hermaphrodita* caused infection or death of a small fraction of the slugs, resulting in inhibition of feeding. Nemaslug should be thoroughly tested for its usefulness for limiting feeding of *A. lusitanicus* and other gastropod species.

THE EFFECT OF ENVIRONMENTAL FACTORS ON THE DIVERSITY AND ABUNDANCE OF MALACOFAUNA OF WATER BODIES OF DIFFERENT STABILITY: THE FLOODPLAIN OF THE BUG RIVER

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The 2007–2009 studies included 25 permanent water bodies, 25 water bodies which dried considerably during low water level, and 24 periodic water bodies which contained water for up to 8–9 months. Molluscs were collected from the bottom deposits and macrophytes. Oxygen content in the water, ammonium and nitrate nitrogen concentration, phosphate, calcium, chloride concentration, BZT₅, proper conductivity and pH were measured. Content of organic matter, nitrogen, phosphorus and carbon, as well as C/N ratio (indicator of the quality of organic matter for macroconsumers) were determined for the bottom deposits. The permanent water bodies had the richest malacofauna with 52 species (more than 91% of all species recorded). The nearly drying and periodic water bodies held 29 and 36 species, respectively. The mean number of species per water body was 18.7 ± 4.0 , 7.7 ± 3.2 and 9.6 ± 5.1 for the permanent, drying out and periodic water bodies, respectively. The respective values of the Shannon-Weaver index (H') were 3.18 ± 0.55 , 2.18 ± 0.72 and 2.07 ± 0.83 . The mean mollusc density differed considerably and varied from 80 individuals/m² in the drying out water bodies to 292 individuals/m² in the periodic water bodies. Content of phosphates and ammonium nitrogen as well as pH had a significant effect on the mollusc density, while oxygen concentration and BZT₅ affected the species richness, diversity and density in the permanent water bodies. In the remaining two groups of water bodies the chemical parameters of the water had no significant effect on the malacocoenoses. The con-

tent of organic matter, nitrogen and phosphorus in the bottom deposits had no effect on the malacocoenoses, but the quality of organic matter expressed as C/N ratio was important: low quality of the deposit (C/N>17) could limit the development of malacocoenoses in some of the water bodies. The studies were financed by grant N30511731/3934 from the Ministry of Science and Higher Education.

PHARMACOLOGICAL ANALYSIS OF STICKY LOCOMOTION OF TERRESTRIAL SNAILS

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We aimed at testing which parameters of the snails' sticky locomotion were affected by pharmacological preparations of neurotransmitters: adrenalin, noradrenalin, serotonin and serotonin-creatinine complex as well as a drug – ambroxol – used to increase cleansing activity of respiratory epithelium. The material included 60 individuals of *Achatina achatina*, weight 19–30 g, from the department's culture. The picture of snail's sole during spontaneous, rectilinear movement on a glass plate was recorded with computer-coupled CDD camera. The following parameters of the snail's movement were analysed: velocity (vg), sole length (lg), number of sole waves (nw), sole wave length (lw), interwave length (liw), surface ratio of sole waves to whole sole ($cw=lw \cdot nw \cdot lg^{-1} \cdot 100\%$), wave frequency (fw), distance covered per sole wave (shw) and wave efficiency coefficient ($u=shw \cdot (shw+lw)^{-1} \cdot 100\%$) in control conditions and during 2 hours after injection of a dose of 2 µg/g body mass of the tested substances into postero-dorsal part of the foot. Statistical significance was tested with the Mann-Whitney U test ($p<0.05$). The velocity of crawling increased under the effect of serotonin and serotonin-creatinine complex, noradrenalin and ambroxol. The sole length and number of sole waves increased under the effect of serotonin. The sole wave length increased under the effect of adrenalin, noradrenalin, serotonin-creatinine complex and ambroxol, the interwave length – under the effect of adrenalin. The surface ratio of sole waves to the whole sole increased under the effect of adrenalin, noradrenalin, dopamin and ambroxol. Adrenalin, noradrenalin and ambroxol increased the wave frequency, the distance covered per sole wave increased under the effect of noradrenalin, serotonin

and serotonin-creatinine complex. The coefficient of sole wave efficiency increased under the effect of serotonin and serotonin-creatinine complex and decreased after application of adrenalin and ambroxol. The use of pharmacological preparations shows that the snail's movement can be changed through changing its various parameters.

USING 3D SCANNING TECHNOLOGY IN MALACOLOGICAL STUDIES AND EDUCATION

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Modern 3D scanning technology makes it possible to create interactive models which can be used for the purposes of scientific studies and education. Precise measurements of complicated spatial structures (e.g. mollusc shell) with traditional methods are usually burdened with a considerable error. Due to the developing technique it is possible to take very precise measurements. Specialist software (Mesh3d, Geomagic Studio 12) makes it possible to obtain virtual sections in any possible plane. The measurements taken with this technique are highly reproducible. Creating animations and three-dimensional models will make it possible to present many problems during teaching and will also aid understanding of complicated phenomena. Establishing the laboratory of 3D scanning, based on Smarttech hardware, at the Collection Department, Faculty of Biology, UAM, has opened new possibilities for biometrical studies on many organisms. In the future it will be possible to make the rich conchological collection available to all who are interested. At present the laboratory has three scanners to digitise objects of various sizes: from a few millimetres to over two metres. Examples of the results can be found at <http://helix.amu.edu.pl>

SPATIAL DISTRIBUTION AND STRUCTURE OF POPULATIONS OF *HELIX POMATIA* L. IN KUJAWSKO-POMORSKIE VOIVODESHIP

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Because of commercial exploitation of the resources of *Helix pomatia* it is necessary to learn the distribution and size of its populations in order to effectively protect the species. Reliable data can be ob-

tained only through detailed, long-term studies in extensive areas. Spatial distribution of the Roman snail populations in Kujawsko-Pomorskie voivodeship was studied in 2009–2010 on commission of the Regional Inspectorate of Environment Protection in Bydgoszcz. All the communes of the voivodeship were included, special attention being paid to the places where purchase points had operated in the previous years. All the populations found were GPS-located (places where the snail was absent were also recorded). Then distribution maps for the voivodeship were prepared using GIS techniques. The snails were counted (using 10 × 10 m grid), weighed and measured in each site. The data served as the basis to determine parameters of each population and to calculate mean values for the whole voivodeship. It is expected that the studies may, in the future, make it possible to devise a model for assessment of population resources over large areas.

AN ATTEMPT AT ASSESSMENT OF ABUNDANCE OF *HELIX POMATIA* L. IN THE FIELD

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Precise assessment of abundance of most invertebrate species in natural conditions is usually impossible. Our studies on abundance of the Roman snail (*Helix pomatia* L.) constitute an attempt at devising a method of abundance assessment which would make it possible to know the possibly most precise numbers. Distribution and abundance of the Roman snail in Kujawsko-Pomorskie voivodeship was studied in 2009–2010 on commission of the Regional Inspectorate of Environment Protection in Bydgoszcz. Shores of lake Mogileńskie were among the localities studied in great detail. The studies were preceded by a thorough analysis of orthophotomaps of the area in order to determine the area of potential Roman snail habitats. Based on the boundaries of snail-favourable habitats we determined the potential size of the area occupied by populations of *Helix pomatia* on the lake. The snail abundance was assessed in several randomly selected plots on the western shore of the lake. Assuming an even distribution of individuals, the total population abundance was assessed based on the resulting mean abundance values. In the second year of the studies we verified the results through analysing the actual snail-inhabited area on the lake. All the sites were GPS-recorded, and the abundance was estimated using square grid. Maps comparing the actual and simulated abundance were made with GIS soft-

ware. These will provide the basis to create a model for assessing abundance of *Helix pomatia*.

USING SCANNING ELECTRON MICROSCOPY TO STUDY SLUG MORPHOLOGY

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The slugs *Arion lusitanicus* and *A. rufus* are serious pests which cause much damage to cultivated plants. In recent years both the distribution range and the abundance of *A. lusitanicus* have increased considerably. The slug is especially numerous in small-area cultivations, gardens, allotments and orchards. With the increasing abundance of *A. lusitanicus*, the number and abundance of populations of *A. rufus* decrease. Since *A. lusitanicus* is an invasive species, it is important to devise precise and easy methods of its identification which could be used by non-malacologists – plant protection inspectors. At the Institute of Plant Protection we attempt to devise such methods. One is molecular, the other – morphological. The first stage of studies on the morphological method focused on the analysis of eggs and radulae. The size and shape of radular teeth were analysed and compared with the use of SEM; the analysis revealed no differences between the two species. The situation was similar with eggs: neither their size nor granulation of their surface showed inter-specific differences.

DOES PREDATOR-INDUCED BEHAVIOUR PROTECT THE ZEBRA MUSSEL FROM ROACH?

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The roach *Rutilus rutilus* is one of the most effective predators of the zebra mussel *Dreissena polymorpha* in Europe. We observed an array of changes of the mussel's behaviour which were induced by the presence of the fish: the mussel attached more strongly to the substratum, more often formed aggregations, less often climbed vertical surfaces. However, there was no information on the effectiveness of these methods of defence. In order to check the effect of the strength of attachment on the roach feeding we placed mussels in ceramic containers (120 × 150 × 25 mm) for one or six days, thus obtaining feebly (mean

0.16 N) and strongly attached (0.74 N) bivalves. Control individuals were not attached to the substratum. The three containers, each with 20 mussels, were placed in 100 l aquaria with roach (180–250 mm). To check the effect of aggregation, we glued mussels with denture glue to the container's bottom in groups of three or singly (total of 12 individuals). The containers with single and grouped mussels were placed in predator-containing aquaria. To test the effect of limiting of vertical migration on the mussel's safety, we glued mussels to the glass bottom of fish-containing aquaria or to their walls at the height of 10, 20 and 30 cm above the bottom. In all the experiments the fish were allowed to forage for one hour, and then the proportion of consumed mussels was scored. The attachment strength limited the effectiveness of roach feeding: the roach consumed most unattached mussels (76% of individuals in the group), feebly attached mussels were consumed less often (39%), while strongly attached mussels were the safest (12% consumed). The differences were statistically significant. Mussels in aggregations were consumed less often than single individuals (53 and 81%, respectively). The position of mussels on the aquarium bottom or wall did not affect the fish effectiveness. Limiting of vertical migrations may be effective only in a habitat with numerous shelters. We found that the mussel's defensive mechanisms considerably limited the predator's feeding.

CEPHALOPODS (MOLLUSCA: CEPHALOPODA) IN THE PALAEOONTOLOGICAL COLLECTION OF THE FACULTY OF BIOLOGY, ADAM MICKIEWICZ UNIVERSITY

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The collections of the Faculty of Biology, Adam Mickiewicz University, contain numerous palaeontological materials, including cephalopods: nautiloids (Nautiloidea), ammonites (Ammonoidea) and belemnites (Belemnitida). The nautiloids are represented by several dozen specimens, mainly orthocone, and several coiled forms. Internal casts, sometimes with preserved shell fragments, prevail. The collection includes a sculptured internal cast and a shell imprint which makes it possible to analyse the surface structure. The ammonites are represented by numerous specimens of a few dozen genera, and are preserved as nearly complete shells, shell fragments, internal casts and imprints. The collections of heteromorphic Cretaceous representatives of the genus *Baculites* from Rzeżuśnia is especially interesting. The belemnites are represented by numerous rostra of different state of preservation; two specimens have

partly preserved phragmocones. Collections from Holzmaden and Solnhofen are of great importance for palaeobiology. The Holzmaden collection includes several dozen shale pieces with ammonite shells. The Solnhofen material comprises coprolites *Lumbricaria intestinum*, which are probably fossilised squid or cuttlefish faeces. The cephalopod fossils from our collection are also used for teaching purposes.

DISTRIBUTION AND OCCURRENCE OF *ARION RUFUS* (LINNAEUS, 1758) AND ITS IMPORTANCE AS PEST

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Arion rufus (Gastropoda: Stylommatophora: Arionidae) occurs mainly in the western and central parts of Europe as well as in the British Isles and Scandinavia. In the last decade it was introduced in the USA and Canada. The first information on its occurrence in Poland dates from half of the 18th c., but only some of the data were confirmed by later studies. The natural eastern distribution border of *A. rufus* crosses Poland. The species occurs in the west, along the belt from the southern boundary to the Baltic coast and Vistula mouth, and in the environs of Poznań reaches the Warta River. It occurs in Lower Silesia, Wielkopolska, Lubuskie Lakeland and Pomerania. In the 1970s it was found in isolated sites in other parts of the country, e.g. in Limanowa and Piwniczna and in the 1990s in Rzeszów. Originally it occurred in the lowlands and mountain valleys, mainly in forests and in some open habitats, avoiding anthropogenic sites and causing little damage. Within the last two decades the slug spread to various regions of the country and started causing damage to cultivations of various plant species. The objective of our studies was to determine its present distribution in Poland and to assess the danger it posed to plants. In 2006–2010 we examined various habitats in order to confirm or detect the slug's presence. We assessed the degree of damage to plants in cultivations of selected species. We found 25 localities of *A. rufus*, including 12 new sites; four sites in each of the Łódzkie and Małopolskie voivodeships, two in Wielkopolska and one in each Silesian and Warmińsko-Mazurskie voivodeships. The greatest damage was observed in the case of root vegetables, cabbage, lettuce and beans, sugar beet, sunflower, potato, winter rapeseed and winter wheat, especially on the edges of plantations.

MOLLUSC ASSEMBLAGES IN HOLOCENE CALCAREOUS TUFAS FROM POMERANIAN SPRING FENS: THE PARSEŃA RIVER SYSTEM

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Mollusc assemblages from two sites in the Parseńa River system: Bobolice and Opatówek in the Chociel River valley were analysed. They came from Holocene spring tufas. The assemblages were diverse and included species from different habitats, in varying proportions. Freshwater snails were numerous: *Anisus contortus*, *Lymnaea peregrea*, *L. truncatula* and *Valvata pulchella*, as well as terrestrial snails: *Nesovitrea hammonis*, *Vallonia pulchella*, *Carychium minimum*, *Vertigo pygmaea*, *V. angustior*. The assemblages are typical of deposits formed in small, permanent or episodic water bodies on flood terraces or in the environs of springs. The studies are financed by grant NN304396638 from the Ministry of Science and Higher Education in 2010–2013.

SHELL ORNAMENTS FROM A MIERZANOWICE CULTURE BURIAL (BEGINNING OF THE 2ND C. BC) IN KICHARY NOWE

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Shell ornaments are artefacts often found in Neolithic and Early Bronze Epoch burials in Poland. Regrettably, they are rarely subject to detailed analysis, though they may provide valuable archaeological information. Studies in the archaeological site in Kichary Nowe (region of Sandomierz) started in 1987. The excavations focused on the cemetery where more than 50 graves had already been examined. They ranged from the middle Neolithic to the early Bronze Epoch, and were dated as 4th/3rd – beginning of the 2nd c. BC. Most graves were associated with the Mierzanowice culture (Early Bronze). Grave no. 43 represented the last stage of the cemetery's use. It contained the body of a male aged 20–30 years and artefacts in the form of an axe, knife, arrowheads and ornaments: three “ceramic” beads and shell ornaments. The ornaments were simple discoidal beads made of shells of local *Unio* spp. and pendants made of marine *Glycymeris* cf. *pilosa* (Linnaeus, 1767) and *Venus verrucosa* (Linnaeus, 1758). Despite their simple form, the beads and pendants are significant finds – they prove the existence of trading contacts with the Mediterranean during the early Bronze Epoch.



SELECTED ASPECTS OF REPRODUCTIVE
BIOLOGY OF *ZONITOIDES EXCAVATUS*
(ALDER, 1830) (GASTROPODA: PULMONATA:
GASTRODONTIDAE)

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Zonitoides excavatus (Alder, 1830) is distributed in the British Isles, coast of the North Sea from Denmark to Belgium and northern France. It occurs in the litter and rotting timber of old natural forests, sometimes in wetlands, exclusively on acid substrata. The objective of the studies was to ascertain parameters of its life cycle in laboratory conditions. The material was collected in July 2007 in the environs of Sheffield, UK. The snails were kept in Petri dishes of a diameter depending on the number of inhabitants (\varnothing 5–14 cm), placed in a climatic chamber at constant temperature (18°C day, 12°C night) and humidity (80%). *Z. excavatus* lays eggs directly on or in the soil, in the moss or rotting timber; adults are also associated with such substrata. The eggs are calcified, of ca. 1 mm diameter, and are produced both by individuals kept in pairs or groups and by individuals kept singly from early development stages. The number of eggs in batches ranges from 2 to 6 (mean 3); some eggs are laid singly. Most individuals produce one batch per day. The incubation lasts from 19 to 35 days (mean 27); the hatching is asynchronous. The number of whorls in hatchlings ranges from 1.4 to 2.0 (mean 1.7). Egg cannibalism on the part of juveniles and adults was observed. The snails become sexually mature in four months.

UNIONIDAE OF THE LAKES OF THE KRUTYNIA
RIVER SYSTEM (MAZURIAN LAKE LAND)

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Unionid bivalves are among the largest native freshwater invertebrates. Being common and reaching high densities, they can play an important part in aquatic ecosystems. In July and August of 2010 we surveyed the unionids of 13 lakes through which the Krutynia River flows; it was a continuation of our earlier studies on the river section of the Krutynia. Eleven of the lakes were inhabited by unionids. The total number of species recorded was four: *Anodonta anatina*, *A. cygnea*, *Unio tumidus* and *U. pictorum*. Three of the lakes held all four species, further five – three species each. Two small and most polluted lakes,

Warpuńskie and Zyndackie, were devoid of unionids but empty shells of *A. anatina* were found in Lake Zyndackie. The last species was found in the greatest number of lakes (12, including empty shells). *A. cygnea* was recorded in ten lakes, *U. tumidus* – in eight, and *U. pictorum* – only in three. The mean unionid density was usually 10–30 indiv./m². The highest density was observed in Lake Lampasz – slightly over 50 indiv./m². Compared to the 1989 results, the density decreased distinctly; only two lakes (Zydrój Wielki and Mokre) showed an increase. In 1989 one more species was recorded from Lake Uplik – *Pseudanodonta complanata*, but in 2010 we did not find even empty shells. This protected species is disappearing even from the river sections of the Krutynia system.

PRELIMINARY RESULTS OF FEEDING
EXPERIMENTS WITH *HELIX ASPERSA*

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Recently the Institute of Animal Husbandry has started studies on various organic and mineral diet supplements which may influence the quality of farm production of *Helix aspersa*. One of our aims was to find the optimum level and proportion of calcium and phosphorus in the plant feed mixture for two subspecies of *H. aspersa*: *H. aspersa aspersa* and *H. aspersa maxima*. We varied the level of calcium and phosphorus in the feed. Morphometric, chemical and physical properties of the shell were the basic criteria for assessment of the snails' quality in individual variants of the experiment. The material comprised juveniles of the two subspecies, aged six weeks and kept in the laboratory in containers with proper air humidity and 18 hours light. Each container held 20 specimens of each subspecies. The total number of 25 containers served to test five fodder variants in five replicates. The control snails received feed without supplements. Protein content in the feed was within 17.1–17.3%, and 17.4% in the control. The respective values of calcium content were 11.4–13.5% and 10.0%, and of phosphorus content – 0.6–1.0% and 0.6%. The Ca:P ratio was 11.4–22.5 and 16.6. After the experiment the snails were subject to morphometric measurements and physical and chemical analyses. Shells of specimens of both subspecies fed with the feed with the highest calcium content (13.5%) and the highest Ca:P ratio (22.5) showed the greatest mechanical resistance.

HISTOLOGICAL STRUCTURE OF THE GONADS AND CHANGES IN GERMINAL EPITHELIUM OF MALE *SINANODONTA WOODIANA* (LEA, 1834) FROM HEATED WATERS

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Species from warm climatic zones often find adequate living and reproducing conditions in waters discharged from cooling systems. One example is the Asian clam *Sinanodonta woodiana* (Lea, 1834); it occurs in masses in thermally polluted waters. It has been present in Poland since the 1980s. We examined the histological structure of the gonad in male *S. woodiana* and the changes in their germinal epithelium in annual cycle. The molluscs (total of 269 males) were sampled monthly from July 2004 till June 2006 from the cooling water channel of the Power Station Dolna Odra (W. Pomerania). The gonad structure was examined under light microscope; cells, multinucleate cysts and vesicles forming the gonads were measured with NIS Elements 2.3 software. The testes have a vesicular structure. The testis is in places overgrown with muscular tissue, and intervacular spaces are filled by haemocoel. The gland parenchyma is formed of vesicles containing germinal cells of the following mean size: spermatogonia 5.5 µm, spermatocytes I 4.2 µm, spermatocytes II 2.6 µm, spermatids 1.5 µm and two kinds of spermatozoa: typical, mean head length 2.8 µm and atypical spermatozoa (2.7 µm). The atypical spermatozoa are released from multinucleate cysts. *S. woodiana* produced spermatozoa throughout the year. Testes with vesicles with typical spermatogenesis appeared most frequently in the first half of the year, those with atypical and post-spawning vesicles – in the second half. The study was financed in 2007–2009 as doctoral project N30306832/2367.

NEW RECORD OF *SINANODONTA WOODIANA* IN A FISH FARM IN WESTERN POLAND

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Based on the inquiry on the occurrence of bivalves in 250 fish farms in Poland, the Polish Angling Association Fish Farm in Osieczna was selected for verification of the inquiry data. In 2010, during a visit to the

office of the fish farm, a single shell of *Sinanodonta woodiana* Lea was found in the collection. It had been collected from the pond Zgliniec in 1998. In 1989–1992 the ponds had been used by a Polish-Hungarian company POLMARYB which stocked the ponds with fish imported directly from Hungary, mainly *Cyprinus carpio* L., *Ctenopharyngodon idella* Val., *Hypophthalmichthys molitrix* Val. and *Aristichthys nobilis* Rich. Already in 1980–1987 fish from Hungary had been brought to the farm from the Fish Farm Gosławice. The shell from the collection, whose age was estimated as 7+, was found on the pond bottom and at the time it was not the only specimen seen. Most bivalves of similar shells at that time were of much smaller size (ANDRZEJ ŁAKOMY, unpublished). The only possible pathway of immigration was transport with the fish from Hungary. Since in 1998 the specimen in question was seven years old, its appearance in the pond should be dated as 1992. This is the oldest known locality of the Chinese mussel in the surface waters of Poland. It can be suspected that in the known localities the species may have appeared earlier than formerly believed and that it is better adapted to local conditions than is commonly thought.

SHELL VARIATION IN *BULGARICA CANA*

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The material included 1,781 shells of *Bulgarica cana* from various museum and private collections. The shell parameters (given as mean (range); shell dimensions given in mm) were the following: shell height 16.30 (12.70–20.40); shell width 3.78 (3.22–4.50); aperture height: 3.56 (2.90–4.46); aperture width: 2.56 (2.03–3.20); number of whorls 11.92 (10.00–14.40); height/width ratio 4.32 (3.26–5.56); aperture height/width ratio 1.39 (1.16–1.64); shell height/aperture height ratio 4.59 (3.82–5.69); ratio shell height/number of whorls 1.37 (1.12–1.62). The shells came from five megaregions: Fennoscandian Peninsula (16 shells), Extra-Alpine Central Europe (215), Alpine Region (73), Carpathian Region (1,156), East European Lowland (251). The shells from the East European Lowland were the smallest, with the smallest mean shell height and width, aperture height and width and number of whorls. The shells from the Alpine Region had the largest apertures in terms of height and width. The shells from the Fennoscandian Peninsula had the greatest mean shell height and number of whorls. The shells from the Carpathian Region were the widest and showed the greatest range of variation.



IN MEMORIAM OF PROFESSOR ADOLF RIEDEL

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Professor Adolf Riedel was born on the 24th of February 1930 in Brwinów near Warsaw, where he lived all his life. He studied biology at Warsaw University in 1947–1952. In 1952 he obtained his philosophy master's degree in zoology at the Faculty of Biology and Earth Sciences, Warsaw University, in 1959 – doctor's degree, in 1967 – habilitation degree. He became extraordinary professor in 1974, and ordinary professor in 1991. The whole of Professor Riedel's scientific career was associated with the Museum and Institute of Zoology, Polish Academy of Sciences [MIZ PAS] in Warsaw. Professor Riedel held numerous positions both at the Polish Academy of Sciences and in other scientific institutions (Head of Invertebrate Department of MIZ PAS in 1956–1972, Deputy Director for General Affairs of MIZ PAS in 1971–1977, Head of the Museum of Zoology of MIZ PAS in 1974–1975, Scientific Deputy Director of MiZ PAS in 1978–1981, Head of Department of Morphology and Systematics of MIZ PAS in 1981–1988). During several consecutive terms he was a member of the Central Qualification Commission (CKK) (1983–1988) and then member of the State Committee for Scientific Degrees and Positions (1991–1993). At the same time he was a member of the Presidium (1984–1986) and Vice-President (1987–1989; 1990–1992) of the Committee of Zoology, Polish Academy of Sciences. Professor Adolf Riedel was editor in chief of the series "Fauna Polski" [Fauna of Poland] (1970–1998) and editor and/or member of editorial boards of several scientific journals published by the Polish Academy of Sciences during several decades. He was referee of many doctoral and habilitation theses, and author of numerous opinions on applications for professorships. Professor Riedel was a member of several Polish and international scientific societies. Professor Riedel dealt with systematics, faunistics and biogeography of terrestrial snails; he was especially interested in Zonitidae and the results of his studies contributed immensely to the knowledge of this family. He published more than 170 scientific papers and enriched the Museum's collection with more than 40,000 specimens collected during his numerous field trips to various parts of the world. His immense zonitid collection is unique in Europe and the World. Professor Adolf Riedel died on August 21st 2010. We lost an outstanding malacologist, superb teacher and dear friend.

CEPAEA VINDOBONENSIS IN THE MAŁOPOLSKA GAP OF THE VISTULA RIVER

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Four papers report on the occurrence of *Cepaea vindobonensis* in the physico-geographical mesoregion of the Małopolska Gap of the Vistula: POLIŃSKI (1917, 1924), RIEDEL (1954) and MIERZWA (2009). They list localities in Nasiłów, Janowiec, Bochoznica, Kazimierz Dolny on the Vistula, and Anopol. Unpublished information (collection of MIZ PAS) pertains also to the above-mentioned localities. MINKIEWICZ (1934), BIELAWSKI (1949), PISARSKI (1950) and RIEDEL (1950–1951) collected voucher specimens in Kazimierz Dolny on the Vistula, MIERZWA (2007–2010) in Nasiłów and Janowiec, RIEDEL (1950) and MIERZWA (2007–2010) in Bochoznica. Twelve new localities of *Cepaea vindobonensis* in the Małopolska Gap of the Vistula were found in August 2010: Dębno, Biedrzyków, Nowe, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Dorotka, Ciszycza Górna, Piotrowice, Kaliszany, Kluczkowice, Piotrawin and Raj.

OCCURRENCE OF *CEPAEA VINDOBONENSIS* IN POLAND – NEW DATA

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My field studies in 2006–2010 provided new data on the occurrence of *Cepaea vindobonensis* in Poland. Additional information was obtained from A. LIANA, T. HUFLEJT and A. EIBICH. The records were located in 30 towns and villages: Murzynowo (HUFLEJT 2006), Dobrzyń on the Vistula (MIERZWA-SZYMKOWIAK 2008), Włocławek (MIERZWA-SZYMKOWIAK 2008) – Płock Basin; Łomna (EIBICH 2006), Łomna-Las (MIERZWA-SZYMKOWIAK 2006), Wilkowice (HUFLEJT & LIANA 2006), Wyszogród (HUFLEJT & LIANA 2006) – Warsaw Basin; Górki (MIERZWA-SZYMKOWIAK 2005–2006, 2008–2010), Ostrówek (MIERZWA-SZYMKOWIAK 2008), Otwock Wielki (MIERZWA-SZYMKOWIAK 2008), Skurcza (MIERZWA-SZYMKOWIAK 2006, 2008, 2010) – Middle Vistula Valley; Przyłęk (HUFLEJT 2008) – Radom Plain; Kielniki (MIERZWA-SZYMKOWIAK 2009–2010) – Częstochowa Upland; Gacki (MIERZWA-SZYMKOWIAK 2009) – Solec Basin; Wola Morawicka (MIERZWA-SZYMKOWIAK 2009) – Szydłów Foreland; Dębno, Biedrzyków, Nowe, Kolonia Słupia Nadbrzeżna, Słupia Nadbrzeżna, Dorotka, Ciszycza Górna, Piotrowice, Kaliszany, Kluczkowice, Piotrawin, Raj (MIERZWA-SZYMKOWIAK 2010) – Małopolska Gap

of the Vistula; Podgórze, Zawichost (MIERZWA-SZYM-KOWIAK 2010) – Vistula Lowland. The specimens are deposited in the malacological collection of MIZ PAS in Warsaw.

REPRODUCTION OF *PISIDIUM CASERTANUM*, *P. GLOBULARE* AND *P. PONDEROSUM* – COMPARISON

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Many authors regard *P. ponderosum* Stelfox, 1918 as an ecological form, variety or subspecies of *P. casertanum* (Poli, 1791), while *P. globulare* Clessin, 1873 has been regarded as a distinct species for only a short time. The observations, conducted in 1997–1999 in the environs of Sapolno (NW. Poland), revealed the following differences in the reproductive biology of these three species. The mean number of juveniles released by adults of the same shell size differed and for example at the shell length of 4 mm was: *casertanum* – 13, *globulare* – 10, *ponderosum* – 43. The maximum number of offspring during the reproductive season was: *casertanum* – 37, *globulare* – 23, *ponderosum* – 75. The mean length of embryonic shell was: *casertanum* – 1.24 mm (range 0.78–1.79 mm), *globulare* – 1.38 mm (0.80–1.91 mm), *ponderosum* – 0.89 mm (0.53–1.29 mm). The embryonic shell height/length ratio was similar for *casertanum* and *ponderosum* (0.760 and 0.750, respectively), but was higher for *globulare* (0.793). In the laboratory juveniles were released by *casertanum* mainly in June and July (rarely somewhat earlier or later, by *ponderosum* from mid-May till mid-June (rarely later), while *globulare* released juveniles throughout the year (including winter); in all the samples collected in the field some adults contained shelled embryos.

CHANGES IN ANTI-OXIDATION DEFENCE OF THE ROMAN SNAIL DURING ENFORCED SPRING AESTIVATION

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Following winter torpor, the Roman snail leaves its winter shelter, feeds and prepares for reproduction; the spring is its most active season. The snails show a seasonal ability to counteract the effect of oxidation stress which is inevitable when coming out of winter torpor. Intensification of anti-oxidation defence was observed at the end of winter torpor, just before re-

sumption of activity, and in the summer when aestivation episodes are likely to occur. The objective of our studies was to check if and how the seasonal pattern of anti-oxidation defence changed as a result of aestivation enforced in the spring. Five groups of snails were examined: 1) induced to aestivate through food and water deprivation, 2) brought out of aestivation through spraying with water, 3) active, one day after coming out of aestivation; two control groups included snails: 4) active in the field and 5) kept active in the laboratory. The activity of antioxidation enzymes; glutathione peroxidase (GPX), reductase (GR) and transferase (GST) and the concentration of the main endogenous antioxidant – glutathione (GSH) were measured for the kidney, hepatopancreas and foot. Besides, the concentration of malonic dialdehyde (MDA) as the marker of lipid peroxidation (effects of free radical damage) was determined. Only the glutathione reductase did not undergo any activity changes. The peroxidase and transferase activity varied between the organs and groups. The peroxidase activity was the greatest in the kidney and the smallest in the hepatopancreas. The transferase activity was the greatest in the hepatopancreas and the smallest in the foot. The greatest differences between the organ in the GPX and GST activity were recorded for the group of snails coming out of aestivation, i.e. during the oxidation stress. The differences in the GST activity persisted still 24 hours after coming out of aestivation. No significant changes in the glutathione or MDA concentration were observed. The anti-oxidation defence in the Roman snail undergoes endogenous seasonal regulation, but our results suggest that it can be modulated by external factors. The studies were partly financed by grant NN304393238 from the Ministry of Science and Higher Education.

COLONISATION AND ADAPTATION IN A TRANSPLANT EXPERIMENT OF THE POLYMORPHIC LAND SNAIL *CEPAEA NEMORALIS* AT THE GEOGRAPHIC RANGE LIMIT

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At the eastern margins of the species range in Europe, populations of *Cepaea nemoralis* occur only in urban environments to which they are possibly limited by relatively warmer climates (the urban heat island phenomenon). In 1999 we introduced 1,101 individuals of *C. nemoralis* originating from cities and towns in Podkarpacie (NE. Poland) to a rural location in the region. The snails colonised the new site and established an abundant and thriving population. This indicates that the pattern of distribution of the species



at the eastern range margin is dispersal- rather than climate-limited. The snails filled available habitats at a rate of approximately 400–600 m²/year. The average maximum speed of dispersal was 20 m/year. A rearrangement of the genetic structure of the population occurred: various morph frequencies changed over time, but the frequency of yellow effectively unbanded, a genetically amalgamate light-shell phenotype remained stable, suggesting that no directional selection affected the populations as a whole. The population adapted to local environmental gradients. In an area of 0.3 ha there were 3 open and 4 shaded interspaced habitats. After 11 years (less than 4 snail generations), frequencies of light shells were repeatably higher in the open compared to adjoining shaded habitats, which is attributable to visual and/or climatic selection. These observations indicate extremely small temporal and spatial scales of adaptation during initial phases of population establishment and spread.

MOLLUSCS OF THE POLISH BALTIC

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The list is based on publications on the Baltic molluscs and benthos and the collections available to the authors; it includes all gastropod and bivalve species recorded from the area between the Gulf of Pomerania and Arconian Basin in the west to the Gotland Basin in the north and the Deep of Gdańsk and Gulf of Gdańsk in the east. The malacofauna of the waters of the Baltic coast: Szczecin Lagoon, Vistula Lagoon, river estuaries and coastal lakes, was also analysed. Eighty three mollusc species were recorded from the Polish part of the Baltic and sea-connected waters: 36 bivalves and 47 gastropods. Freshwater molluscs recorded from the much freshened bays, estuaries and lakes constituted a considerable proportion. They were mainly Sphaeriidae (20 species), Lymnaeidae (9) and Planorbidae (14). A total of 188 mollusc species were recorded from the whole of the Baltic; they represent five classes: Polyplacophora (5 species), Scaphopoda (1), Bivalvia (62), Gastropoda (115), Cephalopoda (5). The number of species decreases distinctly eastward, with decreasing salinity. The malacofauna of the Polish Baltic includes a group of species which are characteristic of brackish and sea waters: *Mytilus trossulus* Gould, *Astarte borealis* (Schumacher), *A. elliptica* (Brown), *Cerastoderma glaucum* (Poiret), *Parvicardium hauniense* (Petersen et Russel), *Macoma balthica* (Linnaeus), *M. calcarea* (Gmelin), *Mya arenaria* Linnaeus, *Hydrobia acuta*

neglecta (Muus), *Peringia ulvae* (Pennant), *Ventrosia ventrosa* (Montagu), *Pusillina inconspicua* (Alder), *Rissoa membranacea* (J. A. Adams), *Eubranchus pallidus* (Alder et Hancock), *Alderia modesta* (Lovén), *Limapontia capitata* (O. F. Müller), *Onchidoris muricata* (O. F. Müller). The most common and abundant bivalves are *M. trossulus*, *C. glaucum* and *M. balthica*. Abundant and fairly widespread brackish snails include *P. ulvae* and *V. ventrosa*. The most interesting fauna was found in the Bay of Puck, but because of the pollution and disappearance of wattens the molluscs became extinct (e.g. *Hydrobia acuta neglecta*) or are seriously endangered.

THE EFFECT OF SYNTHETIC PYRETHROIDS ON THE INTENSITY OF FEEDING OF *ARION LUSITANICUS*

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Synthetic pyrethroids are very effective, photo- and thermostable biocides which are commonly used to protect agricultural and orchard crops. Our studies were to check if and to what extent selected insecticides of the pyrethroid group affected the quantity of food consumed by the invasive pest slug *Arion lusitanicus*. In 2007–2008 we studied food preferences of adult individuals of the species. The slugs were subject to contact and food intoxication (pesticide-treated food fragments) with Bulldock 025 EC (beta-cyfluthrin), Karate Zeon 050 CS (lambda-cyhalothrin), Decis (deltametrin), Fastac 100 EC (alpha-cypermethrin) and Sumi-Alpha 050 EC (esphenvalerate). The results indicate that the quantity of food consumed by the slugs which had previous contact with any of the tested pyrethroids, irrespective of the form of intoxication, was statistically significantly different from the quantities consumed by the control slugs; the differences depended on the chemical used and on the time elapsed from the beginning of the experiment.

AQUAPORES IN LYMNAEID SNAILS

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Selective transport of substances through the cell membrane is the basis of maintaining optimum conditions inside the cell. The discovery of aquapores has made it possible to explain how some cells are able to

transport considerable quantities of water across their membrane. The existence of aquapores not only renders increased water transport possible; it also permits regulation of the process, thus ensuring water homeostasis of single cells and whole organisms. The common occurrence of aquaporines – the proteins building aquapores – testifies to their essential function. They are responsible for the correct course of many physiological processes in animals, plants, fungi, bacteria and archaeons. Most aquaporines detected to date in invertebrates are most similar to the mammalian AQP-4, which plays important roles, i.a. in the nervous, respiratory and excretory systems. There are no literature data on mollusc aquapores. To verify the presence of aquaporines in molluscs we analysed all mollusc nucleotide sequences in the GenBank which showed a similarity to the known aquaporines. Three such sequences from three mollusc species were found and compared. Oligonucleotides, specific to conservative fragments of aquaporines and designed on this basis, were used as primers for PCR reaction. As a result of amplification of cDNA from three lymnaeid species: *Lymnaea stagnalis* (Linnaeus, 1758), *Stagnicola palustris* (O. F. Müller, 1774) and *Catascopia occulta* (Jackiewicz, 1959), we obtained three sequences which showed distinct similarity to the already known aquaporines. We performed bioinformatic analysis of the resulting cDNA fragments coding for aquaporines. Like other known invertebrate aquaporines, they resembled the mammalian AQP-4.

REPRESENTATIVES OF THE GENUS *MONACHA* IN POLAND

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The genus *Monacha* in Europe is represented by 39 species (Fauna Europaea; <http://www.faunaeur.org>), only one of which – *Monacha (Monacha) cartusiana* (O. F. Müller, 1774) – has been recorded from Poland. Though the original distribution range of the species includes western and southern Europe, its eastward and northward expansion has been reported increasingly often. In Poland it has been found in Wrocław, in the environs of Kielce and in Poznań. The snails from the Wrocław and Poznań populations differ morphologically (the Kielce population was not examined). The snails from Wrocław are much smaller than those from Poznań, and are dark-pigmented, while the Poznań snails are light cream-coloured. The differences involve the structure of the genitalia: in the Wrocław snails the genitalia correspond to the literature descriptions of *M. cartusiana*. The specimens from Poznań differ from them at least in two respects:

i) more or less equal length of penis and epiphallus (penis:epiphallus ratio in *M. cartusiana* is ca. 1:2) and ii) evenly tapered, conical shape of appendicula (in *M. cartusiana* it has the form of inverted club, widened at the outlet to the vagina). Besides, the entire reproductive system of the Poznań snails is slender, as a result of different proportions and shape of its components, compared to the specimens from Wrocław. The differences suggest that the two populations may not be conspecific. Fragments of nucleotide sequences *COI*, *ITS2*, *16S* and *28S rRNA* from these populations were analysed, and considerable molecular differences were found. The differences in the barcode sequence (*COI*) were 15%, which may mean that two different species are concerned. Using data from the GenBank we confirmed the correct identification of the Wrocław specimens as *M. cartusiana*. We found no molecular data which would make it possible to identify the snails from the Poznań population. Phylogenetic analyses often place it close to *Monacha cantiana*, but our specimens differ from that species in their shell morphology.

THE GENUS *LEIOSTYLA* (GASTROPODA: PULMONATA) – RELATIONSHIPS AND DISTRIBUTION

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The group of species included by some authors in the genus *Leiostylia* Lowe, by others in the genera *Leiostylia* Lowe and *Euxinolauria* Lindholm (the latter with many subgenera) includes nearly 50 extant and a few fossil species. The extant species are almost exclusively associated with the relic Tertiary forests which have been preserved in the Lesser and Great Caucasus (15 species) and the Atlantic islands: Madeira (28), the Azores (2–3) and the Canary Islands (2). Only one species occurs on the western fringes of Europe and the northern fringes of Africa. Finding several fossil species in the Tertiary deposits of Austria, France, Germany and Italy might suggest that the present disjunct distribution is a remnant of an erstwhile continuous range. The conchological characters, especially the structure of apertural barriers, indicate monophyly, whereas the structure of the genitalia makes it possible to divide the group into subgroups. Each such subgroup occurs in more than one of the component areas of the range, and the two main areas: Madeira and the Caucasus, are inhabited by members of several – and the same – groups each.



This suggests that the evolution and dispersal of the subgroups of different anatomical structure may have taken place before the distribution range became fragmented. Consequently, the species within each component area of the range would not necessarily have to be related among themselves closer than any of them is to species from other areas. In order to test this hypothesis we collected material in all the areas in question. Preliminary results of molecular analyses seem to confirm our view: for example, one of the Azorean species is much more closely related to a Caucasian species than the Caucasian species are among themselves. The studies are in progress.

SEASONAL CHANGES OF AGE STRUCTURE IN A POPULATION OF *ARIANTA ARBUSTORUM* (LINNAEUS, 1758)

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Arianta arbustorum (Linnaeus, 1758), a European species which is common in almost entire Poland, inhabits lowland and montane (up to 2,700 m a.s.l.) damp forests of various kinds, as well as parks, gardens, cemeteries and meadows. Its age structure and growth rate were monitored from May till October 2010, in a population in the north-western part of Wrocław. Each month the snails (23 to 123, depending on the month; total 530) were collected during two hours from a forest plot of ca. 20 m². Their whorls were counted, and their shells were marked with nail varnish in such a way that it was possible to read the shell increment on recapture; then they were released. Eight age classes were distinguished: seven immature and one adult. The smallest juveniles, representing the two youngest classes, were present only in May and in September/October, suggesting that *A. arbustorum* laid eggs in the spring and at the end of summer. The earliest-hatched snails reached four whorls in the same season; most juveniles hibernated when their shells had 2.6–3.5 whorls. The mean time of formation of one whorl (smaller juveniles; first phase of growth) was 20–30 days (1–1.5 whorl per month). Adult size was reached during the next season. Adults were present during the whole study period but were the most numerous in June and July.

COLOUR MORPHS OF *CEPAEA NEMORALIS* (L.) DIFFER IN SHELL RESISTANCE TO CRACKING

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Evolution and maintaining of shell colour polymorphism in populations of *Cepaea* constitute a model problem of evolutionary ecology. Predation pressure and microclimatic selection are regarded as the most important factors which affect the phenomenon, but there is no cohesive theory which would explain the mechanism of selection. Intensive studies on the effect of cryptic colouration and morph frequency in populations of *Cepaea* on birds' preferences revealed no clear pattern. Mechanical resistance of shells of different morphs, which is crucial from the predator's point of view, was not studied before. We examined mechanical resistance of shells of 192 adult *Cepaea nemoralis* (Linnaeus, 1758) representing five morphs from one population. The resistance was positively correlated with the individual size (the first component was based on mutually correlated fresh mass, shell width and spire height). Pink and yellow mid-banded shells were significantly more resistant to cracking than yellow unbanded and yellow five-banded shells. The apex region was much less resistant than the lip region. It seems that the presence of the mid band is correlated with greater resistance to cracking which in turn may deter the predator and increase the snail's chances of survival. The studies are part of the project aimed at ascertaining the dependence between the preferences of song thrushes and small mammals and the mechanical resistance of shells of various morphs of *C. nemoralis*.

DIVERSITY OF CERCARIAE OF DIGENETIC TREMATODES IN SELECTED SNAIL SPECIES

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Intermediate host-specificity varies among trematode species. For example *Fasciola hepatica* in our climatic zone has a wide ultimate host spectrum and only two intermediate hosts: *Galba truncatula* and *Catascopia occulta* (in the laboratory also *S. palustris*). From among larvae which occur in molluscs, cercariae are used in faunistic studies because of good diagnostic characters which sporocysts or rediae lack. Information on the species composition of trematodes in snail populations is a valuable contribu-

tion to the characteristics of local biodiversity. Contrary to vertebrate hosts, snails, being almost sedentary, constitute constant faunal components of the areas which are studied with respect to their biodiversity. We examined snails from three water bodies of the Brodnickie Lakeland. The cercariae were identified based on anatomical and morphological characters, with the use of light microscope and SEM. They represented three main morphological groups: furcocercariae, echinocercariae and xiphidiocercariae. The techniques applied made it possible to observe such characters as the armature in the region of the oral sucker, arrangement of flame cells, structure of urinary bladder and chaetotaxy. In order to identify the species it was necessary to identify the first intermediate host.

MOLLUSCS AS TECHNICAL MODELS

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Very innovative products appear on the market rather rarely. Nature-oriented design methods based on natural solutions seem promising in this respect; after a proper modification, natural models may serve as inspirations for innovative technical solutions. Phenomena which may be essential form the technical point of view are either discovered as a side effect of natural history studies, or solutions to technical problems are deliberately sought among models already existing in nature. Though molluscs are not the focus of interest of designers and constructors of machines and devices, there are several good examples of mollusc-based technical solutions. The aspects of mollusc structure and life used in these cases are: structure of shell-forming material, snail crawling and cephalopod swimming. The recently discovered deep-sea snail *Crysmallon squamiferum* from the Indian Ocean has an unusual structure. Both its shell and its foot-covering scales are multilayered. The layers suppress and absorb energy during attacks of a predator. Their structure will provide a model for new generation bullet-proof jackets. Robots based on mollusc crawling are few. The studies on snail crawling done at the Massachusetts Institute of Technology MIT (USA) resulted in construction of two robots of different kinematics. One of them, RoboSnail, has a rubber elastic foot, the other, Snailbot, has its foot composed of five movable segments and can crawl on vertical walls. The device for cleaning aquaria produced by AquaGenesis is also snail-based, and the Japanese company Tamiya produced a toy snail which can move along a black-marked line. Studies on slow swimming of cephalopods are more numerous. A swimming device constructed at the University of Osaka moves using flippers which make undulating

motion. A model of similarly swimming device based on squid swimming was designed at the Technical University in Kraków. One of the recent and most interesting solutions is the swimming robot built at the Fraunhofer Institute (Bremen) in cooperation with the German Institute for Artificial Intelligence DFKJ. This octopus-based robot has a very rich, inbuilt structure of nanosensors of various kinds. The nanosensors enable it to move, bypass obstacles and work automatically at great depths. There is no information about technical solutions based on cephalopod jet propulsion.

THE OCCURRENCE OF *STAGNICOLA TURRICULA* (HELD, 1836) (GASTROPODA: PULMONATA: LYMNÆIDAE) IN UPPER SILESIA

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Stagnicola turricula (Held, 1836) is one of the 11 lymnaeids occurring in Poland. In Upper Silesia it was first found in 2006. In order to ascertain the environmental factors that determine its occurrence, as well as that of its accompanying species in Upper Silesian localities, we undertook a whole-year monitoring. It included two water bodies (sites 1 and 2) near Tarnowskie Góry. Qualitative-quantitative samples were taken every month from May 2009 till May 2010 (except the period December–February) from plots of 1 m². Physico-chemical parameters of the water and content of organic matter in the bottom deposits were also analysed. Anatomical examination of the reproductive system of *S. turricula* showed that the length ratio praepitium:penis sheath was 1:2.5. The shell height ranged from 2.1 mm (November) to 19.5 mm (July). *S. turricula* was present in the two sites during all the study period, but only in site 1 it was present in all the samples. The density was 7–49 indiv./m² in site 1 and 1–8 indiv./m² in site 2. The whole malacocoenosis included 11 species of snails and five species of bivalves. Depending on the month, the number of species in site 1 ranged from five to nine, in site 2 – from three to 11. In both sites *Pisidium subtruncatum* Malm, 1855 was eudominant. Dominants were *Anisus spirorbis* (Linnaeus, 1758) in site 1 and *Planorbis corneus* (Linnaeus, 1758) and *Gyraulus albus* (O. F. Müller, 1774) in site 2. The values of Shannon-Wiener index were 1.51 in site 1 and 2.74 in site 2. Redundance analysis (RDA) showed that the most important factors determining the occurrence of molluscs, including *S. turricula*, were the content of organic matter in the bottom deposits and water pH.



ORGANISATION OF MITOCHONDRIAL DNA IN DREISSENID BIVALVES

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In contrast to vertebrates, invertebrates and especially bivalves display a variety of organisation of mtDNA. The variation involves the size (from 15,712 bp in *Cristaria plicata* to 32,115 bp in *Placopecten magellanicus*), the number of genes (e.g. absence of gene *atp8* in oysters, extra tRNA gene for methionine in several unrelated families, extra gene of unknown function in unionids) and their sequence and way of coding: on H or L strand of mtDNA. The arrangement of mitochondrial genes in the two studied species of *Dreissena* (*D. polymorpha* and *D. bugensis*) is different from other, previously described mitochondrial genomes in bivalves. Mitochondrial genomes of *Dreissena* have two blocks of protein genes on the opposite strands of DNA, with a greater number on H strands.

THE OCCURRENCE OF *THEODOXUS DANUBIALIS* (MOLLUSCA: GASTROPODA: NERITIDAE) IN UKRAINE

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The exact number of species of *Theodoxus* Montfort, 1810 in the rivers of Ukraine is still unknown because of the differences of opinion on their taxonomy. According to STAROBOGATOV (1977) in Ukraine the genus is represented only by *Th. fluviatilis* (L., 1758), while ANISTRATENKO & ANISTRATENKO (2001) think that there are four more species: *Th. danasteri* (Lindholm, 1908), *Th. sarmaticus* (Lindholm, 1908), *Th. euxinus* (Clessin, 1885) and *Th. velox* Anistratenko, 2001. None of these authors mentions *Th. danubialis* (Pfeiffer, 1828), and ANISTRATENKO & ANISTRATENKO emphasise that it can not be found in Ukraine, including the Danube, because in that river it occurs only above the Iron Gate. We examined snails of the genus *Theodoxus* collected in 1964–2007 from 139 localities in Ukraine, as well as specimens from conchological collections of various museums (Kiev, Lvov, Moscow, St. Petersburg). Because of the very subtle conchological differences between the species we used, besides the traditionally used characters, new conchological characters, electrophoregrams of muscle proteins and modern statistical methods (STATISTICA 6.0). We also considered the original description of *Th. danubialis*. In Ukraine *Th.*

danubialis occurs only in the lower reaches of the Danube. Also the museum collection in Kiev contains specimens of *Th. danubialis* from the lower Danube. Other records of *Th. danubialis* from other regions of Ukraine are not reliable. The species is a reophile found in waters of high oxygen content, β -mesosaprobic class and fast current (0.6–1 m/sec.). It is most often found on stones within reach of shore waves, at the depth of 0.1–0.4 m (sometimes up to 1 m). It prefers water of neutral pH. The population density does not exceed 30–40 indiv./m².

THE EFFECT OF TEMPERATURE AND PESTICIDES ON FEEDING BEHAVIOUR OF *ARION LUSITANICUS*

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Arion lusitanicus originally occurred in the Iberian Peninsula. Today this invasive species is found in the whole of Europe, including Scandinavia. Like most terrestrial gastropods, *A. lusitanicus* is not very susceptible to the effect of synthetic pesticides, but even a small effect may prove essential from economic point of view. The aim of the studies was to check to which extent the temperature and selected pesticides affected the quantity of food consumed by *A. lusitanicus*. The experiments were conducted in July–September 2007 and 2008; we used adult *A. lusitanicus* and pesticides of the following groups: pyrethroids (esphenvalerate), phosphoorganic compounds (diazinon) and bensoil-urea compounds (teflubenzuron). The tests were run at the temperature of 22 and 16°C. Two ways of intoxication were applied: through food (apples from pesticide-free orchards) and on the body surface. Irrespective of the way of intoxication the food consumption of intoxicated slugs differed significantly from that of the control group. The differences depended on the kind of pesticide and on the temperature.

SELECTED PESTICIDES AS FOOD ATTRACTANTS FOR *ARION LUSITANICUS*

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Some components of plant protection chemicals may constitute food attractants for the species that are supposed to be controlled. The problem arises when the chemicals prove attractive to species we do not

mean to control. We wanted to check if food treated with insecticides from several groups was more attractive to *Arion lusitanicus* than untreated food. The experiments were conducted in July–September 2007 and 2008; we used adult *A. lusitanicus* and pesticides of the following groups: pyrethroids (esphenvalerate), phosphoorganic (diazinon), bensoil-urea (teflubenzuron) and neonicotinoid (acetamiprid) compounds. Apples from pesticide-free orchards were used as food. Observation of food preferences of the slugs lasted three days; the slugs had access to both treated and untreated food. None of the tested pesticides showed deterrent properties, but the statistically significant differences in consumption of the two kinds of food indicate that the pesticides may constitute potential food attractants for the slug.

DISTRIBUTION OF MELANOPSIDAE (MOLLUSCA, GASTROPODA) IN UKRAINE

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Melanopsidae are freshwater snails distributed in Southern Europe, Middle East, South-Eastern Asia, New Caledonia and New Zealand. In Ukraine they are represented only by *Fagotia acicularis* (Férussac, 1823) and *F. esperi* (Férussac, 1823), endemic to the Danube-Don zoogeographical province. In Ukraine they are distributed only in the basins of large rivers to the east of the Dnieper (the Danube, the Dniester, the Southern Bug, the Dnieper). The first information on Melanopsidae in Ukraine dates from 1830, when *F. acicularis* and *F. esperi* were mentioned for the first time. Later, dense populations of these snails were found in the Lvov region. The species were then regarded as common in the upper Dnieper. Numerous populations of *F. acicularis* and *F. esperi* were found in the southern Bug system; there was also information on their occurrence in the Danube basin and in the mid-Goryn. At present the distribution of these species in Ukraine is disjunct: its northern part includes the mid section of Goryn and its tributary Sluch. The northern border of the southern part of the range has shifted far to the south, and extends from Antonivka via Arkhangelsk, Pervomaisk – Mogyliv-Podilsky to Ataky. The melanopsids are reophiles, living in clean waters with current velocity of 0.01–2 m/s, although they mostly occur where the velocity is 1–1.5 m/s. The population densities of *F. acicularis* and *F. esperi* differ greatly, with the former being, as a rule, much higher. The species require oxygenation level not smaller than 12 mg O₂/l. They mostly occur in slightly acid, slightly alkaline and neutral waters (pH 4.9–8.1). Their optimum depth is 0.8 m, but they perform seasonal vertical migrations, from 0–0.4 m in warm sea-

sons, to 2 m when it is cold. They prefer stony and sandy-gravelly substrata. Abundant populations are found in the river sections with numerous chalk and marl outcrops. Sometimes the snails are found also on submerged water plants (*Typha latifolia*, *Nymphaea alba*). They are good indicators of water pollution with organic substances, since they live only in the β-mesosaprobic zone. The analysis of the present and past melanopsid distribution in Ukraine shows a marked decrease in the number of populations and in their density. The main reasons for their disappearance are river regulation and industrial pollution.

CONTRIBUTION TO THE KNOWLEDGE OF BIOLOGY AND COMMERCIAL EXPLOITATION OF THE ROMAN SNAIL (*HELIX POMATIA* L.)

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Helix pomatia leave their winter shelters in April and the beginning of May, and mate from mid-May till mid-June; fewer copulating couples are encountered even till the end of August. The egg-laying and hatching occur mainly at the end of June and in the first half of July; single egg-laying snails may be observed even in the autumn. Thus the reproduction (copulation, egg-laying, hatching) takes place in the period between mid-May and end of July. There are no data on natural mortality in the Roman snail populations. Four-year observations of 12 large populations in Wielkopolska showed that a distinct period of natural dying out started just after the reproductive period and became more marked till September. Ascertaining mortality in the winter will require more studies. Companies purchasing the Roman snail operate in May. Because of the weather, in some regions of Poland the snails sometimes appear earlier in the spring; hence some such companies apply for permissions to start operating earlier, at the beginning or in the middle of April. Earlier catches would pose an additional threat to the populations. In that period, during cold nights or ground frost, the snails stay inactive and are easy to collect because the vegetation has not yet developed. At the same time, being starved after hibernation, they are lighter and thus more snails are required per kilogram.



GEOGRAPHICAL VARIATION OF
REPRODUCTIVE STRATEGY OF *ALINDA*
BIPPLICATA (GASTROPODA: CLAUSILIIDAE)

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Alinda biplicata (Montagu, 1803) is distributed over a large part of Europe: from southern England and Scandinavia to Bulgaria and northern Greece. In Poland it is common mainly in the south-west; it reaches its eastern distribution border along the Vistula and Wisłoka rivers. It is ovoviviparous and its life cycle is fragmentarily known. Our objective was to study its reproductive strategy in natural conditions, considering the differences resulting from the wide distribution. Samples of 30 adult *A. biplicata* were taken monthly from sites located in Poland, Germany and Hungary; the populations lived in areas under the effect of different climate types: oceanic, intermediate and continental. We determined the beginning of the reproductive season, time of appearance of juveniles, number of incubated eggs and degree of advancement of development of the embryos during the vegetation season. The results from spring months indicate inter-population differences in the course of reproduction (proportion of gravid individuals and degree of advancement of embryonic development) and fecundity (number of eggs). In the second half of April egg retention was observed in 10% of individuals from central Poland, 50% individuals from western Germany and 70% of those from Lower Silesia and Hungary. At that time only individuals from Hungary contained developmentally advanced embryos (embryonic shell of 2.5–2.9 whorls). In May the proportion of gravid snails in all the populations ranged from 60% to 75%, and the embryos were at various development stages. In June the proportion of egg-incubating individuals exceeded 90%. Most of the embryos were of the same size as juveniles found in the field.

MALACOLOGICAL AND PALYNOLOGICAL
EVIDENCE OF EARLY PLEISTOCENE COOLING
OF THE CLIMATE IN THE CARPATHIAN
FORELAND

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During the geological drilling in the Carpathian Foreland, organic deposits containing shells and plant remains were found in one of the cores (Jawornik, bore 3); they were located at the depth of 55.0 to 38.9 m, below glacial drift. Thirteen terrestrial snail taxa which formed two different assemblages were identified in 55 deposit samples. The lower part (55.0–49.0 m) contained a typical assemblage of cold-loving species, till now known mainly from the Vistulian deposits, with *Vallonia tenuilabris*, *Pupilla loessica*, *Vertigo genesii* and *Columella columella*, while the upper part (49.0–38.9 m) held only one species – *Semilimax kotulae*. The sequence suggests that in the first stage the climate was cold and continental but the prevailing habitats were not necessarily tundra and steppe-tundra with wetlands. Most species, which are regarded as indicative of cold Pleistocene phases in Central Europe and which are still extant in other regions, live also in shaded habitats, such as shrub thickets and sparse forests, with the mean January temperature of –17°C. In the second phase the climate probably became somewhat milder, favouring spread of forests but causing disappearance of the cold-loving species, with only the montane *Semilimax kotulae* surviving. Pollen was found only in the upper part of the sequence, at 46.30–38.90 m. The plant assemblage included both Quaternary and Tertiary (Miocene) taxa; the state of preservation of the pollen and the number of sporomorphs suggested redeposition. Discounting the Quaternary taxa, the assemblage suggests a community of boreal pine forest. Considering the fact that the only level of glacial drift in the Carpathians dates from San 1 glaciation, and the shell-bearing deposits were located below it, the age of the fauna is no doubt Early Pleistocene. It is the oldest malacofauna of this type in Poland.

HISTOLOGICAL STRUCTURE OF THE VAGINA IN THREE CLAUSILIID SPECIES OF DIFFERENT REPRODUCTIVE STRATEGIES

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The gastropod vagina is the part of the reproductive system between the genital atrium and the junction with spermatheca duct. In the clausiliids *Cochlodina laminata* (Montagu, 1803), *Ruthenica filograna* (Rossmässler, 1836) and *Clausilia bidentata* (Ström, 1765) the morphological structure of the vagina is similar. The transverse section of the spermatheca duct in all three species is smaller than that of the free oviduct section; the vagina is always wider and more massive than the free oviduct. The vaginal muscular layer increases in thickness toward the atrium. The length ratio vagina:free oviduct varies between the species. In *C. laminata* the external part of the vaginal wall is a thick layer of longitudinal and circular smooth muscles. The internal layer is cuboid epithelium with numerous microvilli. Its cells are secretory and glycogen-rich. Glia cells with electron dense deposits, secretory cells with granules of medium electron density and cells with electron-light granules are scattered among muscle cells. The epithelium with the connective tissue forms wide and high folds. Toward the atrium the vaginal lumen narrows, the folds become higher and the muscular membrane – thicker. In *R. filograna* the external layer of vaginal wall is a thin layer of smooth muscles; the internal layer is built of high, cylindrical epithelium forming narrow, lamellate folds. The epithelial cells have numerous long microvilli, their cytoplasm is electron-dense and contains numerous cisterns of rough endoplasmic reticulum. Bottle-shaped mucus cells, located among the muscle cells, open between the epithelial cells. Their wide parts are filled by electron-light, flocculent secretion resembling mucus. The basal parts of the bottle-shaped cells contain nucleus, numerous cisterns of rough endoplasmic reticulum and Golgi structures. In *C. bidentata* the external layer of vagina is built of smooth, longitudinal and circular intertwining muscle cells. Bottle-shaped cells embedded in the muscular layer resemble those in *R. filograna* but their secretion is more electron dense. The epithelium lining the vaginal lumen is cylindrical and, like in *R. filograna* is folded, resulting in a serrated outline of the lumen. No bottle-shaped mucus cells were found in *C. laminata*; its secretory cells in the muscular layer are of different type.

MALACOFUNA OF THE MASOVIAN INTERGLACIAL FROM THE LOCALITY HRUD II NEAR BIAŁA PODLASKA

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Locality Hrud II is located in the western part of the interglacial lake between the villages Hrud and Ossówka, ca. 10 km N of Biała Podlaska. Eight samples of sandy deposits of the lake littoral, taken from the depth of 0.8–1.6 m, were examined. Twenty two taxa: eight species and one genus of snails, and 13 species and two genera of bivalves were identified. The number of taxa and specimens ranged from 13 to 19 and from 1,193 to 3,766, respectively, and decreased gradually upwards. The assemblage was dominated by *Valvata piscinalis*, *Viviparus diluvianus* and *Lithoglyphus jahni*. The presence of the last two species, combined with the palynological analysis, indicates the Masovian interglacial. All the molluscs were freshwater taxa. Species of permanent stagnant water bodies (though most can also occur in slow-flowing rivers) dominated; they included *Arniger crista* f. *nautilus*, *Acroloxus lacustris*, *Pisidium lilljeborgii*, those of flowing waters – *Pisidium amnicum*, *P. nitidum* and *Unio pictorum*. With respect to their abundance they formed an accessory component of the assemblage. The presence of *Valvata piscinalis* f. *antiqua* indicates the lacustrine character of the assemblage. It was probably littoral, where also rheophiles could find favourable conditions, but periodic flow can not be excluded. The values of Bithynia-index, increasing from 0.33 in the lower to 0.93 in the upper part of the profile, indicate gradual overgrowing of the lake with reeds and rushes. The small proportion of *Bithynia tentaculata* in the lower part of the profile may be associated with considerable acidity.

LOCOMOTORY ACTIVITY AND ION TRANSPORT IN THE EPITHELIUM OF TERRESTRIAL SNAILS

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We analysed filmed movement of snail's sole on a horizontal glass plate and changes of the image of small air bubbles under the sole during the passage of the wave. We could then conclude about changes of the pressure and the volume of mucus layer between



the sole and the glass. Ion transport was studied in vitro on fragments of snail's sole using Ussing's apparatus; the observations focused on reaction of transepithelial ionic currents to mechanical stimulation of sensory receptors. The sole of moving snail is divided into an immobile area which adheres to the substratum and constitutes ca. 70%, and a few to about a dozen mobile zones constituting ca. 30% of the sole surface. The mobile zones (sole waves) are narrow strips (each of about 3% of the animal's total length) visible on almost the whole sole width. The epithelium in the region of contraction, in the presence of air bubbles, is more remote from the substratum than in the region between the waves. The epithelium surface in that region is thus vaulted and folded above the substratum, and exceeds the area visible on the glass by at least 20%. When a point on the sole epithelium is crossed by the front of the contraction wave, the point is raised above the substratum and travels with the wave to be lowered onto the substratum at the end of the wave. Mechanical stimuli cause changes in transepithelial electric potential in the sole. The reaction may be of significance for the interaction between the epithelial cells and ionised mucus particles. The snail's adhesive movement results from a complex neural activity governing the body muscles, the muscles operating the epithelium and epithelial transport activity. Their mutual interactions in optimising the snail's locomotory activity is the subject of our further studies.

POPULATION CHARACTERISTICS OF *VIVIPARUS* (MOLLUSCA: GASTROPODA) IN UKRAINE

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At present the pollution of the Ukrainian rivers causes a decrease in abundance of many hydrobionts which in turn makes population monitoring necessary. Snails of the genus *Viviparus* are important components of aquatic ecosystems. They feed on detritus, can filter-feed, and thus contribute to water purification. The monitoring of natural *Viviparus* populations consists in estimation of their basic parameters, one of the most important being size-age structure. It makes it possible to assess the life span in different environmental conditions, annual recruitment of juveniles, growth rate, mortality level and survival. The purpose of this study was to analyse the population characteristics of *Viviparus viviparus* (Linnaeus, 1758) and *V. contectus* (Millet, 1813). The average age parameter was used to determine the age-size dynamics: an increase of its values indicates the decline of the numbers of juvenile age classes ("senescence" of the population), whereas its decline shows "rejuvenation" of the population. In various Ukrainian rivers, this para-

meter varied from 1.4 to 3.1. Very "young" populations of *V. viviparus* were found in anthropogenically polluted river Guyva (close to Zhytomyr) and in the Dnieper (near Kherson). A "young" population of *V. contectus* was observed in a lake in the village Pershotravneve (the Uzh basin). Comparatively "old" *Viviparus* populations occurred in the western parts of Ukraine (Khmelnitsk region): *V. viviparus* in the river Khomora and *V. contectus* in the Sluch. The number of individuals in particular age classes was estimated from the level of juvenile recruitment and mortality. The juvenile recruitment varied considerably in space and time. The maximum life span for *V. viviparus* (5 years) was recorded in the Kam'yanka River (Zhytomyr) and for *V. contectus* (6 years) – in the river system of Uzh and Tnya (Zhytomyr region). The minimum values (3–4 years) for *Viviparus* were observed in urban waters. The value of this parameter depends mainly on the mortality. The maximum mortality values (0.49–0.60) were recorded for *V. viviparus* from the Kam'yanka (near Zhytomyr) and the Sluch (Rivne region). The annual survival rate at these sites was less than 55–60%, which corresponded with the shortest life span. In the river Tnya and few lakes on Polesye, with good quality water, the mortality was at its minimum (survival ca. 80–90%), corresponding to the maximum life span. The low juvenile recruitment and high mortality of *Viviparus* result from the deterioration of their habitat quality. Urgent measures should be taken to protect *Viviparus* in the rivers of Ukraine.

REPRODUCTIVE BIOLOGY OF *OPEAS PUMILUM* (L. PFEIFFER, 1840) IN THE LABORATORY

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Opeas pumilum is a pulmonate (Stylommatophora: Subulinidae) from South America. In Poland it occurs only in the Poznań Palm House, where it has been introduced with tropical plants. Adults reach 1.4 mm shell height, the maximum number of whorls is 7–8, and the growth rate is ca. 1 whorl/month; having reached their maximum size the snails soon die. *O. pumilum* is an egg-retainer. Before egg-laying it digs holes in the substratum. Snails kept in the same containers usually use the same place for egg-laying. The egg-laying and hatching require very high humidity; when the humidity is low the eggs are retained for a longer time. Juveniles hatch about 24 hours after egg laying. The eggs are milky white or cream-coloured. Eggs still retained on death of the parent do not hatch but decompose; they are not eaten by the remaining individuals. Hatchlings hide under the substratum and show little mobility. The number of eggs

is correlated with the parent's size. The first eggs are produced when the parent has four whorls. With increasing number of whorls the number of eggs increases but their diameter decreases. The maximum number of retained eggs was five (parent of 7–8 whorls). Juveniles of the same batch, in spite of identical conditions and food abundance, develop at various rate and do not start reproducing simultaneously. In the wild *O. pumilum* occurs in tropical forests of high humidity (nearly 100%) and temperature (ca. 21.5°C), and we tried to create similar laboratory conditions. When it was too damp, the snails climbed high on the container's walls, when it was too dry they showed little mobility and a tendency to aggregate; when dried, they retracted deep into their shells. Too high or too low humidity inhibited feeding. The snails in the Palm House preferred juicy fruits (e.g. *Carica papaja*), fleshy leaves and shoots, as well as roots (e.g. *Selaginella uncinata*). In the laboratory they were fed apple, cucumber, lettuce and carrot; rotting food was also readily consumed. The snails were found to move towards sources of artificial light, but it is unknown if the attractant was light itself or temperature.

MOLLUSC RESOURCES OF THE SZCZECIN LAGOON AND Odra ESTUARY

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Comprehensive hydrobiological studies in the Polish part of the Szczecin Lagoon in 1998–2002 provided data to estimate the abundance and production of the main components of the biocoenosis, including macrobenthos and macrozooperiphyton in the whole lagoon. The total biomass of bottom macrofauna in the lagoon of 410 km² was 84 thousand tons wet weight (molluscs, including shells, constituted 83% of that value), and the production was 160 thousand tons wet weight (molluscs – 47%). The biomass of macrophyte-dwelling molluscs was nearly 1,100 tons wet weight, and the production was 2,150 tons wet weight. The total production of the malacofauna was: *Dreissena polymorpha* – 58,800 tons wet weight, Gastropoda and Sphaeriidae – 9,300 tons wet weight and Unionidae – 1,750 tons wet weight. It added up to the total of 69,850 tons wet weight (shells included). The data on the abundance of the zebra mussel were very close to those reported in the 1950s. The mussel plays a very important biocoenotic role (filtration, habitats for benthos), deposit-forming role (shells, faeces) and modifies some hydrochemical parameters. Molluscs were important components of the fish food, mainly benthos-feeders: *D. polymorpha*: the fish consumed annually nearly 13 thousand tons of the mussels, i.e. 22% of the annual

mussel production in the lagoon; most mussels were consumed by adult roach. Birds consumed only 1% of the mussel production. Other molluscs: the fish consumed 5 thousand tons wet weight of other molluscs per year (45% of annual mollusc production). Adult and juvenile roach and juvenile bream were the main consumers of Gastropoda and Sphaeriidae. Consumption by birds was less than 1% of the production. Molluscs were usually diet supplements for the fish; only for adult roach they were the main food (37%: 32.5% zebra mussel, 4.5% other molluscs).

CASES OF HERMAPHRODITISM IN THE UKRAINIAN POPULATIONS OF UNIONIDAE

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Palaeartic unionids are regarded as gonochoric and rarely hermaphroditic; their reproductive strategy is termed facultative hermaphroditism. Hermaphroditism is more widespread in the Nearctic unionids: three North-American species are obligate hermaphrodites and 14 of are facultative hermaphrodites. The aim of our research was to ascertain the sex status of several unionid species with different methods. We collected *Unio pictorum*, *U. tumidus*, *U. crassus*, *Anodonta cygnea*, *A. piscinalis*, and *Pseudanodonta complanata* in March–October 2005–2009 from water bodies and streams of the Central Polissya region. The sex status of all individuals (325) was checked on temporary microscope slides using traditional methods, and on permanent slides of the gonads. One hundred thirty five specimens were examined with the method used by North-American scientists (whole gonads). Two groups of specimens were distinguished based on the temporary slides: males and females. The histological slides of the gonad revealed numerous cases of hermaphroditism (12 out of 22 samples). The proportion of hermaphrodites varied from 4.6±2.0% in *U. tumidus* to 31.7±7.3% in *A. cygnea*. In the studied region, 11.8±1.8% of unionids were found to produce male and female gametes simultaneously. On investigation of the whole gonad, the proportion of hermaphrodites increased more than twice (27.4±3.8%). The reason for the difference between the results of these two histological methods is the different location of male and female acini and uneven proportion of male and female tissues in the gland. Hermaphrodites, males and females occurred in roughly the same proportions in all age classes. Thus, the reason for the higher level of hermaphroditism in European unionids is the accurate histological analysis of the whole gonad. Also, the changes in the population sex structure and the appearance of many hermaphrodites may be associated with the negative changes in aquatic ecosystems, resulting in a rapid de-



crease in the population density and facilitating trematode invasions.

CAN SNAILS RUN A FEVER?

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Increased body temperature as defence against pathogene invasion is shared by homoio- and poikilothermic animals. Poikilothermic animals increase their body temperature through migrating to microhabitats of higher temperature. The reaction, called behavioural fever, has been observed in reptiles, amphibians, fishes, arthropods and annelids. Molecular mechanism of fever in homoiothermic animals consists in binding pyrogen by the receptor, initiating a cascade of cytokins, which, binding with receptor of the blood-brain barrier, cause secretion of prostaglandin (PGE₂) in the brain. PGE₂ changes the tem-

perature set-point in the hypothalamus which is the direct reason for the fever reaction. Poikilothermic animals, including molluscs, are capable of producing various kinds of cytokins and also prostaglandins (PGA, PGF, PGE), of a structure similar to those metabolites in homoiothermic animals. This makes it possible to propose a hypothesis on the possible role of these substances in the course of behavioural fever. Attempts at evoking fever reactions in molluscs (two species of the genera *Lymnaea* and *Semisulcospira*), which were given pyrogen gave no positive results. No fever reaction was observed in representatives of *Lymnaea*, *Biomphalaria* and *Planorbarius* infected by digenetic trematodes. In our studies parasite-free adult *Planorbarius corneus* were exposed to two kinds of pyrogens: bacterial endotoxin (LPS) and a component of yeast cell wall (zymosan). Pyrogen injections caused an increase in thermal preferences of the experimental groups, compared to the control. Besides, the thermobehavioural reaction depended on the pyrogen dose. The latency time of behavioural fever in *P. corneus* was fairly long and dependent on the kind of pyrogen. The results suggest that *P. corneus* may serve as a model species for studies of fever processes in poikilothermic animals.